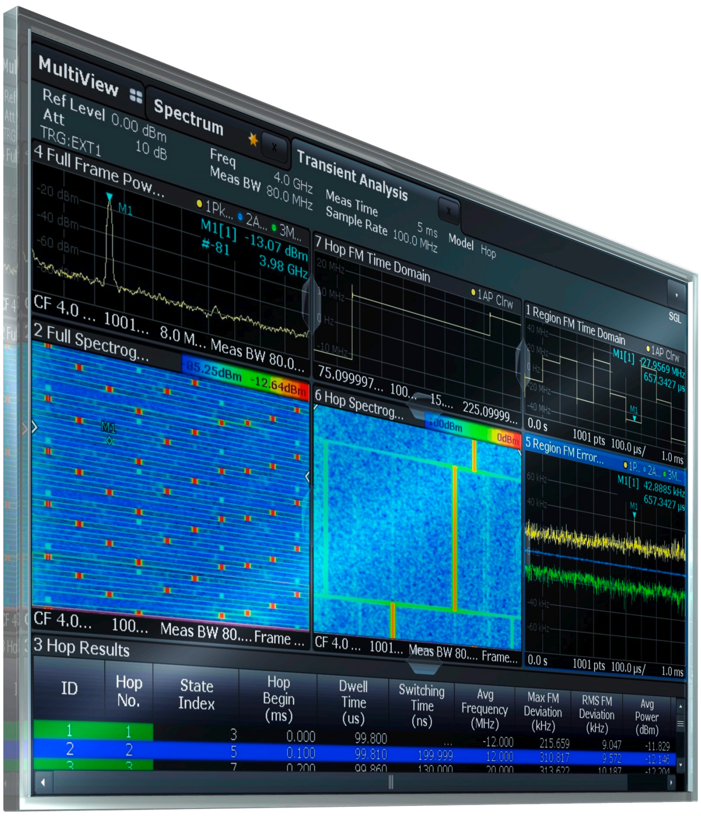
R&S®FSW-K60
Transient Analysis
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 2.40 and higher:

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

The following firmware options are described:

- R&S FSW-K60 Transient Analysis (1313.7495.02)
- R&S FSW-K60H Transient Hop Measurements (13122.9916.02)
- R&S FSW-K60C Transient Chirp Measurements (1322.9745.02)

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

Contents

1 Preface

1.1 About this Manual

This Transient Analysis User Manual provides all the information **specific to the application**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FSW User Manual.

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

- **Welcome to the Transient Analysis Application**
  Introduction to and getting familiar with the application
- **Measurements and Result Displays**
  Details on supported measurements and their result types
- **Measurement Basics**
  Background information on basic terms and principles in the context of the measurement
- **Configuration + Analysis**
  A concise description of all functions and settings available to configure measurements and analyze results with their corresponding remote control command
- **How to Perform Measurements in the Transient Analysis Application**
  The basic procedure to perform each measurement and step-by-step instructions for more complex tasks or alternative methods
- **Measurement Examples**
  Detailed measurement examples to guide you through typical measurement scenarios and allow you to try out the application immediately
- **Optimizing and Troubleshooting the Measurement**
  Hints and tips on how to handle errors and optimize the test setup
- **Remote Commands for Transient Analysis**
  Remote commands required to configure and perform Transient Analysis in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FSW User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Reference**
  File format description
- **List of remote commands**
  Alphabetical 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
- User manuals and online manual for base unit and options provided on the product page
- Service manual provided on the internet for registered users
- Instrument security procedures provided on the product page
- Release notes provided on the product page
- Data sheet and brochures provided on the product page
- Application notes provided on the Rohde & Schwarz website

You find the user documentation on the R&S FSW product page mainly at:

http://www.rohde-schwarz.com/product/FSW > "Downloads" > "Manuals"

Additional download paths are stated directly in the following abstracts of the documentation types.

Getting Started

Introduces the R&S FSW and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc.

Online Help

Offers quick, context-sensitive access to the information needed for operation and programming. It contains the description for the base unit and the software options. The Online Help is embedded in the instrument's firmware; it is available using the ? icon on the toolbar of the R&S FSW.

User Manuals and Online Manual

Separate manuals are provided for the base unit and the software options:

- **Base unit** manual
  Contains the description of the graphical user interface, an introduction to remote control, the description of all SCPI remote control commands, programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the **Getting Started** manual.
- **Software option** manuals
  Describe the specific functions of the option. Basic information on operating the R&S FSW is not included.

The **online manual** provides the contents of the user manuals for the base unit and all software options for immediate display on the internet.

Service Manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS).

Instrument Security Procedures

Deals with security issues when working with the R&S FSW in secure areas.

Data Sheet and Brochures

The data sheet contains the technical specifications of the R&S FSW. Brochures provide an overview of the instrument and deal with the specific characteristics, see:

http://www.rohde-schwarz.com/product/FSW > "Downloads" > "Brochures and Data Sheets"

Release Notes

Describes the firmware installation, new and modified features and fixed issues according to the current firmware version. You find the latest version at:

http://www.rohde-schwarz.com/product/FSW > "Firmware"

Application Notes, Application Cards, White Papers, etc.

These documents deal with special applications or background information on particular topics, see:

http://www.rohde-schwarz.com/ > "Downloads" > "Applications".

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.

Convention	Description
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.

1.3.3 Notes on Screenshots

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

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

2 Welcome to the Transient Analysis Application

The R&S FSW-K60 is a firmware application that adds functionality to detect transient signal effects to the R&S FSW.

The R&S FSW-K60 features:

- Analysis of transient effects
- Quick analysis even before measurement end due to online transfer of captured and measured I/Q data
- Easy analysis of user-defined regions within the captured data
- Analysis of frequency hopping or chirped FM signals (with additional Transient Analysis options)

This user manual contains a description of the functionality that the application provides, including remote control operation.

Functions that are not discussed in this manual are the same as in the Spectrum application and are described in the R&S FSW User Manual. The latest version is available for download at the product homepage.

Installation

You can find detailed installation instructions in the R&S FSW Getting Started manual or in the Release Notes.

2.1 Starting the Transient Analysis Application

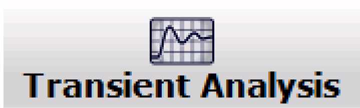
The Transient Analysis application adds a new application to the R&S FSW.

To activate the Transient Analysis application

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 "Transient Analysis" item.

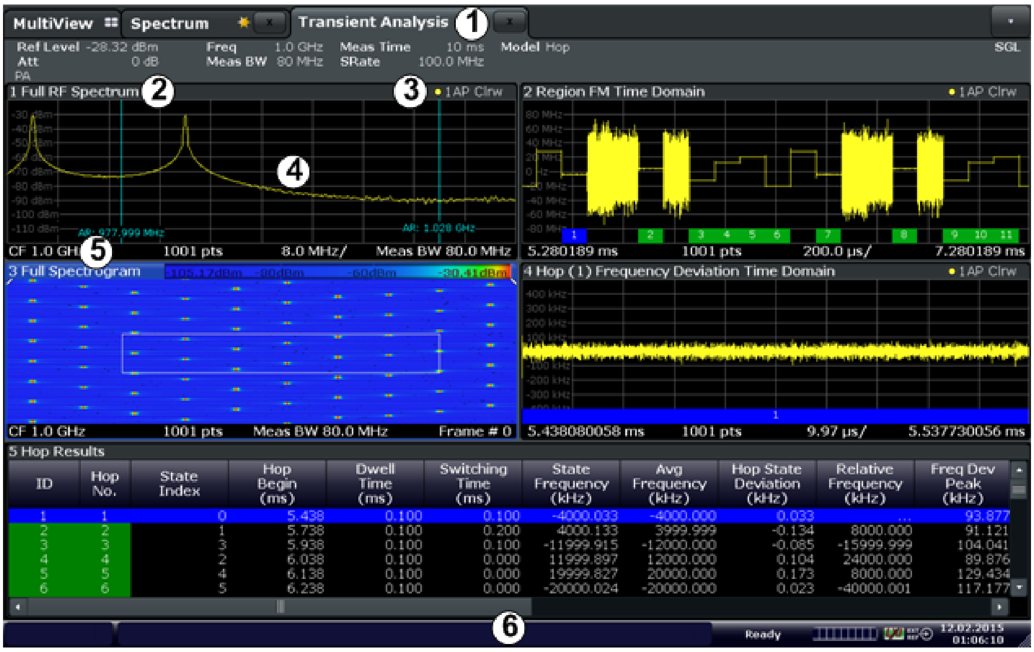
   

   The R&S FSW opens a new measurement channel for the Transient Analysis application.

The measurement is started immediately with the default settings. It can be configured in the Transient "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see Chapter 6.1, "Configuration Overview", on page 69).

2.2 Understanding the Display Information

The following figure shows a measurement diagram during analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.



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

MSRA/MSRT operating mode

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

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

Channel bar information

In the Transient Analysis application, the R&S FSW shows the following settings:

Table 2-1: Information displayed in the channel bar in the Transient Analysis application

Ref Level	Reference level
Att	RF attenuation
Freq	Center frequency for the RF signal
Meas BW	Measurement bandwidth
Meas Time	Measurement time (data acquisition time)
Sample Rate	Sample rate
Model	Signal model (hop, chirp or none)
SGL	The sweep is set to single sweep mode.

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

Window title bar information

For each diagram, the header provides the following information:

Figure 2-1: Window title bar information in the R&S FSW Transient Analysis application

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

Diagram footer information

The diagram footer (beneath the diagram) contains the following information, depending on the evaluation:

Time domain:

- Start and stop time of data acquisition
- Number of data points
- Time displayed per division

Frequency domain:

- Center frequency
- Number of data points
- Bandwidth displayed per division
- Measurement bandwidth

Spectrogram:

- Center frequency
- Number of data points
- Measurement bandwidth
- Selected frame number

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

3 About Transient Analysis

Transient analysis refers to signal effects which may appear briefly or change rapidly in time or frequency. Typical examples are spurious emissions or modulated signals using frequency-hopping techniques. Such signals often require analysis of a large bandwidth, if possible without gaps.

Ideally, such signals are analyzed in real-time mode, which employs special hardware in order to capture and process data simultaneously, and seamlessly. However, if a real-time analyzer is not available, the Transient Analysis application is a good choice.

Similarly to real-time mode, but without the special hardware, this application captures data and asynchronously - before data acquisition is completed - starts analyzing the available input and displays first results. Especially for large bandwidths or long measurement times, analysis becomes much more efficient and the complete measurement task can be sped up significantly. Although gaps may occur between successive measurements with large bandwidths, the results from each individual measurement are complete without gaps.

Thus, the Transient Analysis application supports you in analyzing time- and frequency-variant signals with large bandwidths.

4 Measurement Basics

Some background knowledge on basic terms and principles used in analysis of transient signals is provided here for a better understanding of the required configuration settings.

4.1 Data Acquisition

The R&S FSW Transient Analysis application measures the power of the signal input over time. How much data is captured depends on the measurement bandwidth and the measurement time. These two values are interdependant and allow you to define the data to be measured using different methods:

- By defining a bandwidth around the specified center frequency to be measured at a specified sample rate
- By defining a time length during which a specified number of samples are measured at the specified center frequency

4.2 Signal Processing

The R&S FSW Transient Analysis application measures the power of the signal input over time. In order to convert the time domain signal to a frequency spectrum, an FFT (Fast Fourier Transformation) is performed which converts a vector of input values into a discrete spectrum of frequencies.

The application calculates multiple FFTs per capture, by dividing one capture into several overlapping FFT frames. This is especially useful in conjunction with window functions since it enables a gap-free frequency analysis of the signal.

Using overlapping FFT frames leads to more individual results and improves detection of transient signal effects. However, it also extends the duration of the calculation. The size of the FFT frame depends on the number of input signal values (record length), the overlap factor, and the time resolution (time span used for each FFT calculation).

FFT window functions

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

Additional filters can be applied after demodulation to filter out unwanted signals, or correct pre-emphasized input signals.

Asynchronous data processing

During a measurement in the R&S FSW Transient Analysis application, the data is captured and stored in the capture buffer until the defined measurement time has expired. As soon as a minimum amount of data is available, the first FFT calculation is performed. As soon as the required number of (overlapping) FFT results is available (defined by the "sweep count"), the detector function is applied to the data and the first frame is displayed in the Spectrogram (and any other active result displays).

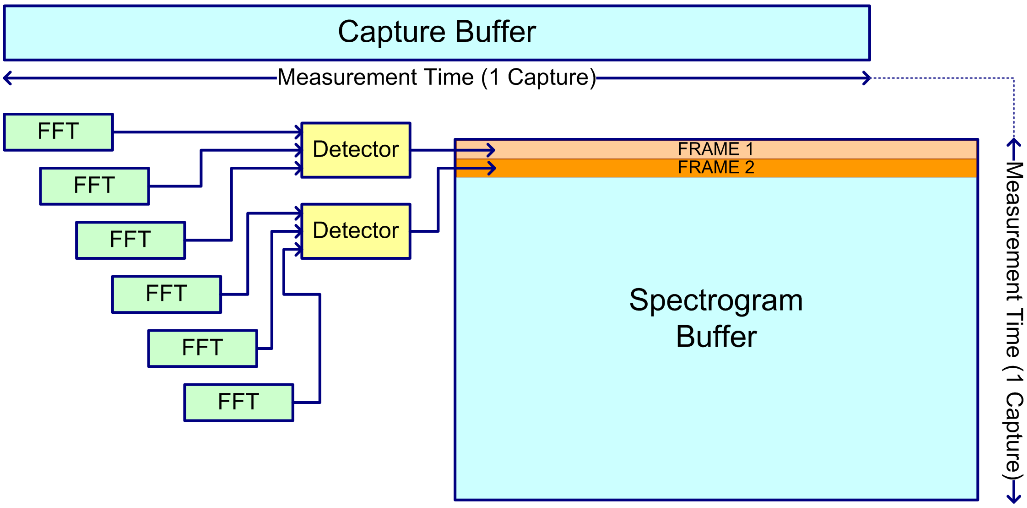


Figure 4-1: Signal processing: calculating one spectrogram frame

Shortly after the measurement time is over, the final results are displayed and the measurement is complete. Due to this asynchronous processing, initial analysis results are available very quickly. At the same time, the data is captured over the full bandwidth entirely without gaps. The following figure illustrates how the capture and result display processes are performed asynchronously.

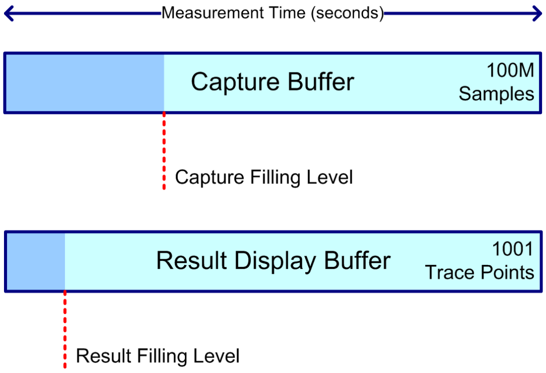


Figure 4-2: Asynchronous data processing

Multiple spectrograms

However, after each data acquisition, a short delay occurs before the next acquisition can be carried out. Thus, for measurements for which several spectrograms are required and the capturing process is repeated several times (defined by the "frame count"), a short gap in the results between spectrograms can be detected.

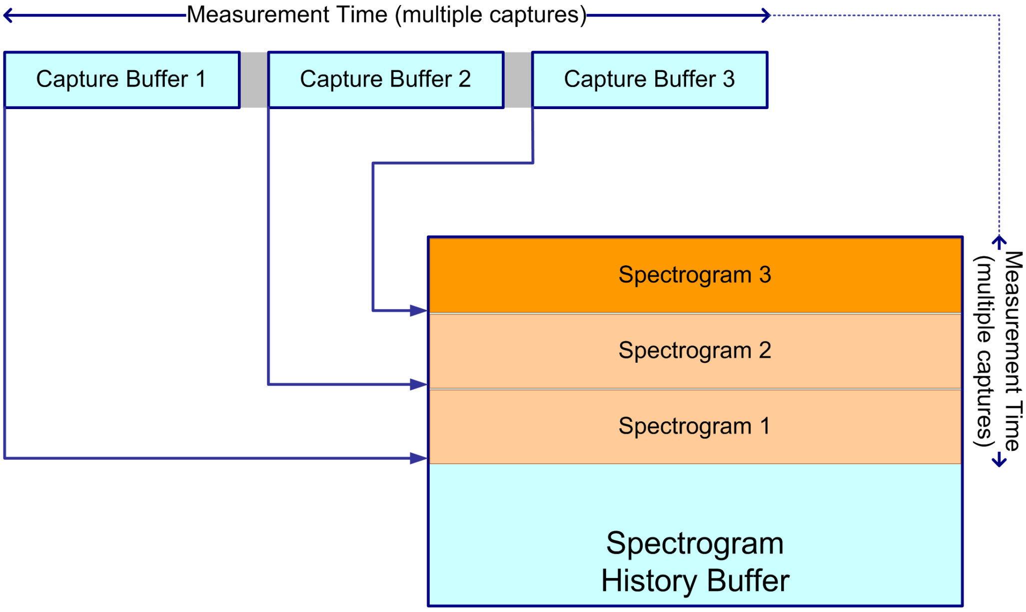


Figure 4-3: Signal processing: calculating several spectrograms

Resolution bandwidth

The resolution bandwidth (RBW) has an effect on how the spectrum is measured and displayed. It determines the frequency resolution of the measured spectrum and is directly coupled to the selected analysis bandwidth (ABW). The ABW can be the full measurement bandwidth, the bandwidth of the analysis region, or the length of the result range, depending on the evaluation basis of the result display (see Chapter 4.4, "Basis of Evaluation", on page 22). If the ABW is changed, the resolution bandwidth is automatically adjusted. Which coupling ratios are available depends on the selected FFT Window.

A small resolution bandwidth has several advantages. The smaller the resolution bandwidth, the better you can observe signals whose frequencies are close together and the less noise is displayed. However, a small resolution bandwidth also increases the required measurement time.

The resolution bandwidth parameters can be defined in the bandwidth configuration, see Chapter 6.6, "Bandwidth Settings", on page 111.

Time resolution

The time resolution determines the size of the bins used for each FFT calculation. The shorter the time span used for each FFT, the shorter the resulting span, and thus the higher the resolution in the spectrum becomes. The time resolution to be used for R&S FSW can be defined manually or automatically according to the data acquisition settings.

4.3 Signal Models

If the additional firmware options R&S FSW-K60H or -K60C are installed, the R&S FSW Transient Analysis application supports different signal models for which similar parameters are characteristic.

4.3.1 Frequency Hopping

Some digital data transmission standards employ a *frequency-hopping* technique, in which a carrier signal is rapidly switched among many frequency channels. Discrete frequencies and continuous modulation are characteristic of this signal model.

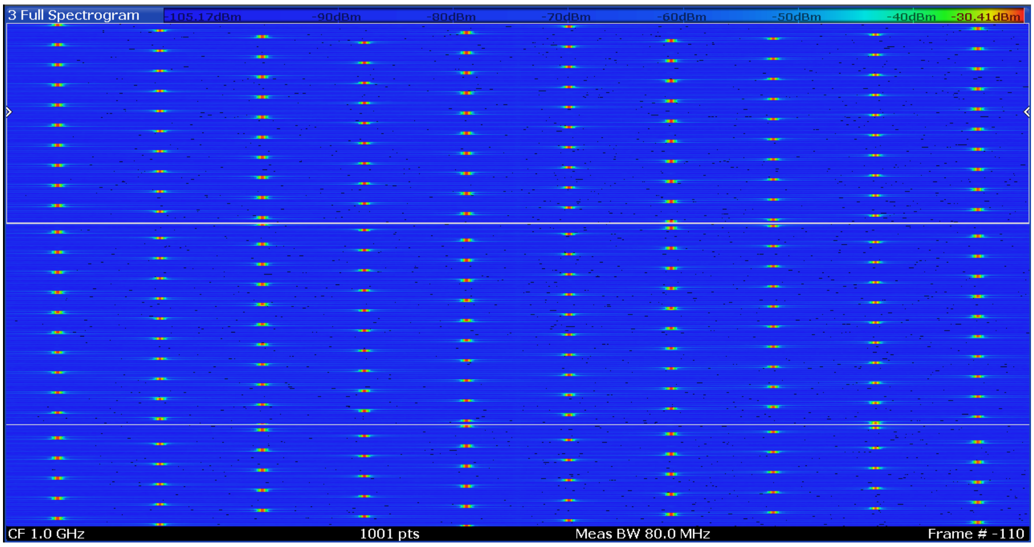


Figure 4-4: Typical spectrogram of a frequency-hopping signal

Analyzing such signals includes the following challenges:

- Detecting the currently used carrier frequency and a possible offset
- Determining the duration the signal stays at one frequency and the time it takes to switch to another
- Measuring the average power level
- Demodulating the signal correctly

The R&S FSW Transient Analysis application (with the additional R&S FSW-K60H option installed) can automatically detect frequency hops in a measured signal and determine characteristic hop parameters. Both pulsed and continuous wave hopping signals can be analyzed.

Assuming a frequency-hopping signal model, the frequency bands in which the carrier can be expected are usually known in advance. Therefore, you can configure conditions that must apply to the measured signal in order to detect a frequency hop and distinguish it from random spurs or frequency distortions. Such conditions can be a frequency tolerance around a defined nominal value, for instance, or a minimum or maximum dwell time in which the frequency remains steady.

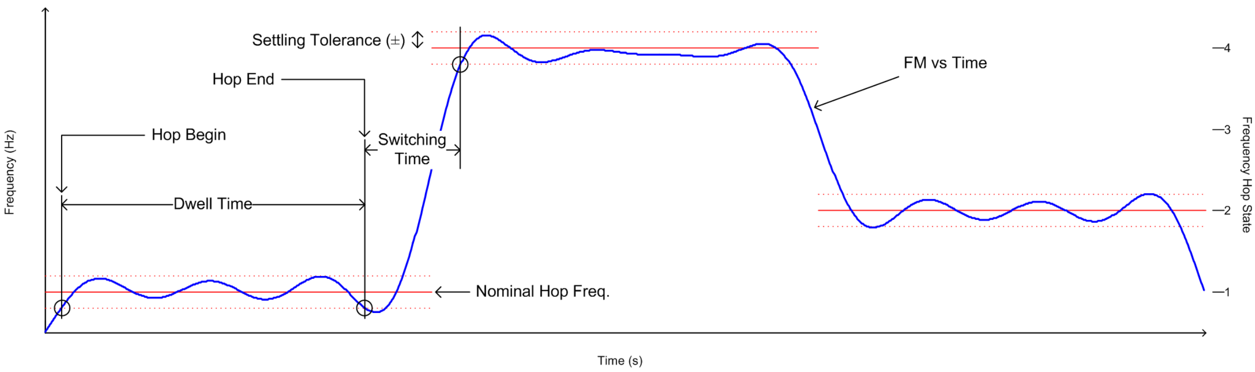


Figure 4-5: Parameters required to detect hops

Nominal Frequency Values (Hop States)

The (nominal) frequency values the carrier is expected to "hop" to are defined in advance. Each such level is considered to be a *hop state*. The hop states are defined as frequency offsets from the center frequency. A tolerance span can be defined to compensate for settling effects. As long as the deviation remains within the tolerance above or below the nominal frequency, the hop state is detected.

The nominal frequency levels are numbered consecutively in the "Hop States" table (see Chapter 6.2.2, "Signal States", on page 72), starting at 0. The state index of the corresponding nominal frequency level is assigned to each detected hop in the measured signal results.

Dwell Time Conditions

The dwell time is the time the signal remains in the tolerance area of a nominal hop frequency, or in other words: the duration of a hop from beginning to end. In a default measurement, useful dwell times for the current measurement are determined automatically. However, you can define minimum or maximum dwell times, or both, manually, in order to detect only specific hops, for example.

4.3.2 Frequency Chirping

Frequency chirping is similar to hopping, however, instead of switching to discrete frequencies, the frequency varies with time at a particular *chirp rate*. Transient analysis with the R&S FSW application (and the additional R&S FSW-K60C option) is restricted to the commonly used *linear* FM chirp signals. In this case, the nominal chirp switches to discrete values, referred to as the *chirp states*.

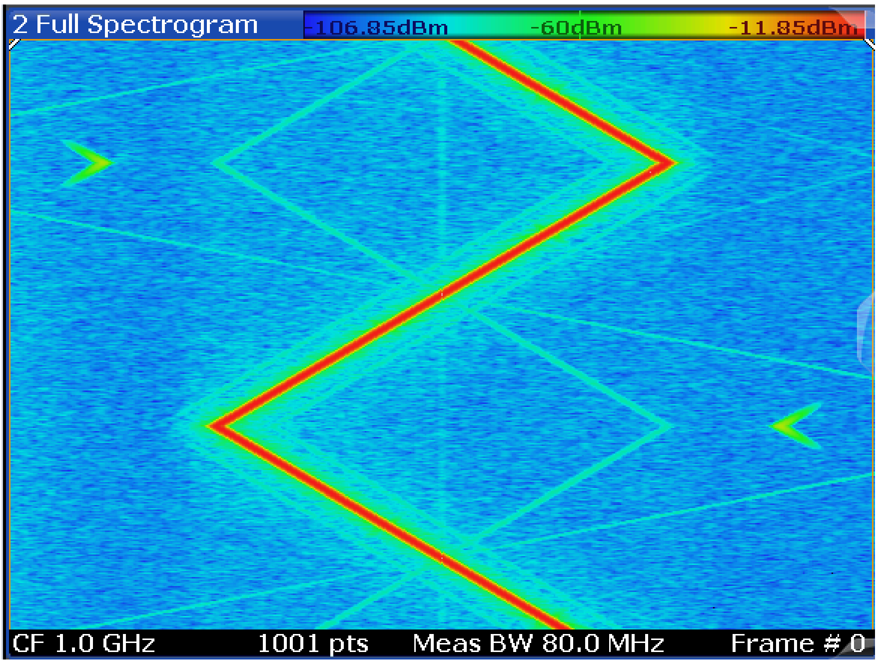


Figure 4-6: Typical spectrogram of a chirped signal

The R&S FSW Transient Analysis application can automatically detect chirps in a measured signal and determine characteristic chirp parameters. Both pulsed and continuous wave chirp signals can be analyzed.

Obviously, if you consider the chirps rather than the individual frequencies, the measured data from chirped signals is very similar to hopped signals, and thus the analysis tasks and the characteristic parameters are very similar, as well.

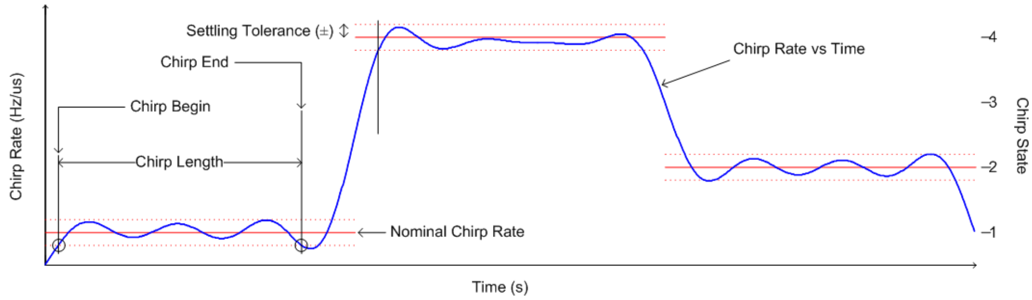


Figure 4-7: Parameters required to detect chirps

In the R&S FSW Transient Analysis application, for a chirp signal, the derivation of the captured signal data is calculated before further analysis. From there, processing is identical for both signal models.

4.3.3 Automatic vs. Manual Hop/Chirp State Detection

By default, the R&S FSW Transient Analysis application automatically detects the existing hop/chirp states in a pre-measurement. For an initial overview of the signal at hand this detection is usually sufficient. For more accurate results, particularly if the input signal is known in advance, the nominal frequency or chirp values can be defined manually.

4.4 Basis of Evaluation

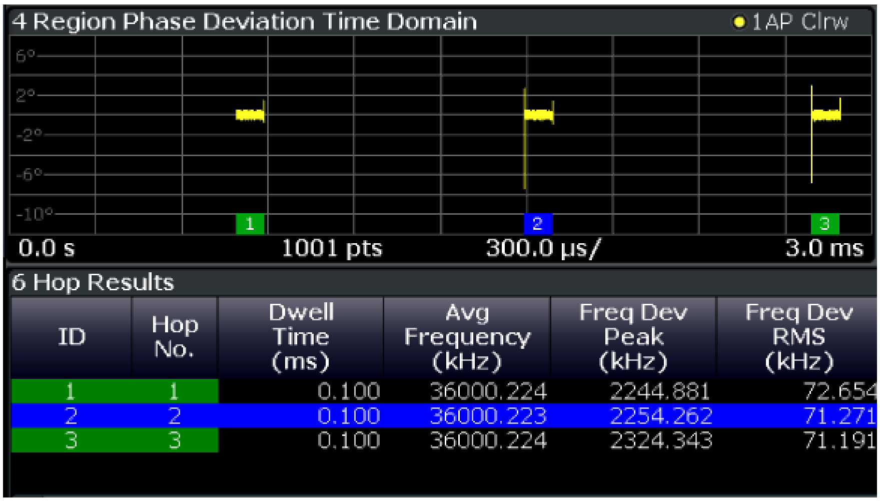
Depending on the measurement task, not all of the measured data in the capture buffer may be of interest. In some cases it may be useful to restrict analysis to a specific user-definable region, or to a selected individual chirp or hop. This makes analysis more efficient and the display clearer.

Automatic detection of hops or chirps, for example, is always based on a restricted analysis region. Numeric results for characteristic parameters, as well as statistical results, are also calculated on this restricted basis.

For graphical displays, selecting an individual hop or chirp allows you to analyze or compare characteristic values in detail.

Which evaluation basis is available for which result display is indicated in Table 5-1.

Detected hops/chirps are indicated by green bars along the x-axis in graphical result displays. The selected hop/chirp (see "Select Hop / Select Chirp" on page 130) is indicated by a blue bar. The hop/chirp index as displayed in the result tables is indicated at the bottom of each bar.



ID	Hop No.	Dwell Time (ms)	Avg Frequency (kHz)	Freq Dev Peak (kHz)	Freq Dev RMS (kHz)
1	1	0.100	36000.224	2244.881	72.654
2	2	0.100	36000.223	2254.262	71.271
3	3	0.100	36000.224	2324.343	71.191

Figure 4-8: Example of detected hops with hop index in graphical result display and result table

4.5 Analysis Region

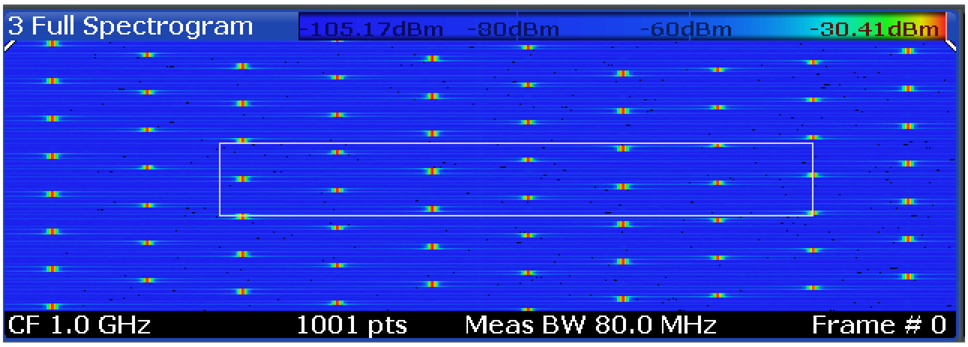
The *analysis region* determines which of the captured data is analyzed and displayed on the screen. By default, the entire capture buffer data is defined as the analysis region. However, you can select a specific frequency and time region which is of interest for analysis. The results can then be restricted to this region (see Chapter 7.3, "Evaluation Basis", on page 130).

Note, however, that only *one* analysis region can be defined. All result displays that are restricted to the analysis region thus have the same data basis.

Numeric results (displayed in the result or statistics tables) are always calculated based on the analysis region.

For graphical result displays based on the analysis region, the x-axis range corresponds to the analysis region length (see "Time Gate Length" on page 111).

The analysis region is indicated by a colored frame in the Full Spectrogram display, and by vertical blue lines in result displays based on the full capture buffer.



The colors used to indicate the analysis range in spectrograms are configurable, see "Modifying Analysis Region and Sweep Separator Colors" on page 137.

Defining the analysis region

There are different methods of defining the analysis region:

- absolute definition: by defining an absolute frequency span and an absolute time gate
  The frequency span is defined by an offset from the center frequency and an analysis bandwidth.
  The time gate is defined by a starting point after measurement begin and the gate length.
- relative definition: by linking the analysis region to the full capture buffer and defining a percentage of the full bandwidth and measurement time
  The specified frequency offset or time gate start are also considered for relative values.
- graphically: The analysis region is indicated by a dotted frame in the Spectrogram display and by vertical lines in the full spectrum display. Its size and position can be moved by tapping and dragging the frame on the touchscreen.
  Furthermore, the data zoom and shift functions allow you to change the size and position of the analysis region from any graphical result display (see Chapter 4.6, "Zooming and Shifting Results", on page 26).

The absolute and relative methods can be combined, for example by defining an absolute frequency span and a relative time gate.

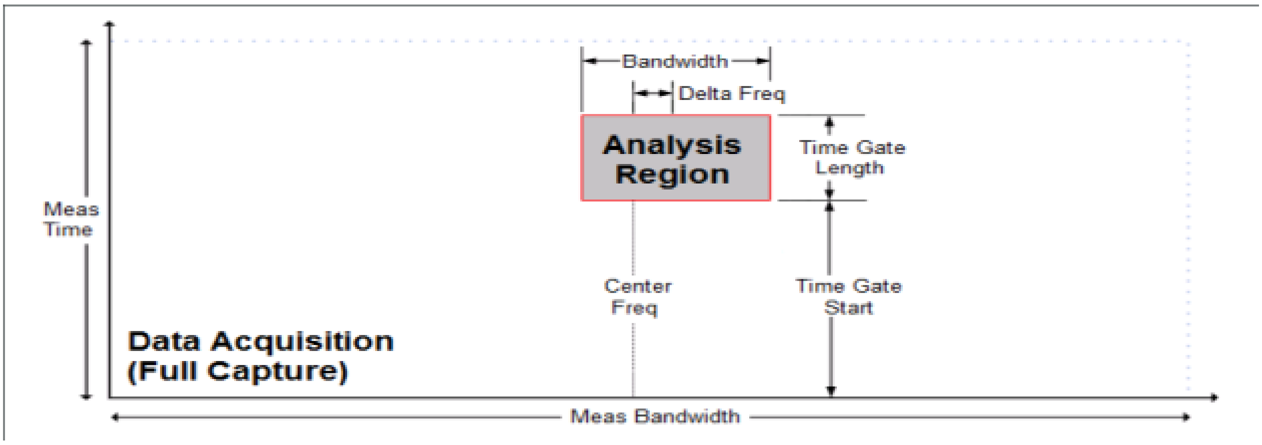


Figure 4-9: Visualization of absolute analysis region parameters

Processing data in the analysis region - data zoom

In result displays restricted to the analysis region, only the data measured for the specified frequency range and within the defined time gate is considered. Furthermore, the analysis region data is taken only from the latest data acquisition, that is, only data that is still in the capture buffer is analyzed.

Restricting the results to an analysis region has the same effect as a data zoom: the results are recalculated for a restricted data base. The data in the capture buffer is filtered by the defined time gate; the measured data within that time span then passes a bandpass filter, so only the frequency range of interest is analyzed. Depending on the selected result display, the data is then demodulated, if necessary, and distributed among the trace points using a detector. The time span displayed per division of the diagram is much smaller compared to the initial full data analysis. Thus, the results of the analysis range become more precise.

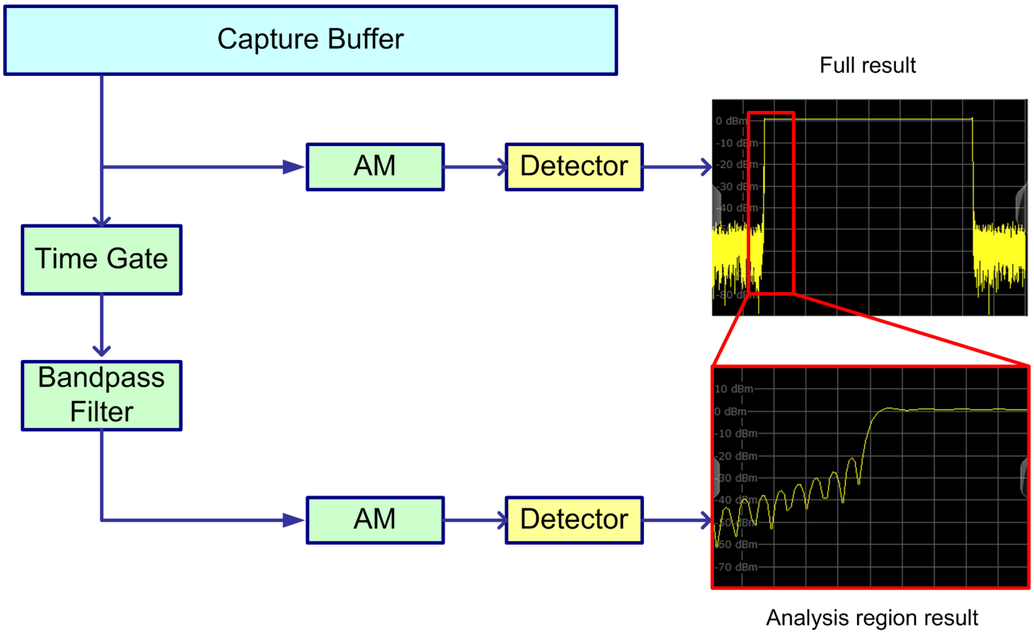


Figure 4-10: Data zoom - full result vs. analysis region result

4.6 Zooming and Shifting Results

As described above (Processing data in the analysis region - data zoom),restricting the results to an analysis region has the same effect as a data zoom: the results are recalculated for a restricted data base.

This is exactly what the "Data Zoom" ( ) function in the toolbar does: it changes the size of the analysis region and re-evaluates the new data base. Thus, if the analysis region is reduced, less data is displayed in the same area of the screen, thus enlarging the display of the selected data. If the analysis region is enlarged, more data is displayed.

The "Data Shift" ( ) function, on the other hand, does not change the size of the analysis region, but the position. Thus you can scroll through the signal and analyze several hops/chirps after another, for example.

The effects of a data zoom or shift are reflected in the Analysis Region settings of the "Data Acquisition" dialog box.

Similarly, when the data zoom and shift functions are applied to a hop/chirp-based result display, the size or position of the result range are changed (see Chapter 7.2.1, "Result Range", on page 121).

This means that *ALL* result displays based on the analysis region or hop/chirp result range are re-evaluated after a data zoom or shift function is applied in any window. This includes result tables, which may take some time to re-calculate. Close the result tables during a data shift/zoom to improve the screen update speed.

Use the data zoom or shift functions in the full spectrum or spectrogram displays and analyze the data sequentially or hop-by-hop / chirp-by-chirp in the other result displays!

4.7 Measurement Range

In order to calculate frequency, phase or power results in frequency hopping or chirped signals more accurately, it may be useful not to take the entire dwell time of the hop (or length of the chirp) into consideration, but only a certain range within the dwell time/ length. Thus, it is possible to eliminate settling effects, for instance. For such cases, a *measurement range* can be defined for frequency, phase and power results, in relation to specific hop or chirp characteristics.

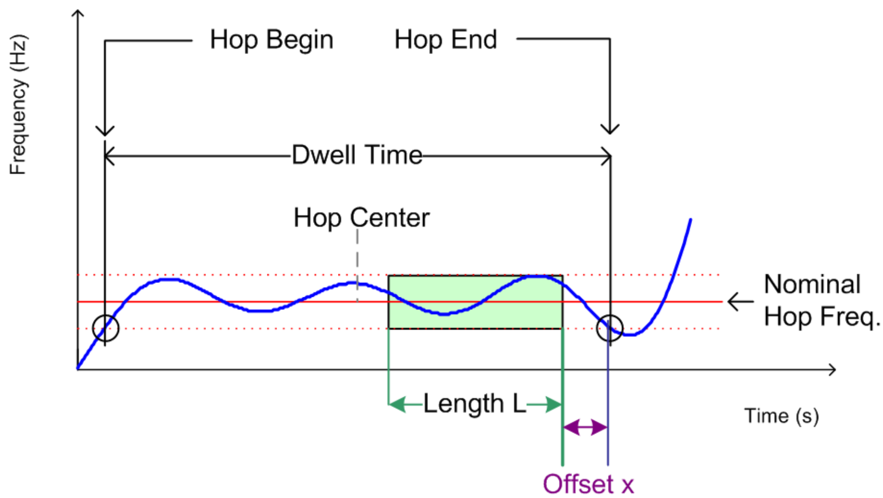


Figure 4-11: Measurement range parameters for hopped signals

Similarly, for chirped signals, a measurement range can be defined for the corresponding parameters.

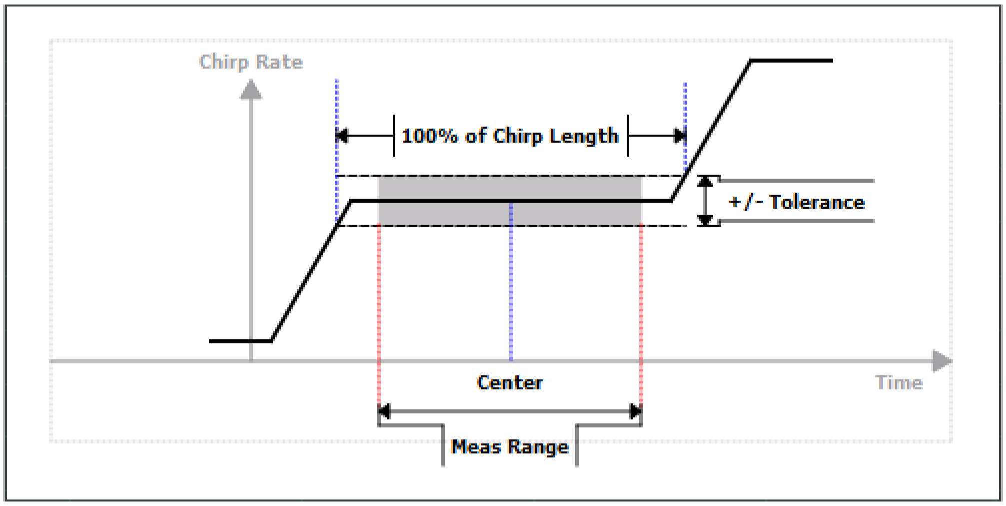


Figure 4-12: Measurement range parameters for chirped signals

Each range is defined by a reference point, an offset, and the range length. The reference point can be either the center or either edge of the hop/chirp, or a point defined by an offset to one of these characteristic points. The range is then centered around this reference point.

Example:

In Figure 4-11, the indicated measurement range could be defined by the following parameters, for example:

- "Reference": *Hop End*
- "Offset":*-x*
- "Alignment": *right*
- "Length": *L*

Measurement range vs result range

While the measurement range defines which part of the hop/chirp is used for individual calculations, the **result range** determines which part is **displayed** on the screen in the form of AM, FM or PM vs. time traces (see also Chapter 7.2.1, "Result Range", on page 121).

4.8 Trace Evaluation

Traces in graphical result displays based on the defined result range (see Chapter 7.2.1, "Result Range", on page 121) can be configured, for example to perform statistical evaluations over the selected hop/chirp or all hops/chirps.

You can configure up to 6 individual traces for the following result displays (see Chapter 5.3, "Evaluation Methods for Transient Analysis", on page 59):

- RF Power Time Domain

- FM Time Domain
- Frequency Deviation Time Domain
- PM Time Domain
- PM Time Domain (Wrapped)
- Chirp Rate Time Domain

Find out more about trace evaluation:

4.8.1 Mapping Samples to Measurement Points with the Trace Detector

A trace displays the values measured at the measurement points. The number of samples taken during a measurement is much larger than the number of measurement points that are displayed in the measurement trace.

Obviously, a data reduction must be performed to determine which of the samples are displayed for each measurement point. This is the trace detector's task.

The trace detector can analyze the measured data using various methods:

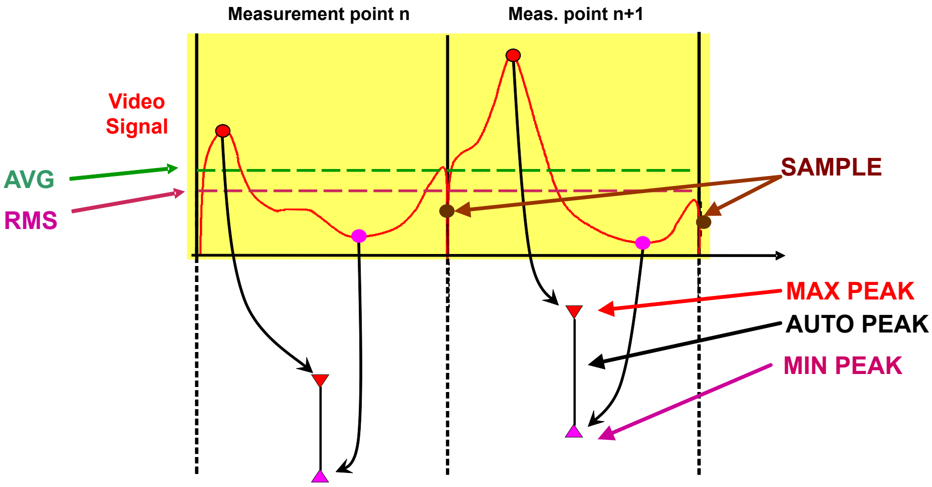
The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation.

Table 4-1: 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
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
RMS	Rm	Calculates the root mean square of all samples contained in a measurement 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.

Detector	Abbrev.	Description
Average	Av	Calculates the linear average of all samples contained in a measurement 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 measurement point thus corresponds to the average of the measured values summed up in the measurement 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 measurement point is displayed as the value at this x-axis 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.

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

Trace mode	Detector
View	–
Blank	–

4.8.2 Analyzing Several Traces - Trace Mode

If several measurements are performed one after the other, or continuous measurements are performed, the trace mode determines how the data for subsequent traces is processed. After each measurement, 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 4.8.1, "Mapping Samples to Measurement Points with the Trace Detector", on page 29.

The R&S FSW offers the following trace modes:

Table 4-2: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each measurement. This is the default setting. All available detectors can be selected.
Max Hold	The maximum value is determined over several measurements and displayed. The R&S FSW saves the measurement 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 measurement until all signal components are detected in a kind of envelope.
Min Hold	The minimum value is determined from several measurements and displayed. The R&S FSW saves the measurement 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.
Average	The average is formed over several measurements and displayed. The Sweep / Average Count determines the number of averaging procedures. (See also Chapter 4.8.3, "Trace Statistics", on page 32.)
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.

4.8.3 Trace Statistics

Each trace represents an analysis of the data measured in one result range. As described in Chapter 4.8.2, "Analyzing Several Traces - Trace Mode", on page 31, statistical evaluations can be performed over several traces, that is, result ranges. Which ranges and how many are evaluated depends on the configuration settings.

Selected hop/chirp vs all hops/chirps

The Sweep / Average Count determines how many measurements are evaluated.

For each measurement, in turn, either the selected hop/chirp only (that is: one result range), or all detected hops/chirps (that is: possibly several result ranges) can be included in the statistical evaluation.

Thus, the overall number of averaging steps depends on the Sweep / Average Count and the statistical evaluation mode.

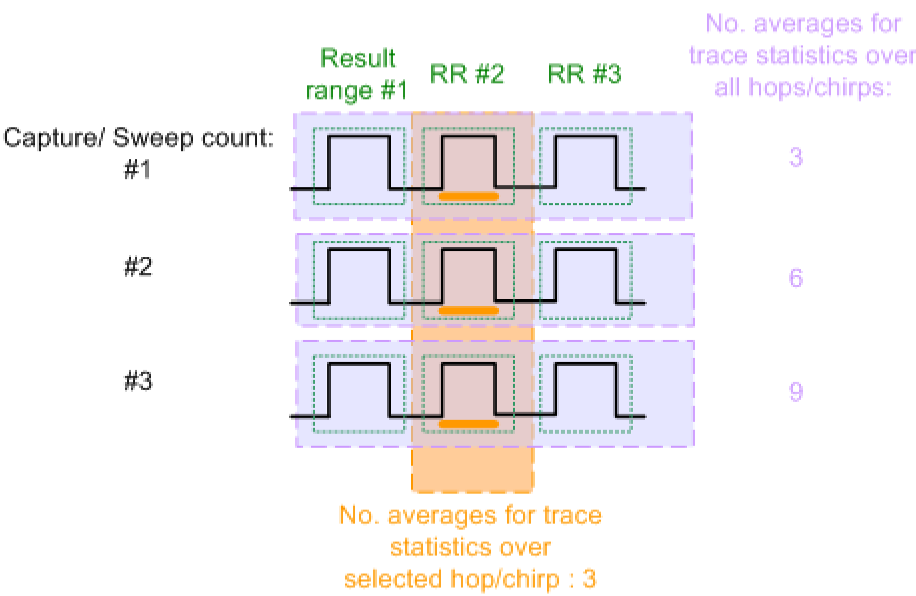


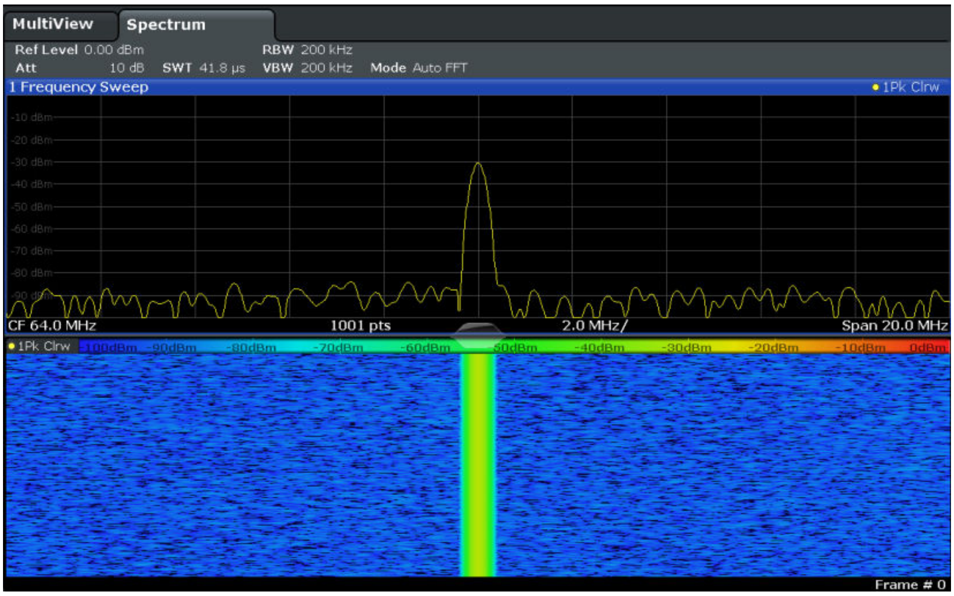
Figure 4-13: Trace statistics - number of averaging steps

4.9 Working with Spectrograms

In addition to the standard "level versus frequency" or "level versus time" 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:



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:

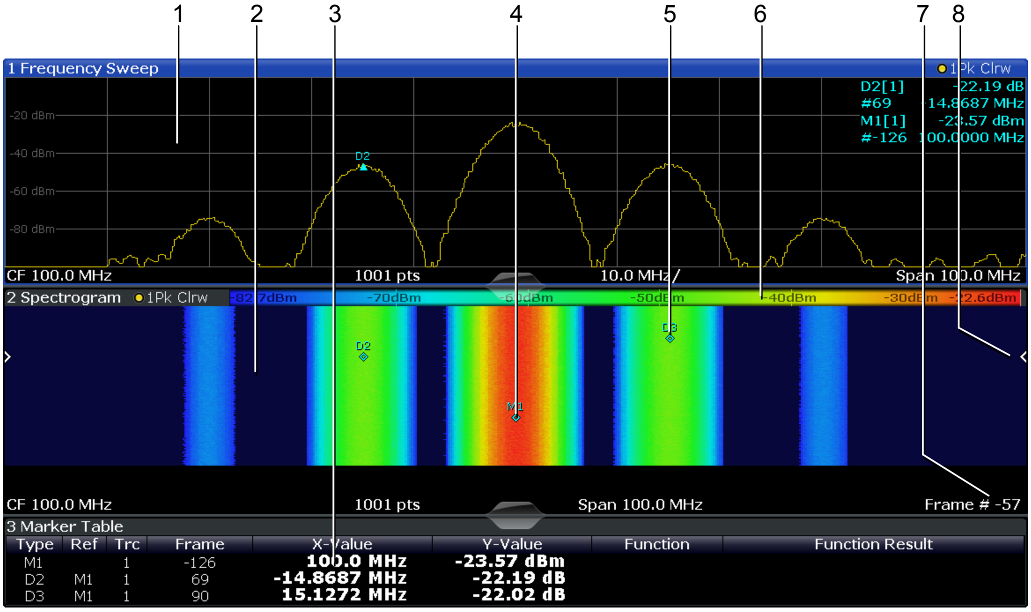


Figure 4-14: Screen layout of the spectrogram result display

1 = Spectrum result display
2 = Spectrogram result display
3 = Marker list
4 = Marker
5 = Delta marker
6 = Color map
7 = Timestamp / frame number
8 = Current frame indicator

For more information about spectrogram configuration, see Chapter 7.6, "Spectrogram Settings", on page 135.

Remote commands:

Activating and configuring spectrograms:

Chapter 11.6.10, "Configuring Spectrograms", on page 304

Storing results:

MMEMory:STORe<n>:SPECtrogram on page 378

4.9.1 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 measurement and is called a **time frame** or simply "frame". As with standard spectrum traces, several measured values are combined in one measurement point using the selected detector.

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 measurement, 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 measurements unless they are cleared manually.

The frames for each individual sweep are separated by colored lines.

The scaling of the time axis (y-axis) is not configurable. However, you can enlarge the spectrogram display by maximizing the window using the "Split/Maximize" key.

Alternatively, use a spectrogram based on the analysis region and decrease the size of the region to zoom into the data of interest. (See also Chapter 4.6, "Zooming and Shifting Results", on page 26.)

Tracking absolute time - timestamps

Alternatively to the frame count, the absolute time (that is: a *timestamp*) at which a frame was captured can be displayed. While the measurement is running, the timestamp shows the system time. In single measurement mode or if the measurement is stopped, the timestamp shows the time and date at the end of the measurement.Thus, the individual frames can be identified by their timestamp or their frame count.

When active, the timestamp replaces the display of the frame number in the diagram footer (see Figure 4-14).

Displaying individual frames

The spectrogram diagram contains 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 timestamp, 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.

4.9.2 Color Maps

Spectrograms assign power levels to different colors 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:

For each color scheme, you can select the suitable color used to display the analysis region frame and sweep separator lines, see "Modifying Analysis Region and Sweep Separator Colors" on page 137.

- **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. Display only parts of interest.

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, to visualize a certain area of the value range 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 range 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:

In the color map based on the linear color curve, the range from -100 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.

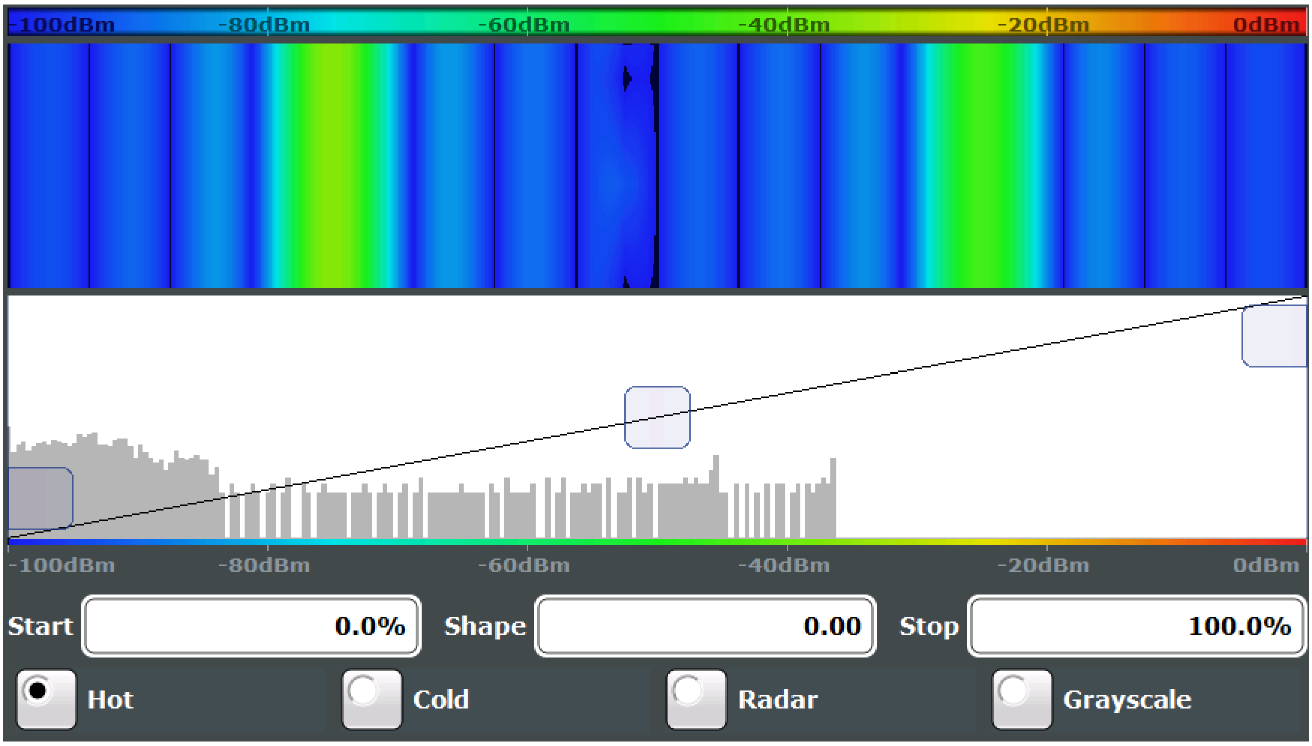


Figure 4-15: Spectrogram with (default) linear color curve shape = 0

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 -100 dBm to -60 dBm (blue, green and yellow). This range 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.

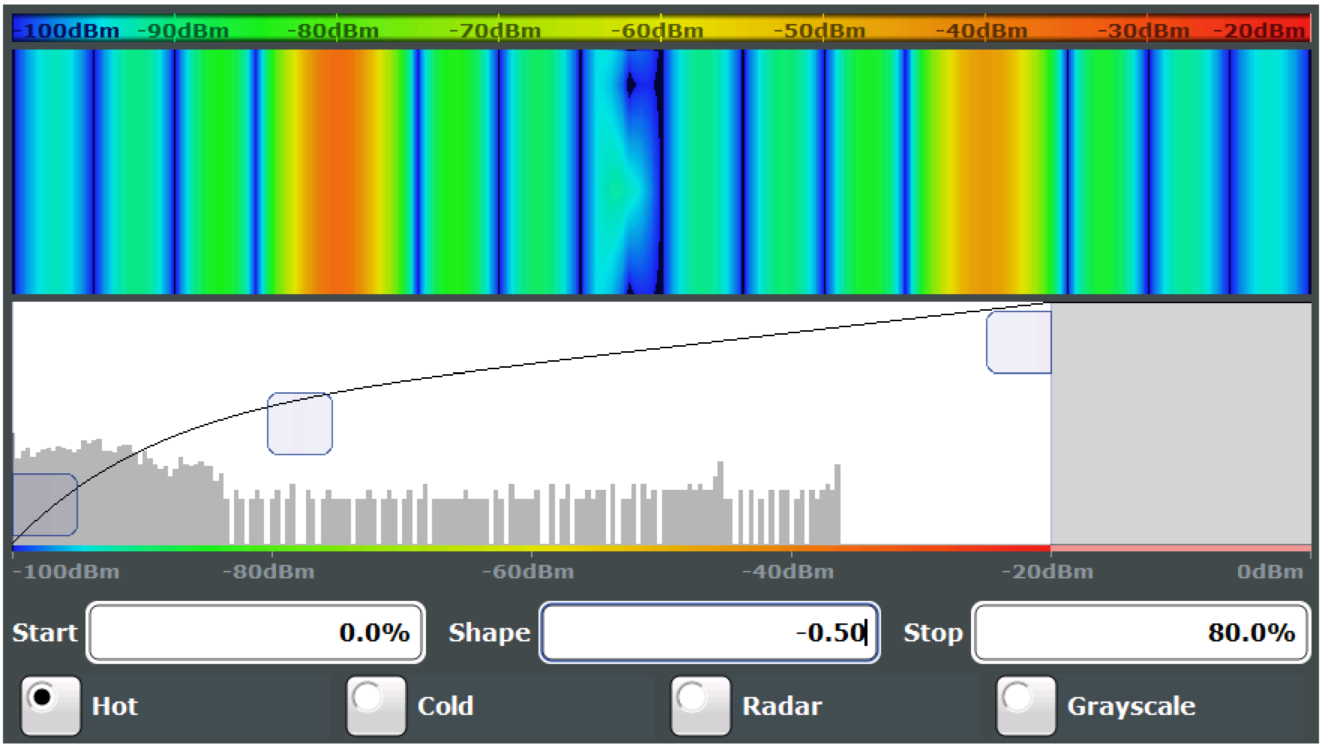


Figure 4-16: Spectrogram with non-linear color curve (shape = -0.5)

4.9.3 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.

4.10 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).

4.10.1 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`.

4.10.2 Basics on Input from I/Q Data Files

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

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

The I/Q data must be stored in a format with the file extension `.iq.tar`. For a detailed description see Chapter A.2, "I/Q Data File Format (iq-tar)", on page 390.

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

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

Sample iq.tar files

If you have the optional R&S FSW VSA application (R&S FSW-K70), some sample `iq.tar` files are provided in the `C:/R_S/Instr/user/vsa/DemoSignals` directory on the R&S FSW.

Pre-trigger and post-trigger samples

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

4.10.3 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 99

4.10.4 Receiving and Providing Trigger Signals

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

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

External trigger as input

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

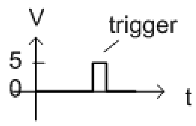
Trigger output

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

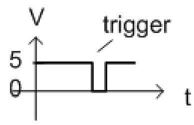
The trigger signal can be output by the R&S FSW automatically, or manually by the user. If it is provided automatically, a high signal is output when the R&S FSW has triggered due to a measurement start ("Device Triggered"), or when the R&S FSW is ready to receive a trigger signal after a measurement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

Manual triggering

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



low-level constant, high-level trigger



high-level constant, low-level trigger

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

4.11 Transient Analysis in MSRA/MSRT Mode

The R&S FSW Transient Analysis application can also be used to analyze data in MSRA or MSRT operating mode. The main difference between the two modes is that in MSRA mode, an I/Q analyzer performs data acquisition, while in MSRT mode, a real-time measurement is performed to capture data.

In MSRA/MSRT operating mode, only the MSRA/MSRT Master actually captures data; the MSRA/MSRT applications receive an extract of the captured data for analysis, referred to as the **application data**. For the R&S FSW Transient Analysis application in MSRA/MSRT operating mode, the application data range is defined by the same settings used to define the signal capture in Signal and Spectrum Analyzer mode. In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the application data for transient analysis. The "Capture Buffer" displays show the application data of the R&S FSW Transient Analysis application in MSRA/MSRT mode.

Data acquisition in MSRT mode

By default, the R&S FSW Transient Analysis application uses the largest possible measurement bandwidth. Depending on which bandwidth extension options are installed (if any), this may be up to 500 MHz. However, in MSRT mode a maximum of 160 MHz bandwidth is available. Thus, you must ensure the measurement bandwidth for Transient Analysis is available in MSRT mode. Otherwise you will not obtain useful results.

Data coverage for each active application

Generally, if a signal contains multiple data channels for multiple standards, separate applications are used to analyze each data channel. Thus, it is of interest to know which application is analyzing which data channel. The MSRA/MSRT Master display indicates the data covered by each application by vertical blue lines labeled with the application name.

Analysis interval

However, the individual result displays of the application need not analyze the complete data range. The data range that is actually analyzed by the individual result display is referred to as the **analysis interval**.

In the R&S FSW Transient Analysis application the analysis interval is automatically determined according to the analysis region settings, as in Signal and Spectrum Analyzer mode. The currently used analysis interval (in seconds, related to capture buffer start) is indicated in the window header for each result display.

Analysis line

A frequent question when analyzing multi-standard signals is how each data channel is correlated (in time) to others. Thus, an analysis line has been introduced. The analysis line is a common time marker for all MSRA slave applications. It can be positioned in any MSRA slave application or the MSRA Master and is then adjusted in all other slave applications. Thus, you can easily analyze the results at a specific time in the measurement in all slave applications and determine correlations.

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

- **orange "AL"**: the line lies within the interval
- **white "AL"**: the line lies within the interval, but is not displayed (hidden)
- **no "AL"**: the line lies outside the interval

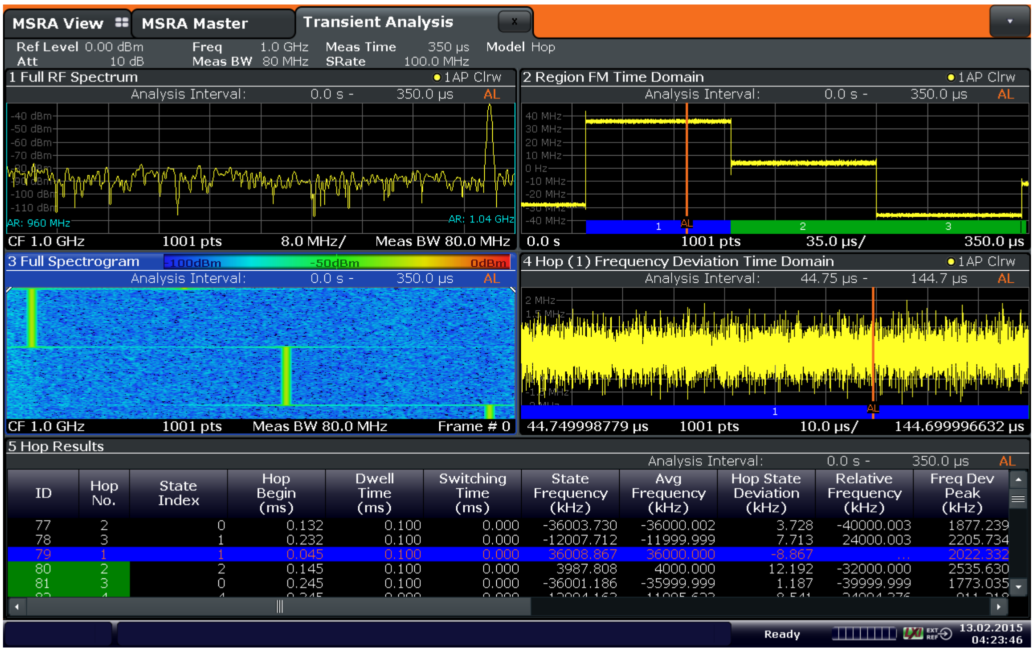


Figure 4-17: Analysis line in R&S FSW Transient Analysis application

For details on the MSRA operating mode see the R&S FSW MSRA User Manual. For details on the MSRT operating mode see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

5 Measurement Results

The data that was measured by the R&S FSW can be evaluated using various different methods.

Basis of evaluation

For some displays you can define whether the results are calculated for:

- the entire capture buffer
- the selected analysis region
- a selected individual chirp or hop (for options R&S FSW-K60C/-K60H)

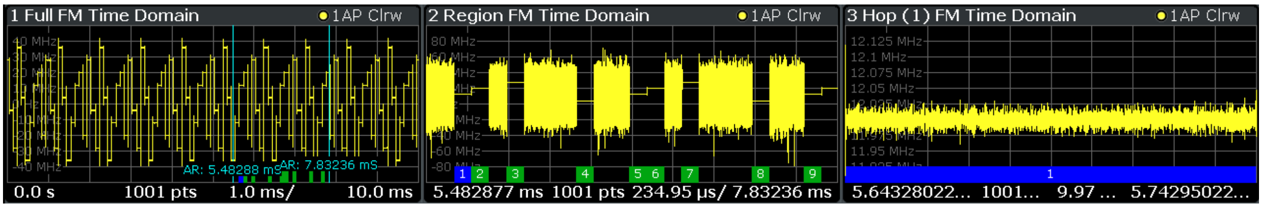


Figure 5-1: Example for different data sources for the same result display (FM Time Domain)

The data source for each result display is selected in the MEAS menu. It is indicated in the description of the individual result displays.

The analysis region is indicated by a colored frame in the Full Spectrogram display, and by vertical blue lines in result displays based on the full capture buffer. For details on the analysis region see Chapter 4.5, "Analysis Region", on page 23.

For hop/chirp-based result displays, the current hop/chirp index as displayed in the result tables is indicated at the bottom of the hop/chirp bar.

Measurement range vs result range

The **measurement range** defines which part of a hop/chirp is used for calculation (for example for frequency estimation), whereas the **result range** determines which data is **displayed** on the screen in the form of AM, FM or PM vs. time traces.

Exporting Table Results to an ASCII File

Measurement result tables can be exported to an ASCII file for further evaluation in other (external) applications.

For step-by-step instructions on how to export a table, see Chapter 8.2, "How to Export Table Data", on page 163.

5.1 Hop Parameters

If the R&S FSW-K60H option is installed, various hop parameters can be determined during transient analysis.

The hop parameters to be measured are based primarily on the IEEE 181 Standard 181-2003. For detailed descriptions refer to the standard documentation ("IEEE Standard on Transitions, hops, and Related Waveforms", from the IEEE Instrumentation and Measurement (I&M) Society, 7 July 2003).

The following graphic illustrates the main hop parameters and characteristic values. (For a definition of the values used to determine the measured hop parameters see Chapter 4.3.1, "Frequency Hopping", on page 19.)

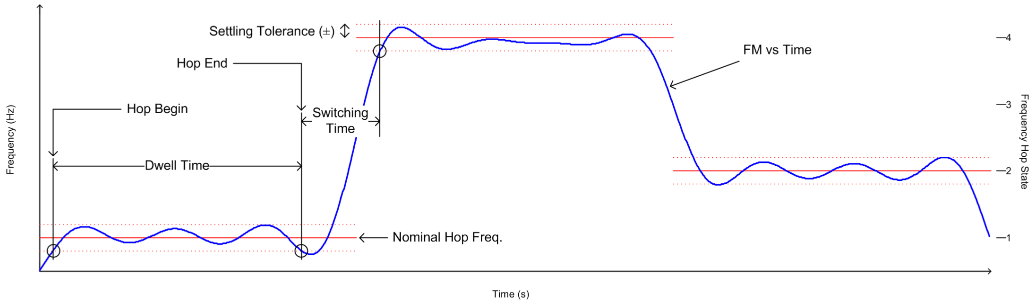


Figure 5-2: Definition of the main hop parameters and characteristic values

In order to obtain these results, select the corresponding parameter in the result configuration (see Chapter 7.2.2, "Table Configuration", on page 122) or apply the required SCPI parameter to the remote command (see Chapter 11.6.5, "Table Configuration", on page 262 and Chapter 11.9.1, "Retrieving Information on Detected Hops", on page 340).

Hop ID and Hop number

Each individual hop can be identified by a timestamp which corresponds to the absolute time the beginning of the hop was detected. In addition, each hop is provided with a consecutive number, which starts at 1 for each new measurement. This is useful to distinguish hops in a measurement quickly.

Remote command:

`[SENSe:]HOP:ID?` on page 349

`[SENSe:]HOP:NUMBer?` on page 352

State parameters
Hop state parameters

Remote command:
CALCulate<n>:HOPDetection:TABLe:STATe:ALL[:STATe] on page 273

State Index ← State parameters
The nominal frequency levels are numbered consecutively in the "Hop States" table (see Chapter 6.2.2, "Signal States", on page 72), starting at 0. The state of a detected hop is defined as the index of the corresponding nominal frequency.

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:STATe:INDex on page 273
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:STATe[:INDex]? on page 354

Timing parameters
Hop timing parameters

Remote command:
CALCulate<n>:HOPDetection:TABLe:TIMing:ALL[:STATe] on page 274

Hop Begin ← Timing parameters
The relative time (in ms) from the capture start at which the signal first enters the tolerance area of a nominal hop (within the analysis region). The tolerance area is defined by the settling tolerance above and below the defined nominal hop frequencies.

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:TIMing:BEGin on page 274
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:TIMing:BEGin? on page 356

Dwell Time ← Timing parameters
The duration of a hop from begin to end, that is, the time the signal remains in the tolerance area of a nominal hop frequency.

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:TIMing:DWELl` on page 274
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:TIMing:DWELl?` on page 357

Switching Time ← Timing parameters
The time the signal requires to "hop" from one level to the next. It is defined as the time between a hop end and the following hop begin. The first switching time result can only be determined after the first hop has been detected.

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:TIMing:SWITching` on page 274
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:TIMing:SWITching?` on page 357

Frequency parameters
Hop frequency parameters

Remote command:
`CALCulate<n>:HOPDetection:TABLe:STATe:ALL[:STATe]` on page 273

State Frequency (Nominal) ← Frequency parameters
Nominal frequency of the hop state as defined in "Hop States" table.

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:STATe:STAFrequency` on page 274
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:STATe:STAFrequency?` on page 355

Average Frequency ← Frequency parameters
Average frequency measured within the frequency measurement range of the hop (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:FREQuency:AVGFm` on page 271
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:FREQuency:FREQuency?` on page 347

Hop State Deviation ← Frequency parameters
Deviation of the hop frequency from the nominal hop state frequency

$$fdev_{state} = \hat{f}_{avg} - f_{nom}$$

Where

$\hat{f}_{avg}$ Average hop frequency estimate obtained from the frequency meas range of a hop

f_{nom}: Nominal hop frequency corresponding to a detected or predefined hop state

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:FREQuency:FMERror` on page 271
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:FREQuency:FMERror?` on page 346

Relative Frequency (Hop-to-Hop) ← Frequency parameters
Relative difference in frequency between two hops.

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:FREQuency:RELFrequency` on page 271
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:FREQuency:RELFrequency?` on page 348

Frequency Deviation (Peak) ← Frequency parameters
Maximum of Frequency Deviation vs Time trace

All hop frequency deviation table values are calculated from the time domain result:

$fdev(k) = f_{meas}(k) - f_{ideal}(k)$

for hop start ≤ k ≤ hop start + dwell time

where:

$f_{meas}(k)$: instantaneous frequency of the measured signal

$f_{ideal}(k)$: ideal frequency trajectory obtained from weighted linear regression of the instantaneous signal phase $\varphi_{meas}(k)$ within the frequency measurement range (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114)

The peak deviation is thus defined as:

$fdev_{peak} = max(|fdev(k)|)$

for k∈ {frequency meas range}

Remote command:
Display:
`CALCulate<n>:HOPDetection:TABLe:FREQuency:MAXFm` on page 271
Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]HOP:FREQuency:MAXFm?` on page 347

Frequency Deviation (RMS) ← Frequency parameters
RMS of Frequency Deviation vs Time trace

$$fdev_{RMS} = \sqrt{\frac{1}{\text{frequency meas range}} \sum_{k} fdev^2(k)}$$

for k∊ {frequency meas range}

(fdev is defined in "Frequency Deviation (Peak)" on page 49)

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:FREQuency:RMSFm on page 271
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:FREQuency:RMSFm? on page 349

Frequency Deviation (Average) ← Frequency parameters
Average of Frequency Deviation vs Time trace

$$fdev_{RMS} = \sqrt{\frac{1}{\text{frequency meas range}} \sum_{k} fdev^2(k)}$$

for k∊ {frequency meas range}

(fdev is defined in "Frequency Deviation (Peak)" on page 49)

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:FREQuency:AVGFm on page 271
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:FREQuency:AVGFm? on page 345

Phase parameters
Hop phase parameters

All hop phase deviation table values are calculated from the time domain result:

$\varphi dev(k) = \varphi_{meas}(k) - \varphi_{ideal}(k)$

for hop start ≤ k ≤ hop start + dwell time

where:

$\varphi_{meas}(k)$: instantaneous phase of the measured signal

$\varphi_{ideal}(k)$: ideal phase trajectory obtained from weighted linear regression of $\varphi_{meas}(k)$ within the frequency meas range

Remote command:
CALCulate<n>:HOPDetection:TABLe:PHASe:ALL[:STATe] on page 272

Phase Deviation (Peak) ← Phase parameters
Maximum of Phase Deviation vs Time trace

The deviation is calculated within the phase measurement range of the hop (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

$\varphi dev_{peak} = max(|\varphi dev(k)|)$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:PHASe:MAXPm on page 272
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:PHASe:MAXPm? on page 350

Phase Deviation (RMS) ← Phase parameters
RMS of Phase Deviation vs Time trace

$$\varphi dev_{RMS} = \sqrt{\frac{1}{\text{frequency meas range}} \sum_k \varphi dev^2(k)}$$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:PHASe:RMSPm on page 272
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:PHASe:RMSPm? on page 351

Phase Deviation (Average) ← Phase parameters
Average of Phase Deviation vs Time trace

$$\varphi dev_{avg} = \frac{1}{\text{frequency meas range}} \sum_k \varphi dev(k)$$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:PHASe:AVGPm on page 272
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:PHASe:AVGPm? on page 349

Power parameters
Hop power parameters

Remote command:
CALCulate<n>:HOPDetection:TABLe:POWer:ALL[:STATe] on page 272

Minimum Power ← Power parameters
Minimum power level measured during a hop. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range settings (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:POWer:MINPower on page 273

Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:POWer:MINPower? on page 353

Maximum Power ← Power parameters
Maximum power level measured during a hop. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range settings (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:POWer:MAXPower on page 273
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:POWer:MAXPower? on page 352

Average Power ← Power parameters
Average power level measured during a hop. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range settings (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:POWer:AVEPower on page 273
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:POWer:AVEPower? on page 352

Power Ripple ← Power parameters
The power ripple is defined as the ratio of maximum to minimum power inside the power measurement range of the detected hop (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:HOPDetection:TABLe:POWer:PWRRipple on page 273
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]HOP:POWer:MINPower? on page 353

5.2 Chirp Parameters

If the additional option R&S FSW-K60C is installed, various chirp parameters can be determined during transient analysis.

The chirp parameters to be measured are very similar to the hop parameters; however, some values are based on the chirp rather than a frequency, so the resulting unit is Hz/µs.

The following graphic illustrates the main chirp parameters and characteristic values. (For a definition of the values used to determine the measured chirp parameters see Chapter 4.3.2, "Frequency Chirping", on page 21.)

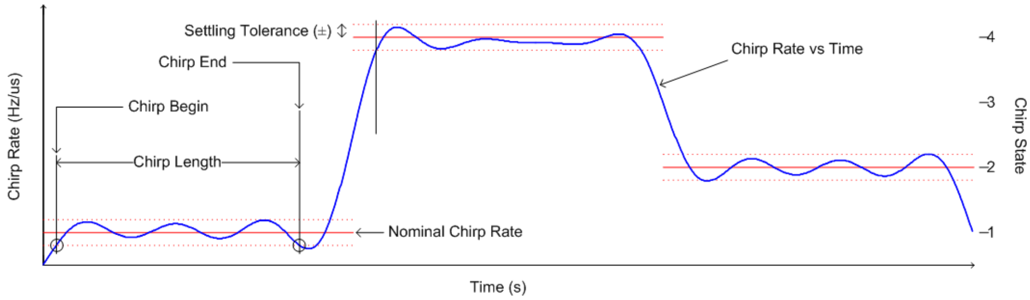


Figure 5-3: Definition of the main chirp parameters and characteristic values

In order to obtain these results, select the corresponding parameter in the result configuration (see Chapter 7.2.2, "Table Configuration", on page 122) or apply the required SCPI parameter to the remote command (see Chapter 11.6.5, "Table Configuration", on page 262 and Chapter 11.9.1, "Retrieving Information on Detected Hops", on page 340).

Chirp ID and Chirp number

Each individual chirp can be identified by a timestamp which corresponds to the absolute time the beginning of the chirp was detected. In addition, each chirp is provided with a consecutive number, which starts at 1 for each new measurement. This is useful to distinguish chirps in a measurement quickly.

Remote commands:

`[SENSe:]CHIRp:ID?` on page 366

`[SENSe:]CHIRp:NUMBer?` on page 366

State parameters
Chirp state parameters

State Index ← State parameters
The nominal chirps are numbered consecutively in the "Chirp States" table (see Chapter 6.2.2, "Signal States", on page 72), starting at 0. The state of a detected chirp is defined as the index of the corresponding nominal chirp frequency.

Remote command:
Display:
`CALCulate<n>:CHRDetection:TABLe:STATe:INDex` on page 267
Results:
`CALCulate<n>:CHRDetection:TABLe:RESults?` on page 360
`[SENSe:]CHIRp:STATe?` on page 371

Timing parameters
Chirp timing parameters

Remote command:
`CALCulate<n>:CHRDetection:TABLe:TIMing:ALL[:STATe]` on page 267

Chirp Begin ← Timing parameters
Time offset from the analyis region start at which the signal first enters the tolerance area of a nominal chirp. The tolerance area is defined by the settling tolerance above and below the defined nominal chirps.

Remote command:
Display:
`CALCulate<n>:CHRDetection:TABLe:TIMing:BEGin` on page 268
Results:
`CALCulate<n>:CHRDetection:TABLe:RESults?` on page 360
`[SENSe:]CHIRp:TIMing:BEGin?` on page 372

Chirp Length ← Timing parameters
The duration of a chirp from begin to end, that is, the time the signal remains in the tolerance area of a nominal chirp.

Remote command:
Display:
`CALCulate<n>:CHRDetection:TABLe:TIMing:LENGth` on page 268
Results:
`CALCulate<n>:CHRDetection:TABLe:RESults?` on page 360
`[SENSe:]CHIRp:TIMing:LENGth?` on page 373

Chirp Rate ← Timing parameters
Derivative of the FM vs time trace within the frequency measurement range (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
`CALCulate<n>:CHRDetection:TABLe:TIMing:RATE` on page 268
Results:
`CALCulate<n>:CHRDetection:TABLe:RESults?` on page 360
`[SENSe:]CHIRp:TIMing:RATE?` on page 373

Frequency parameters
Chirp frequency parameters

Remote command:
`CALCulate<n>:CHRDetection:TABLe:FREQuency:ALL[:STATe]` on page 265

Chirp State Deviation ← Frequency parameters
Deviation of the detected chirp rate from the nominal chirp state (in kHz/us).

$$dfdev_{state} = d\hat{f}_{avg} - df_{nom}$$

where:

$\hat{f}_{avg}$: Average chirp rate estimate obtained from the frequency meas range of a hop

f_{nom}: Nominal chirp rate corresponding to a detected or predefined hop state

Remote command:
Display:
`CALCulate<n>:CHRDetection:TABLe:FREQuency:CHERror` on page 265
Results:
`CALCulate<n>:CHRDetection:TABLe:RESults?` on page 360
`[SENSe:]CHIRp:FREQuency:CHERror?` on page 363

Average Frequency ← Frequency parameters
Average frequency measured within the frequency measurement range of the chirp (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
`CALCulate<n>:CHRDetection:TABLe:FREQuency:FREQuency` on page 265
Results:
`CALCulate<n>:CHRDetection:TABLe:RESults?` on page 360
`[SENSe:]CHIRp:FREQuency:FREQuency?` on page 364

Frequency Deviation (Peak) ← Frequency parameters
Maximum of Frequency Deviation vs Time trace.

All chirp frequency deviation table values are calculated from the time domain result:

$fdev(k)= f_{meas}(k) - f_{ideal}(k)$

for chirp start ≤ k ≤ chirp start + chirp length

where:

$f_{meas}(k)$: instantaneous frequency of the measured signal

$f_{ideal}(k)$: ideal frequency trajectory obtained from weighted quadratic regression of the instantaneous signal phase φ_{meas} (k) within the frequency measurement range (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114)

The peak deviation is thus defined as:

$fdev_{peak} = max(|fdev(k)|)$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:FREQuency:MAXFm on page 265
Results:
CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:FREQuency:MAXFm? on page 365

Frequency Deviation (RMS) ← Frequency parameters

$$fdev_{RMS} = \sqrt{\frac{1}{\text{frequency meas range}} \sum_k fdev^2(k)}$$

for k∈ {frequency meas range}

(fdev is defined in "Frequency Deviation (Peak)" on page 55)

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:FREQuency:RMSFm on page 265
Results:
CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:FREQuency:RMSFm? on page 365

Frequency Deviation (Average) ← Frequency parameters

$$fdev_{RMS} = \sqrt{\frac{1}{\text{frequency meas range}} \sum_k fdev^2(k)}$$

for k∈ {frequency meas range}

(fdev is defined in "Frequency Deviation (Peak)" on page 55)

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:FREQuency:AVGFm on page 265
Results:
CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:FREQuency:AVGFm? on page 363

Phase parameters
Chirp phase parameters

All chirp phase deviation table values are calculated from the time domain result:

$\varphi dev(k) = \varphi_{meas}(k) - \varphi_{ideal}(k)$

for chirp start ≤ k ≤ chirp start + chirp length where:

$\varphi_{meas}(k)$: instantaneous phase of the measured signal

$\varphi_{ideal}(k)$: ideal phase trajectory obtained from weighted linear regression of $\varphi_{meas}(k)$ within the frequency meas range

Remote command:
CALCulate<n>:CHRDetection:TABLe:PHASe:ALL[:STATe] on page 265

Phase Deviation (Peak) ← Phase parameters
Maximum of Phase Deviation vs Time trace.

The deviation is calculated within the phase measurement range of the hop (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

$\varphi dev_{peak} = max(|\varphi dev(k)|)$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:PHASe:MAXPm on page 266
Results:
CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:PHASe:MAXPm? on page 367

Phase Deviation (RMS) ← Phase parameters
RMS of Phase Deviation vs Time trace

$$\varphi dev_{RMS} = \sqrt{\frac{1}{\text{frequency meas range}} \sum_k \varphi dev^2(k)}$$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:PHASe:RMSPm on page 266
Results:
CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:PHASe:RMSPm? on page 368

Phase Deviation (Average) ← Phase parameters
Average of Phase Deviation vs Time trace

$$\varphi dev_{avg} = \frac{1}{\text{frequency meas range}} \sum_k \varphi dev(k)$$

for k∈ {frequency meas range}

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:PHASe:AVGPm on page 266
Results:

CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:PHASe:AVGPm? on page 366

Power parameters
Chirp power parameters

Remote command:
CALCulate<n>:CHRDetection:TABLe:POWer:ALL[:STATe] on page 266

Minimum Power ← Power parameters
Minimum power level measured during a chirp. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range settings (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:POWer:MINPower on page 267
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]CHIRp:POWer:MINPower? on page 370

Maximum Power ← Power parameters
Maximum power level measured during a chirp. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range settings (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:POWer:MAXPower on page 267
Results:
CALCulate<n>:HOPDetection:TABLe:RESults? on page 342
[SENSe:]CHIRp:POWer:MAXPower? on page 369

Average Power ← Power parameters
Average power level measured during a chirp. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:POWer:AVEPower on page 267
Results:
CALCulate<n>:CHRDetection:TABLe:RESults? on page 360
[SENSe:]CHIRp:POWer:AVEPower? on page 369

Power Ripple ← Power parameters
The power ripple is defined as the ratio of maximum to minimum power inside the power measurement range of the detected hop (see Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114).

Remote command:
Display:
CALCulate<n>:CHRDetection:TABLe:POWer:PWRRipple on page 267

Results:
`CALCulate<n>:HOPDetection:TABLe:RESults?` on page 342
`[SENSe:]CHIRp:POWer:PWRRipple?` on page 371

5.3 Evaluation Methods for Transient Analysis

Access: "Overview" > "Display Config"

The data that was measured by the R&S FSW can be evaluated using various different methods, depending on the measurement task.

Table 5-1: Available evaluation methods and evaluation basis

Measurement task	Evaluation	Evaluation basis
Frequency domain analysis	RF Spectrum	Full capture buffer Analysis region Individual hop / chirp*)
Time domain analysis	RF Power Time Domain PM Time Domain FM Time Domain PM Time Domain (Wrapped) chirp vs. time	Full capture buffer Analysis region Individual hop / chirp*)
Joint time / frequency analysis	Spectrogram	Full capture buffer Analysis region Individual hop / chirp *)
Demodulation quality analysis	Frequency Deviation Time Domain*) Phase Deviation Time Domain*)	Analysis region Individual hop / chirp
Signal characteristics	Hop/Chirp Results Table*) Hop/Chirp Statistics Table*) Parameter Distribution Parameter Trend	Analysis region
Online I/Q data transfer analysis	RF Spectrum Spectrogram RF Power Time Domain PM Time Domain FM Time Domain PM Time Domain (Wrapped)	Full capture buffer
*) requires additional option R&S FSW-K60C/-K60H		

All evaluation modes available for Transient Analysis are displayed in the selection bar in SmartGrid mode.

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

By default, the Transient Analysis results are displayed in the following windows:

- RF Spectrum (full capture buffer)
- FM Time Domain (analysis region)
- Spectrogram (full capture buffer)
- RF Power Time Domain (analysis region)

If the additional options R&S FSW-K60C/-K60H are installed, the default result displays are:

- RF Spectrum (full capture buffer)
- FM Time Domain (analysis region)
- Spectrogram (full capture buffer)
- Frequency Deviation Time Domain (hop/chirp)
- Hop/Chirp Result Table (analysis region)

The following evaluation methods are available for Transient Analysis:

RF Spectrum

The RF Spectrum diagram displays the measured power levels for the detected hops/chirps. The displayed data corresponds to one particular frame in the spectrogram. During a running measurement, the most recently captured frame is always displayed. During analysis, which frame is displayed depends on the selected frame in the spectrogram configuration (see "Selecting a frame to display" on page 118) or the marker position in the spectrogram (see "Frame (for Spectrograms only)" on page 146).

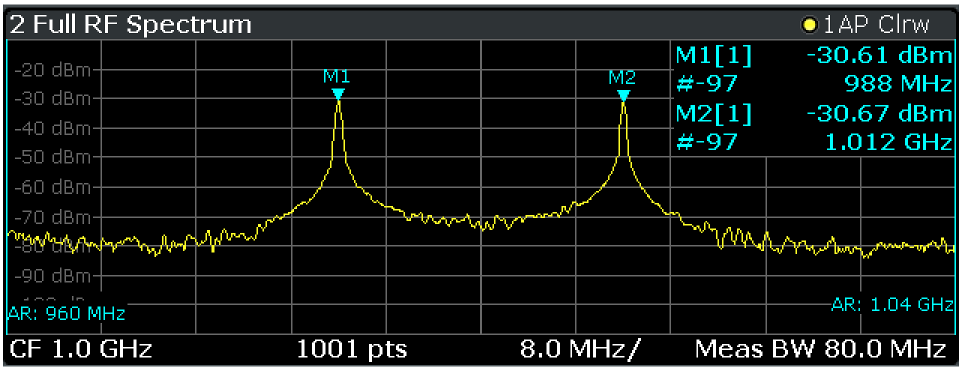


Figure 5-4: RF Spectrum result display

Thus, the RF Spectrum is useful to analyze the input signal measured at a specific time in more detail.

Detected hops/chirps are indicated by green bars along the x-axis in graphical result displays. The selected hop/chirp (see "Select Hop / Select Chirp" on page 130) is indicated by a blue bar. The hop/chirp index as displayed in the Hop/Chirp Results Table is indicated at the bottom of each bar.

In the RF Spectrum for the full capture buffer, the analysis region (AR) is indicated by vertical blue lines.

Remote command:
`LAY:ADD? '1',RIGH, RFSP`, see `LAYout:ADD[:WINDow]?` on page 252

Spectrogram

The spectrogram is a way of displaying multiple consecutive spectra over time. The power, or more exactly the power level, which is usually displayed over frequency, is displayed over frequency and time. Thus, joint analysis in the time and frequency domain is possible.

Graphically, time and frequency represent the vertical and horizontal axes of the diagram. Each coordinate (frequency f, time t) of the diagram is filled with a color representing the level for the respective frequency and time.

At the beginning of a measurement, the diagram is empty. As the measurement advances, the graph is filled line by line from top to bottom. Lines in the spectrogram are called frames, as each frame represents one spectrum.

As the graph fills from top to bottom, the latest spectrum is always the topmost line, whereas older frames move towards the bottom. However, older frames that have disappeared from the visible display area can be returned to view by selecting a particular frame or timestamp.

The frames for each individual sweep are separated by colored lines.

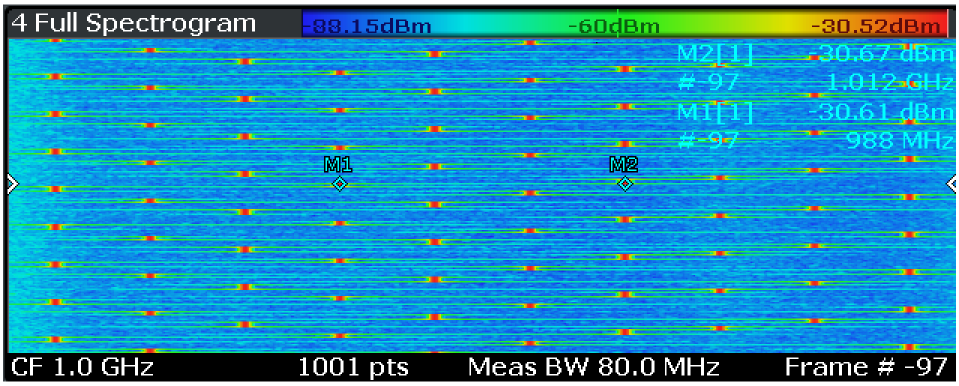


Figure 5-5: Spectrogram of a frequency hopper

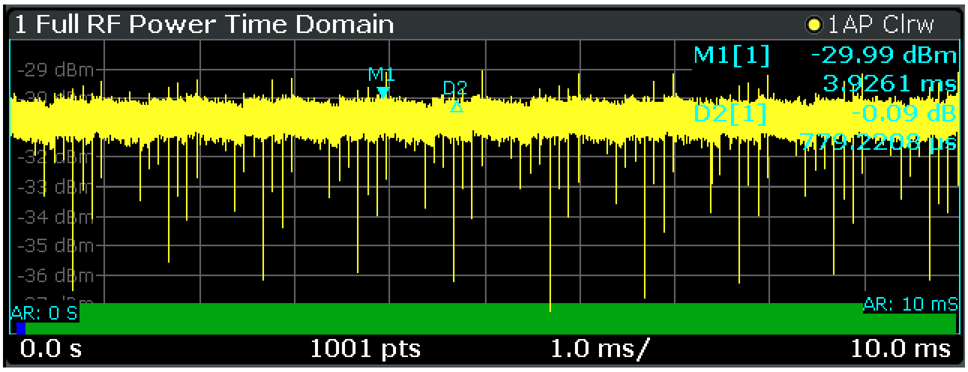
Spectrograms are highly configurable. In particular, the number of frames and the colors used to display the power levels can be defined by the user.

Spectrograms are particularly useful in combination with a spectrum display. In this case, the spectogram provides an overview of events over time, whereas the spectrum provides details for a specific frame.

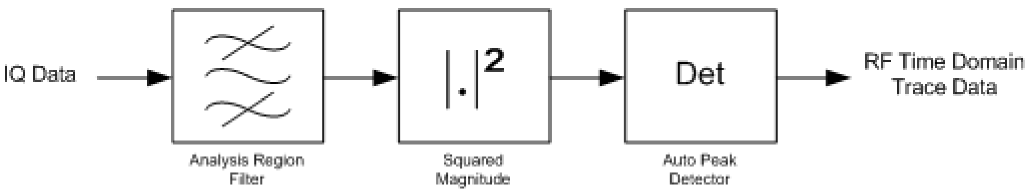
For more information on working with spectrograms see Chapter 4.9, "Working with Spectrograms", on page 33.

Remote command:
`LAY:ADD? '1',RIGH, SGR`, see `LAYout:ADD[:WINDow]?` on page 252

RF Power Time Domain
Displays the RF power (in dBm) versus time.



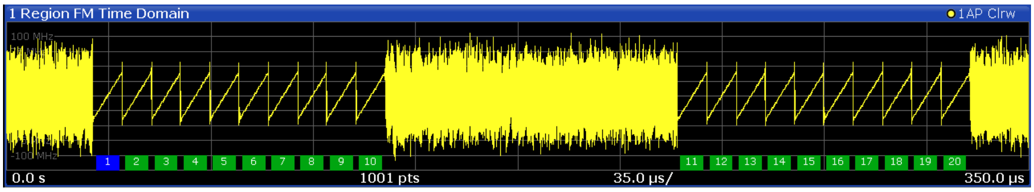
The RF Power Time Domain trace is determined as follows:



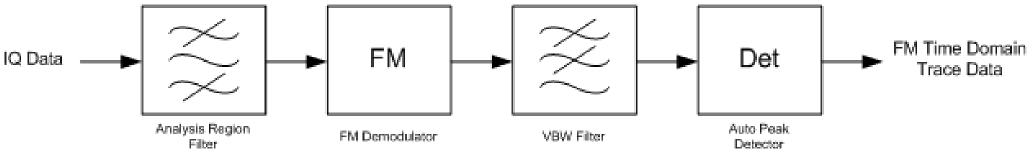
Remote command:
`LAY:ADD? '1',RIGH,RFPT`, see `LAYout:ADD[:WINDow]?` on page 252)

FM Time Domain

Displays the frequency of the demodulated FM signal versus time.



The FM time domain trace is determined as follows:



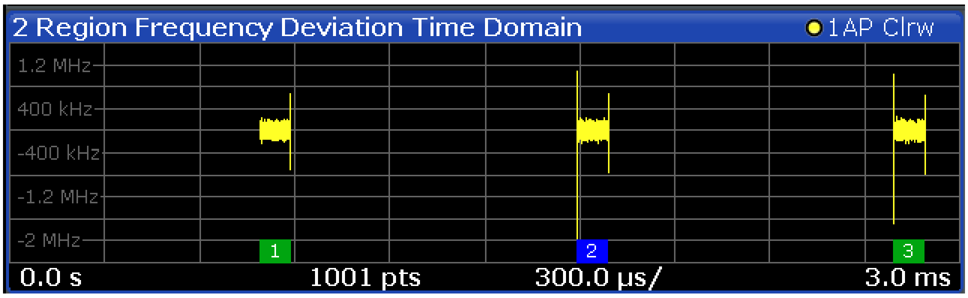
Remote command:

`LAY:ADD? '1',RIGH,FMT`, see `LAYout:ADD[:WINDow]?` on page 252)

Frequency Deviation Time Domain

Displays the frequency error of the demodulated FM signal versus time.

This display requires additional option R&S FSW-K60C/-K60H.



Note: The frequency error is calculated for complete hops/chirps only. Thus, where no (complete) hops/chirps are available, gaps will occur in the error display.

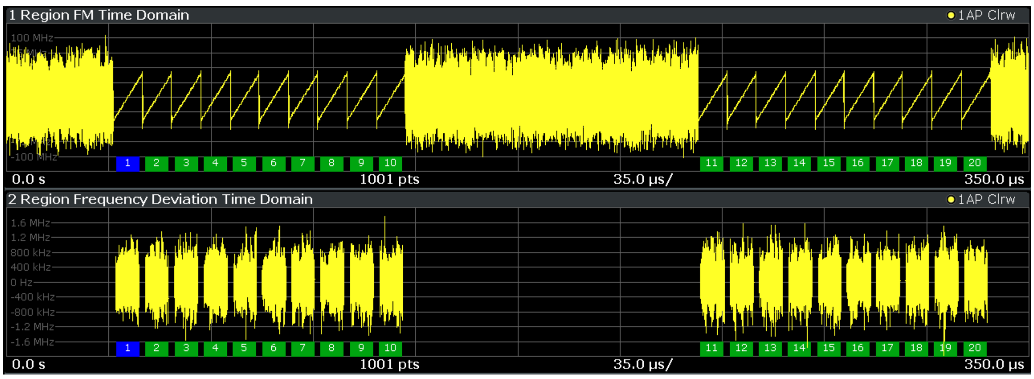


Figure 5-6: Frequency Deviation Time Domain display with gaps where no (complete) chirps are detected

The Frequency Deviation for the analysis region in the hop model is calculated as fol-lows:

$$FMerr(k) = FM(k) - \widehat{f_{avg}}, \qquad hop\ start \leq k \leq hop\ start + dwell\ time$$

Where

$\widehat{f_{avg}}$ *Average frequency estimate obtained from the frequency meas range of a hop*

In the chirp model it is calculated as:

$$FMerr(k) = FM(k) - \widehat{df_{avg}}\left(k - \frac{chirp\ length}{2}\right) - \widehat{f_{avg}}, \qquad chirp\ start \leq k \leq chirp\ start + chirp\ length$$

Where

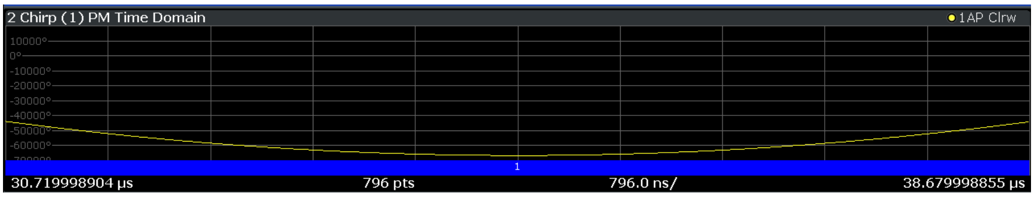
$\widehat{df_{avg}}$ *Average chirp rate estimate obtained from the frequency meas range of a chirp*

$\widehat{f_{avg}}$ *Average frequency estimate w.r.t. the chirp center obtained from the frequency meas range of a chirp*

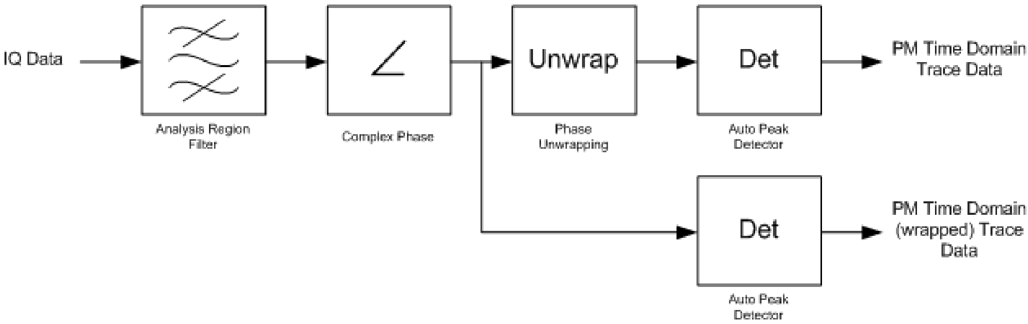
For an individual hop/chirp, $k \in Result\ Range$

Remote command:
`LAY:ADD? '1',RIGH,FDEV`, see `LAYout:ADD[:WINDow]?` on page 252

PM Time Domain
Displays the phase deviations of the demodulated PM signal (in rad or °) versus time.

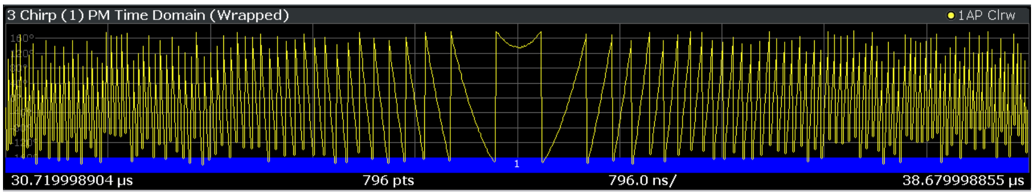


The PM time domain trace is determined as follows:



Remote command:
`LAY:ADD? '1',RIGH,PMT`, see `LAYout:ADD[:WINDow]?` on page 252)

PM Time Domain (Wrapped)
Displays the phase deviations of the *wrapped* demodulated PM signal (in rad or °) versus time.



Remote command:
`LAY:ADD? '1',RIGH,PMWR`, see `LAYout:ADD[:WINDow]?` on page 252

Phase Deviation Time Domain

Displays the phase error of the demodulated PM signal (in rad or °) versus time.

This display requires additional option R&S FSW-K60C/-K60H.

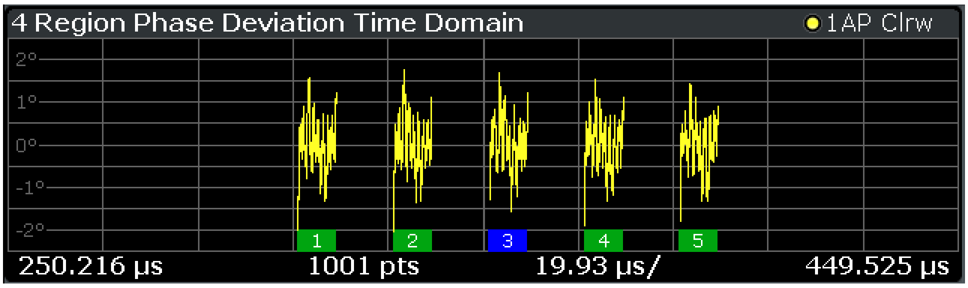


Figure 5-7: Phase deviation per chirp over time

Note: Similar to frequency deviation, the phase error is calculated for complete hops/ chirps only. Thus, where no (complete) hops/chirps are available, gaps will occur in the error display.

The phase deviation for the analysis region in the hop model is calculated as follows:

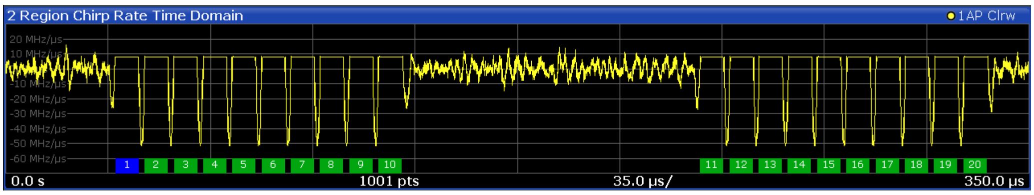
In the chirp model it is calculated as:

For an individual hop/chirp, $k \in$ *Result Range*

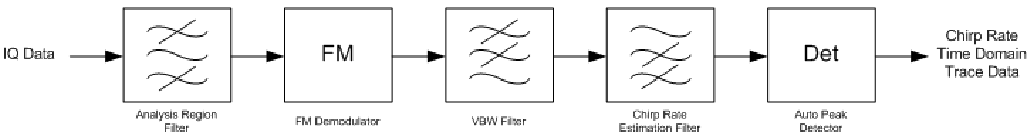
Remote command:
`LAY:ADD? '1',RIGH,PDEV`, see `LAYout:ADD[:WINDow]?` on page 252

Chirp Rate Time Domain

Displays the chirp rate versus time. This display requires additional option R&S FSW-K60C/-K60H.



The chirp rate time domain trace is determined as follows:



Remote command:
`LAY:ADD? '1',RIGH,CRT`, see `LAYout:ADD[:WINDow]?` on page 252

Hop/Chirp Results Table

Displays the automatically detected hop/chirp parameters in a table of results. This display requires additional option R&S FSW-K60C/-K60H.

Which parameters are displayed depends on the "Result Configuration" (see Chapter 7.2.2, "Table Configuration", on page 122). The currently selected hop/chirp is highlighted blue. The remaining hops/chirps contained in the current capture buffer are highlighted green.

5 Hop Results

ID	Hop No.	State Index	Hop Begin (ms)	Dwell Time (ms)	Switching Time (ms)	State Frequency (kHz)	Avg Frequency (kHz)	Hop State Deviation (kHz)	Relative Frequency (kHz)	Freq Dev Peak (kHz)
1	1	0	5.438	0.100	0.100	-4000.033	-4000.000	0.033	...	93.877
2	2	1	5.738	0.100	0.200	4000.133	3999.999	-0.134	8000.000	91.121
3	3	3	5.938	0.100	0.100	-11999.915	-12000.000	-0.085	-15999.999	104.041
4	4	2	6.038	0.100	0.000	11999.897	12000.000	0.104	24000.000	89.876
5	5	4	6.138	0.100	0.000	19999.827	20000.000	0.173	8000.000	129.434
6	6	5	6.238	0.100	0.000	-20000.024	-20000.000	0.023	-40000.001	117.177

Figure 5-8: Hop Results Table

For details on the individual parameters see Chapter 5.1, "Hop Parameters", on page 46 or Chapter 5.2, "Chirp Parameters", on page 52.

Remote command:
`LAY:ADD:WIND '2',RIGH,RTAB` see `LAYout:ADD[:WINDow]?` on page 252

Hop/Chirp Statistics Table

Displays statistical values (minimum, maximum, average, standard deviation) for the measured hop/chirp parameters in a table of results. This display requires additional option R&S FSW-K60C/-K60H.

Both the current capture buffer data and the cummulated captured data from a series of measurements are evaluated. The statistics computed only from hops/chirps within the current capture buffer are highlighted green. For reference, the measured parameters from the Select Hop / Select Chirp are also shown, highlighted blue. The displayed parameters are the same as in the Hop/Chirp Results Table and can be configured in the "Result Configuration" (see Chapter 7.2.2, "Table Configuration", on page 122).

2 Hop Statistics

Statistic	State Index	Hop Begin (ms)	Dwell Time (µs)	Switching Time (ns)	State Frequency (MHz)	Avg Frequency (MHz)	Hop State Deviation (kHz)	Relative Frequency (MHz)	Freq Dev Peak (kHz)
Selected	9	0.056	99.930	50.000	3.992	4.000	8.428	...	2409.827
Average	4	4.256	99.967	32.941	-0.142	-0.141	0.674	0.190	2359.054
Std. Dev.	2	2.468131	0.019397	19.989493	22.953792	22.948780	6.572411	36.459741	317.525893
Maximum	9	8.456	100.000	80.000	36.006	36.000	8.432	64.000	3127.913
Minimum	0	0.056	99.910	10.000	-36.003	-36.000	-8.902	-40.000	1807.365
Average	4	4.939	99.493	32.067	0.061	0.062	0.497	0.098	2373.978
Std. Dev.	2	2.850073	5.610992	19.666186	22.995292	22.989849	7.226803	36.550840	309.108072
Maximum	9	9.899	100.000	120.000	36.008	36.000	11.123	64.000	3540.204
Minimum	0	0.013	4.150	10.000	-36.005	-36.000	-13.500	-40.000	1616.558

Figure 5-9: Hop Statistics Table

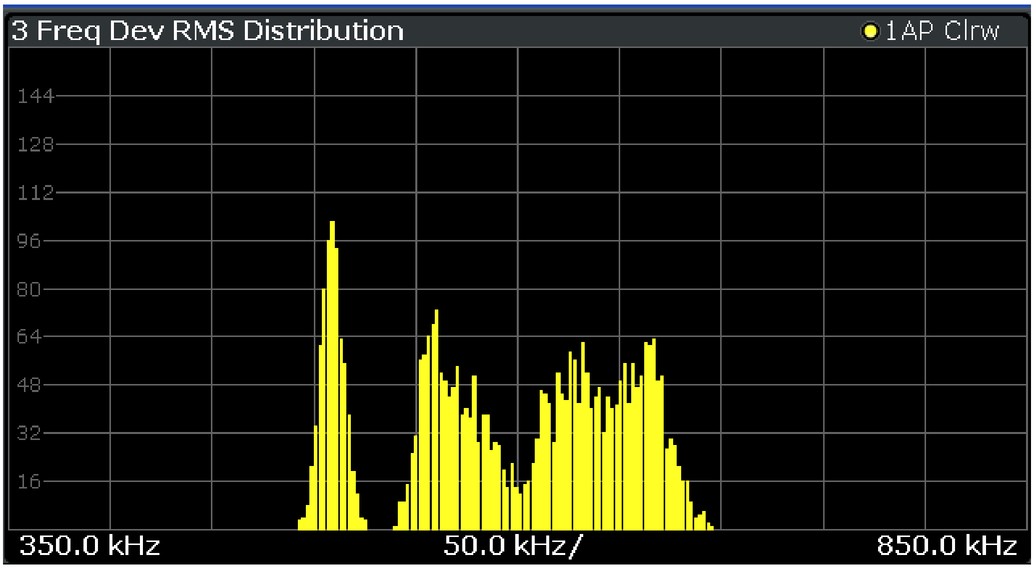
For details on the individual parameters see Chapter 5.1, "Hop Parameters", on page 46 or Chapter 5.2, "Chirp Parameters", on page 52.

Remote command:
`LAY:ADD:WIND '2',RIGH,STAB` see `LAYout:ADD[:WINDow]?` on page 252

Parameter Distribution

Plots a histogram of a particular parameter, i.e. all measured parameter values from the current capture vs hop/chirp count or occurrence in %. Thus you can determine how often a particular parameter value occurs. For each parameter distribution window you can configure a different parameter to be displayed.

This evaluation method allows you to distinguish transient and stable effects in a specific parameter, such as a spurious frequency deviation or a fluctuation in power over several hops.



Note that averaging is not possible for parameter distribution traces.

Remote command:

`LAY:ADD:WIND '2',RIGH,PDIS` see `LAYout:ADD[:WINDow]?` on page 252

`CALCulate<n>:DISTribution:X?` on page 281

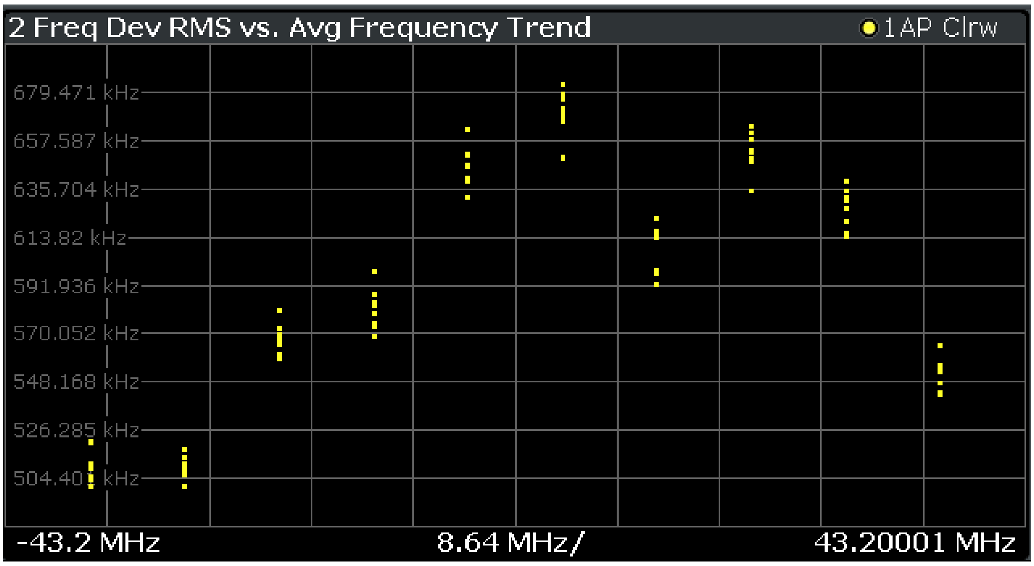
`CALCulate<n>:DISTribution:Y?` on page 282

Chapter 11.6.6, "Configuring Parameter Distribution Displays", on page 275

Parameter Trend

Plots all measured parameter values from the current capture vs another parameter or the hop/chirp state index. This evaluation allows you to determine trends in a specific parameter, such as a frequency deviation or a fluctuation in power over several hops.

For each parameter trend window you can configure a different parameter to be displayed for both the x-axis and the y-axis, making this a very powerful and flexible analysis tool. Note, however, that the same parameter may not be selected on the x-axis and y-axis.



Note that averaging is not possible for parameter trend traces.

Remote command:

`LAY:ADD:WIND '2',RIGH,PTR` see `LAYout:ADD[:WINDow]?` on page 252

`CALCulate<n>:TRENd:X?` on page 283

`CALCulate<n>:TRENd:Y?` on page 283

Chapter 11.6.7, "Configuring Parameter Trends", on page 282

Marker Table

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

6 Marker Table

Wnd	Type	eferenc	Trace	Frame	X-Value	Y-Value
1	M1		1	0	13.25 GHz	-113.96 dBm
1	D2	M1	1	0	-320.0 kHz	-0.52 dB
1	D3	M1	1	0	320.0 kHz	-0.52 dB
1	D4	M1	1	0	-640.0 kHz	-2.08 dB
3	M1		1	0	13.25 GHz	-113.96 dBm
3	D2	M1	1	0	-320.0 kHz	-0.52 dB
3	D3	M1	1	0	320.0 kHz	-0.52 dB
3	D4	M1	1	0	-640.0 kHz	-2.08 dB

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

Remote command:

`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 252

Results:

`CALCulate<n>:MARKer<m>:X` on page 313

`CALCulate<n>:MARKer<m>:Y?` on page 313

6 Configuration

Access: MODE > "Transient Analysis"

Transient analysis requires a special application on the R&S FSW.

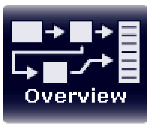
When you switch a measurement channel to the Transient Analysis application the first time, a set of parameters is passed on from the currently active application. After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

When you activate a measurement channel in the Transient Analysis application, a Transient measurement for the input signal is started automatically with the default configuration. The "Meas Config" menu is displayed and provides access to the most important configuration functions.

Automatic refresh of preview and visualization in dialog boxes after configuration changes

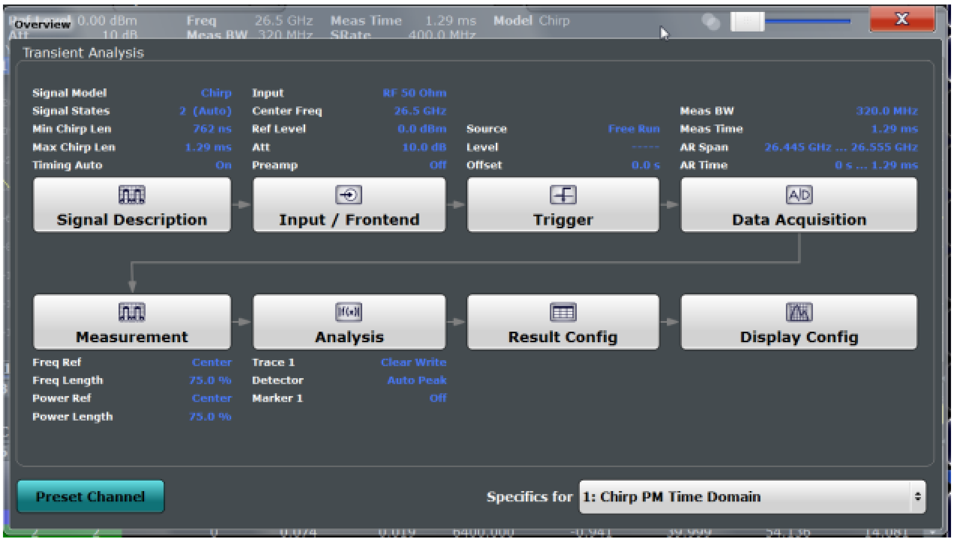
The R&S FSW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before closing the dialog.

6.1 Configuration Overview



Access: all menus

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



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See Chapter 6.2, "Signal Description", on page 71.
2. Input and frontend settings
   See Chapter 6.3, "Input, Output and Frontend Settings", on page 77
3. Triggering
   See Chapter 6.4, "Trigger Settings", on page 101
4. Data acquisition
   See Chapter 6.5, "Data Acquisition and Analysis Region", on page 108
5. Measurement settings
   See Chapter 6.7, "Hop / Chirp Measurement Settings ", on page 114
6. Analysis
   See Chapter 7, "Analysis", on page 120
7. Result configuration
   See Chapter 7.2, "Result Configuration", on page 120
8. Display configuration
   See Chapter 7.1, "Display Configuration", on page 120

To configure settings

► Select any button to open the corresponding dialog box.

Select a setting in the channel bar (at the top of the measurement channel tab) or in the diagram footer of a graphical result display to change a specific setting.

For step-by-step instructions on configuring a measurement for Transient Analysis, see Chapter 8, "How to Perform Transient Analysis", on page 156.

Preset Channel

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 186

Specifics for

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

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

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

6.2 Signal Description

Access: "Overview" > "Signal Description"

The "Signal Description" settings provide information on the expected signal which can improve measurement and analysis.

6.2.1 Signal Model

Access: "Overview" > "Signal Description" > "Signal Model" tab

The signal model defines which type of signal to expect (if known), thus determining the analysis method. These settings are only available if at least one of the additional options R&S FSW-K60C/-K60H are installed.

Hop Model / Chirp Model

Defines which type of signal to expect (if known), thus determining the analysis method.

These settings are only available if the additional options R&S FSW-K60C/-K60H are installed.

For more information see Chapter 4.3, "Signal Models", on page 19.

"Hop Model" Signals "hop" between random carrier frequencies in short intervals

"Chirp Model" The carrier frequency is either increased or decreased linearly over time.

Remote command:
`[SENSe:]SIGNal:MODel` on page 223

6.2.2 Signal States

Access: "Overview" > "Signal Description" > "Signal States" tab

The (nominal) frequencies or chirps the signal is expected to switch to are defined in advance in the "Signal State" table. Each possible frequency/chirp is considered to be a *hop state*/*chirp state*.These settings are only available if at least one of the additional options R&S FSW-K60C/-K60H are installed.

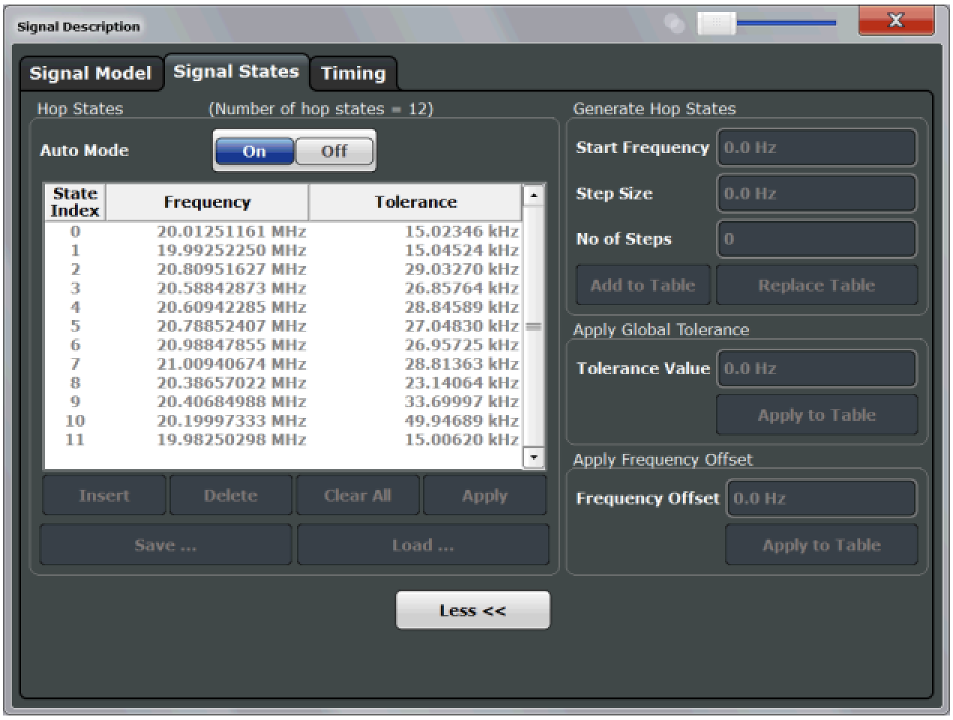


Figure 6-1: Hop States configuration dialog with additional settings

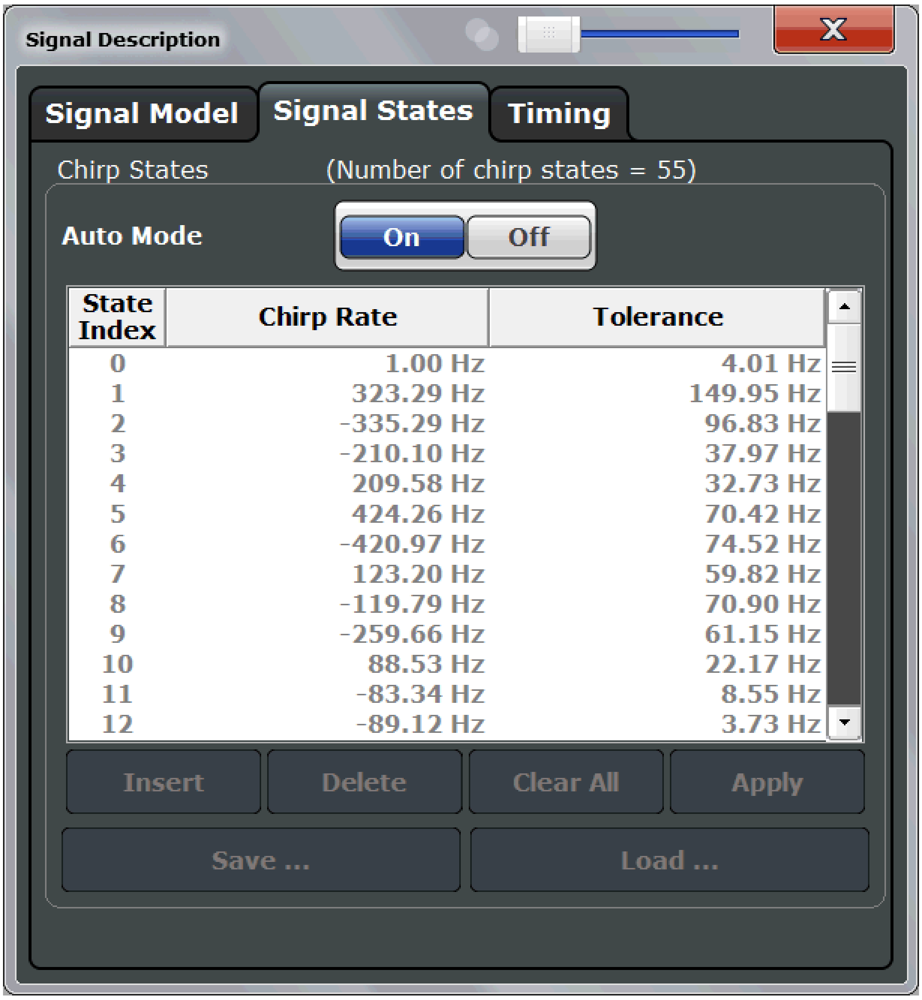


Figure 6-2: Chirp States configuration dialog

For details on the individual parameters see Chapter 4.3.1, "Frequency Hopping", on page 19.

Auto Mode

By default, the R&S FSW Transient Analysis application performs an automatic hop/chirp detection according to the measured data. For an initial overview of the signal at hand this detection is usually sufficient. For more accurate results, particularly if the input signal is known in advance, the signal states can be adapted as required.

For details see Chapter 4.3.3, "Automatic vs. Manual Hop/Chirp State Detection", on page 22.

Remote command:
`CALCulate<n>:CHRDetection:STATes:AUTO` on page 225
`CALCulate<n>:HOPDetection:STATes:AUTO` on page 228

Hop / Chirp State Index

The nominal frequency levels are numbered consecutively in the "Hop States"/"Chirp States" table, starting at 0. A maximum of 1000 states can be defined. The state index of the corresponding nominal frequency level is assigned to each detected hop/chirp in the measured signal.

Remote command:
`CALCulate<n>:HOPDetection:STATes:NUMBer?` on page 229
`CALCulate<n>:CHRDetection:STATes:NUMBer?` on page 226
`CALCulate<n>:HOPDetection:STATes:TABLe:NSTates?` on page 230

Frequency Offset / Chirp Rate

The hop states are defined as frequency offsets from the center frequency. Hops are only detected at these frequencies.

Chirp states are defined as a (linear) chirp rate. Chirps are only detected at these chirp rates.

Remote command:
`CALCulate<n>:CHRDetection:STATes[:DATA]` on page 226
`CALCulate<n>:HOPDetection:STATes[:DATA]` on page 229

Tolerance

A tolerance span can be defined to compensate for settling effects in the signal after switching the frequency. As long as the deviation remains within the tolerance above or below the nominal frequency, the signal state is detected.

Remote command:
`CALCulate<n>:CHRDetection:STATes[:DATA]` on page 226
`CALCulate<n>:HOPDetection:STATes[:DATA]` on page 229

Inserting a signal state

Inserts an additional signal state before the currently selected state.

Deleting a signal state

Deletes the currently selected signal state.

Clearing the signal state table
Deletes all signal states in the signal state table.

Applying changes to the signal state table
Applies the changes to the current signal state table configuration.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:SAVE` on page 231
`CALCulate<n>:CHRDetection:STATes:TABLe:SAVE` on page 226

Saving the signal state table to a file
Saves the current signal state table configuration to a file for later use.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:SAVE` on page 231
`CALCulate<n>:CHRDetection:STATes:TABLe:SAVE` on page 226

Loading a signal state table from a file
Loads the selected signal state table configuration from a file.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:LOAD` on page 230
`CALCulate<n>:CHRDetection:STATes:TABLe:LOAD` on page 226

Generating a series of hop states
For hop signals, additional settings are available which allow you to generate several regularly spaced hop states very easily and quickly.

These settings are displayed or hidden when you select the "More/Less" button in the "Signal States" tab of the "Signal Description" dialog box for hop signals.

Start Frequency ← Generating a series of hop states
The frequency at which the first hop state will be generated.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:STARt?` on page 232

Step Size ← Generating a series of hop states
The distance between two hop states.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:STEP?` on page 232

No of States ← Generating a series of hop states
Number of hop states to be generated. A maximum of 1000 states can be defined in one table.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:NSTates?` on page 230

Add to Table ← Generating a series of hop states
Adds the defined number of hop states, starting at the Start Frequency, with the defined Step Size and a tolerance of 1/2 the Step Size to the existing states in the Hop States table.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:ADD` on page 229

Replace Table ← Generating a series of hop states
Replaces any existing states in the "Hop States" table by the defined number of hop states, starting at the Start Frequency, with the defined Step Size and a tolerance of 1/2 the Step Size.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:REPLace` on page 231

Applying a global tolerance value ← Generating a series of hop states
Applies a global Tolerance value to all hop states in the table at once. By default, a tolerance of 1/2 the Step Size is applied when a series of states is generated.

To edit the tolerance value for an *individual* hop state, select the value directly in the "Hop States" table and enter the new value.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:TOLerance` on page 232

Applying a global frequency offset ← Generating a series of hop states
Applies a global Frequency Offset value to all hop states in the table at once.

To edit the frequency offset for an *individual* hop state, select the value directly in the "Hop States" table and enter the new value.

Remote command:
`CALCulate<n>:HOPDetection:STATes:TABLe:OFFSet` on page 231

6.2.3 Timing

Access: "Overview" > "Signal Description" > "Timing" tab

The dwell time is the time the signal remains in the tolerance area of a nominal hop frequency, that is, the duration of a hop from beginning to end. A hop/chirp is only detected if its dwell time lies within the defined minimum and maximum values.

Auto Mode
If "Auto Mode" is enabled (default), useful dwell time/chirp length limits for the current measurement are defined automatically.

Otherwise, the manually defined Minimum / Maximum values apply.

Remote command:
`CALCulate<n>:CHRDetection:LENGth:AUTO` on page 224
`CALCulate<n>:HOPDetection:DWELl:AUTO` on page 227

Minimum / Maximum
If "Auto Mode" is disabled, you can define minimum or maximum dwell times, or both, manually, in order to detect only specific hops, for example.

Remote command:
`CALCulate<n>:CHRDetection:LENGth:MAXimum` on page 224
`CALCulate<n>:CHRDetection:LENGth:MINimum` on page 225
`CALCulate<n>:HOPDetection:DWELl:MAXimum` on page 227
`CALCulate<n>:HOPDetection:DWELl:MINimum` on page 228

6.3 Input, Output and Frontend Settings

Access: "Overview" > "Input/Frontend"

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

The frequency and amplitude settings represent the "frontend" of the measurement setup.

6.3.1 Input Source Settings

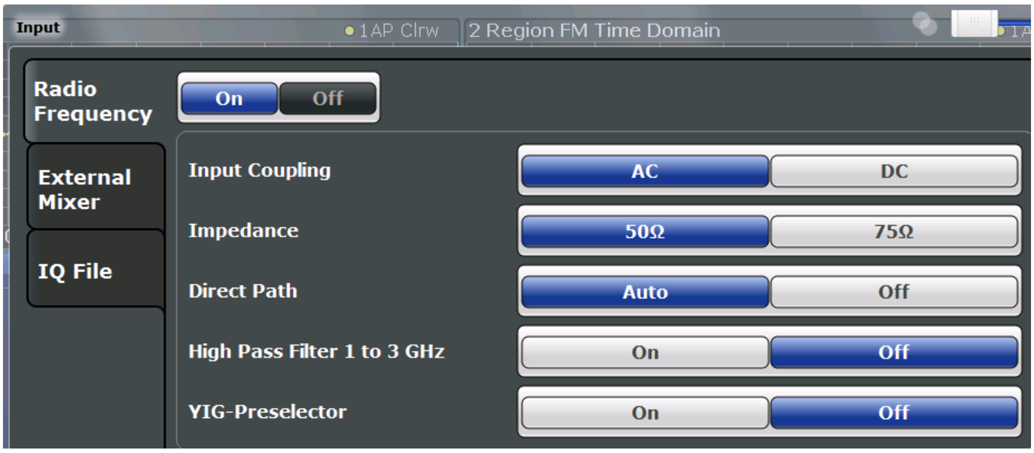
Access: "Overview" > "Input/Frontend" > "Input Source" tab

Some settings are also available in the "Amplitude" tab of the "Amplitude" dialog box.

6.3.1.1 Radio Frequency Input

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

The default input source for the R&S FSW is the radio frequency. If no additional options are installed, this is the only available input source.



Radio Frequency State

Activates input from the RF INPUT connector.

Remote command:
`INPut:SELect` on page 189

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.

Remote command:
`INPut:COUPling` on page 187

Impedance

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

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

Remote command:
`INPut:IMPedance` on page 189

Direct Path
Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be deactivated. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

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

Remote command:
`INPut:DPATh` on page 188

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

This function requires an additional hardware option.

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

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 188

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

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

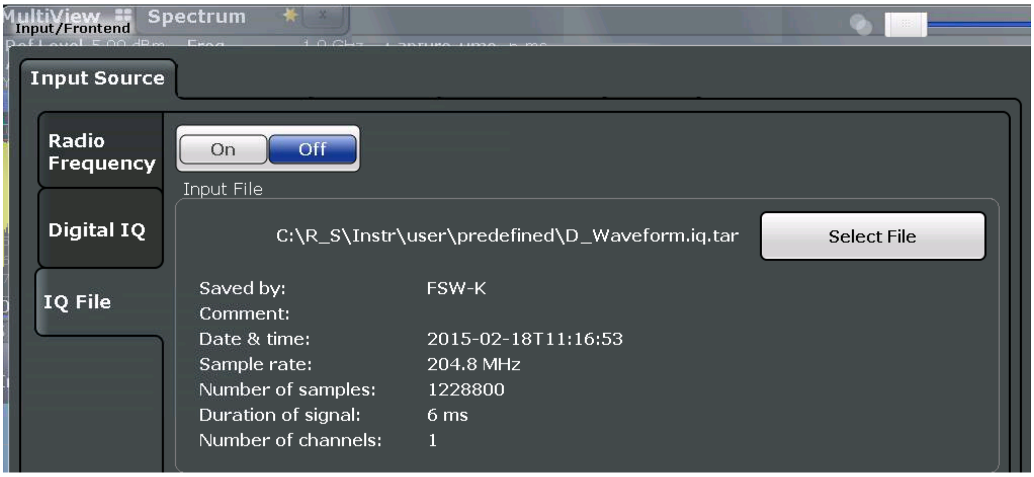
Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 188

6.3.1.2 Settings for Input from I/Q Data Files

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

Or: INPUT/OUTPUT > "Input Source Config" > "Input Source" > "IQ file"



For details, see Chapter 4.10.2, "Basics on Input from I/Q Data Files", on page 40.

I/Q Input File State

Activates input from the selected I/Q input file.

If enabled, the application performs measurements on the data from this file. Thus, most measurement settings related to data acquisition (attenuation, center frequency, measurement bandwidth, sample rate) cannot be changed. The measurement time can only be decreased, to perform measurements on an extract of the available data only.

Note: Even when the file input is deactivated, the input file remains selected and can be activated again quickly by changing the state.

Remote command:
`INPut:SELect` on page 189

Select I/Q Data File

Opens a file selection dialog box to select an input file that contains I/Q data.

Note that the I/Q data must have a specific format (`.iq.tar`) as described in Chapter A.2, "I/Q Data File Format (iq-tar)", on page 390.

The default storage location for I/Q data files is `C:\R_S\Instr\user\`.

Remote command:
`INPut:FILE:PATH` on page 202

6.3.1.3 External Mixer Settings

Access: INPUT/OUTPUT > "External Mixer Config"

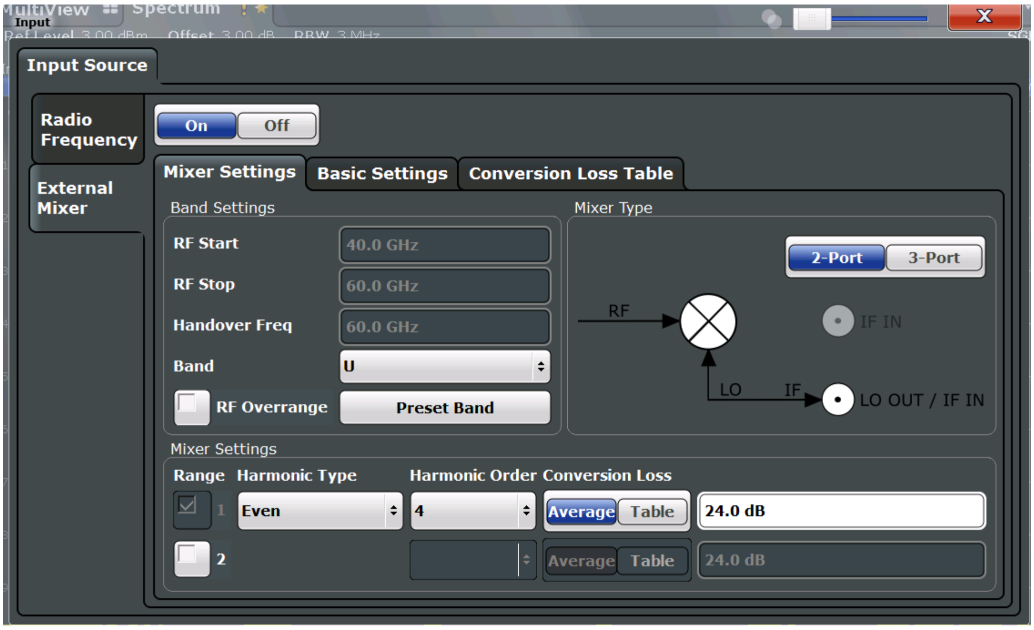
If installed, the optional external mixer can be configured from the R&S FSW Transient Analysis application.

Note that external mixers are not supported in MSRA/MSRT mode.

For details on using external mixers, see the R&S FSW User Manual.

Mixer Settings

Access: INPUT/OUTPUT > "External Mixer Config" > "Mixer Settings"



External Mixer State

Activates or deactivates the external mixer for input. If activated, "ExtMix" is indicated in the channel bar of the application, together with the used band (see "Band" on page 82).

Remote command:

`[SENSe:]MIXer[:STATe]` on page 190

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 83).

For details on available frequency ranges, see table 11-3 on page 193.

Remote command:
`[SENSe:]MIXer:FREQuency:STARt?` on page 192
`[SENSe:]MIXer:FREQuency:STOP?` on page 192

Handover Freq.

If due to the LO frequency the conversion of the input signal is not possible using one harmonic, the band must be split. An adjacent, partially overlapping frequency range can be defined using different harmonics (see "Mixer Settings (Harmonics Configuration)" on page 83). In this case, the sweep begins using the harmonic defined for the first range. At the specified "handover frequency" in the overlapping range, it switches to the harmonic for the second range.

The handover frequency can be selected freely within the overlapping frequency range.

Remote command:
`[SENSe:]MIXer:FREQuency:HANDover` on page 191

Band

Defines the waveguide frequency band or user-defined frequency band to be used by the mixer.

The start and stop frequencies of the selected band are displayed in the "RF Start" and "RF Stop" fields.

For a definition of the frequency range for the pre-defined bands, see table 11-3 on page 193.

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 83).

Remote command:
`[SENSe:]MIXer:HARMonic:BAND[:VALue]` on page 192

RF Overrange

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

If "RF Overrange" is enabled, the frequency range is not restricted by the band limits ("RF Start" and "RF Stop"). In this case, the full frequency range that can be reached using the selected harmonics is used.

Remote command:
`[SENSe:]MIXer:RFOVerrange[:STATe]` on page 195

Preset Band

Restores the presettings for the selected band.

Note: changes to the band and mixer settings are maintained even after using the PRESET function. This function allows you to restore the original band settings.

Remote command:
`[SENSe:]MIXer:HARMonic:BAND:PRESet` on page 192

Mixer Type

The External Mixer option 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

Remote command:
`[SENSe:]MIXer:PORTs` on page 195

Mixer Settings (Harmonics Configuration)

The harmonics configuration determines the frequency range for user-defined bands (see "Band" on page 82).

Range 1/2 ← Mixer Settings (Harmonics Configuration)

Enables the use of one or two frequency ranges, where the second range is based on another harmonic frequency of the mixer to cover the band's frequency range.

For each range, you can define which harmonic to use and how the Conversion loss is handled.

Remote command:
`[SENSe:]MIXer:HARMonic:HIGH:STATe` on page 193

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 83). Which harmonics are supported depends on the mixer type.

Remote command:
`[SENSe:]MIXer:HARMonic:TYPE` on page 194

Harmonic Order ← Mixer Settings (Harmonics Configuration)

Defines which order of the harmonic of the LO frequencies is used to cover the frequency range.

By default, the lowest order of the specified harmonic type is selected that allows conversion of input signals in the whole band. If due to the LO frequency the conversion is not possible using one harmonic, the band is split.

For the "USER" band, you define the order of harmonic yourself. The order of harmonic can be between 2 and 61, the lowest usable frequency being 26.5 GHz.

Remote command:
`[SENSe:]MIXer:HARMonic[:LOW]` on page 194
`[SENSe:]MIXer:HARMonic:HIGH[:VALue]` on page 193

Conversion loss ← Mixer Settings (Harmonics Configuration)
Defines how the conversion loss is handled. The following methods are available:

"Average" Defines the average conversion loss for the entire frequency range in dB.

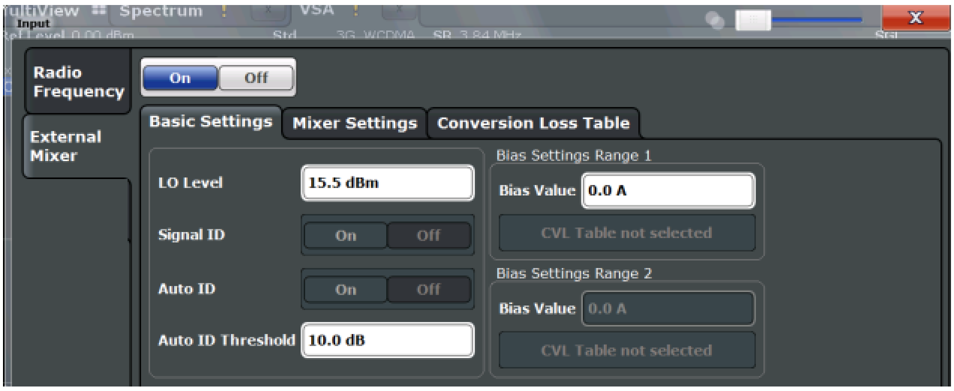
"Table" Defines the conversion loss via the table selected from the list. Predefined conversion loss tables are often provided with the external mixer and can be imported to the R&S FSW. Alternatively, you can define your own conversion loss tables. Imported tables are checked for compatibility with the current settings before being assigned.
Conversion loss tables are configured and managed in the Conversion Loss Table tab.
For details on importing tables, see "Import Table" on page 86.

Remote command:
Average for range 1:
`[SENSe:]MIXer:LOSS[:LOW]` on page 195
Table for range 1:
`[SENSe:]MIXer:LOSS:TABLe[:LOW]` on page 195
Average for range 2:
`[SENSe:]MIXer:LOSS:HIGH` on page 194
Table for range 2:
`[SENSe:]MIXer:LOSS:TABLe:HIGH` on page 194

Basic Settings

Access: INPUT/OUTPUT > "External Mixer Config" > "Basic Settings"

The basic settings concern general use of an external mixer. They are only available if the External Mixer State is "On".



LO Level
Defines the LO level of the external mixer's LO port. Possible values are from 13.0 dBm to 17.0 dBm in 0.1 dB steps. Default value is 15.5 dB.

Remote command:
[SENSe:]MIXer:LOPower on page 191

Signal ID / Auto ID / Auto ID Threshold
Not available for the R&S FSW Transient Analysis application.

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).

Tip: The trace in the currently active result display (if applicable) is adapted to the settings immediately so you can check the results.

To store the bias setting in the currently selected conversion loss table, select the Write to <CVL table name> button.

Remote command:
[SENSe:]MIXer:BIAS[:LOW] on page 190
[SENSe:]MIXer:BIAS:HIGH on page 190

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 85). If no conversion loss table is selected yet, this function is not available ("CVL Table not selected").

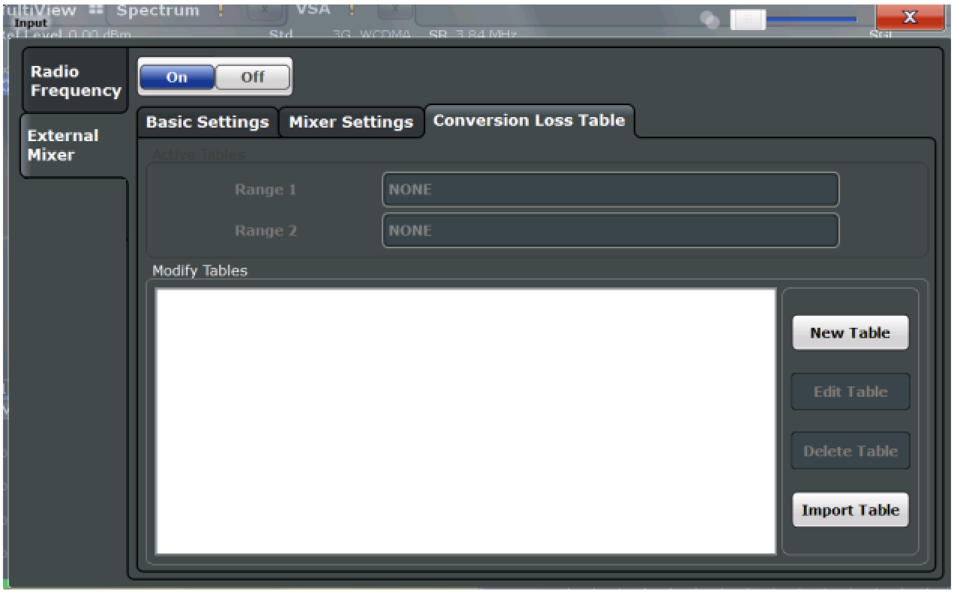
Remote command:
[SENSe:]CORRection:CVL:BIAS on page 196

Managing Conversion Loss Tables

Access: INPUT/OUTPUT > "External Mixer Config" > "Conversion Loss Table"

In this tab, you configure and manage conversion loss tables. Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. The correction values for frequencies between the reference points are obtained via interpolation.

The currently selected table for each range is displayed at the top of the dialog box. All conversion loss tables found in the instrument's C:\R_S\INSTR\USER\cvl\ directory are listed in the "Modify Tables" list.



New Table

Opens the "Edit Conversion loss table" dialog box to configure a new conversion loss table. For details on table configuration, see "Creating and Editing Conversion Loss Tables" on page 87.

Remote command:
`[SENSe:]CORRection:CVL:SELect` on page 199

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 87.

Note that only common conversion loss tables (in `.acl` files) can be edited. Special B2000 tables (in `b2g` files) can only be imported and deleted.

Remote command:
`[SENSe:]CORRection:CVL:SELect` on page 199

Delete Table

Deletes the currently selected conversion loss table after you confirm the action.

Remote command:
`[SENSe:]CORRection:CVL:CLEAr` on page 197

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 84).

Note: When using the optional 2 GHz bandwidth extension (R&S FSW-B2000), special conversion loss tables are required. Supported tables have the file extension `.b2g`, as opposed to `.acl` for common tables.
While `.acl` files can be used, data acquisition with the B2000 option using such conversion loss tables will lead to substantial inaccuracy. Using no conversion loss tables at all during data acquisition with the B2000 option will cause even more inaccuracy.

Note that only common conversion loss tables (in `.acl` files) can be edited. Special B2000 tables (in `b2g` files) can only be imported and deleted.

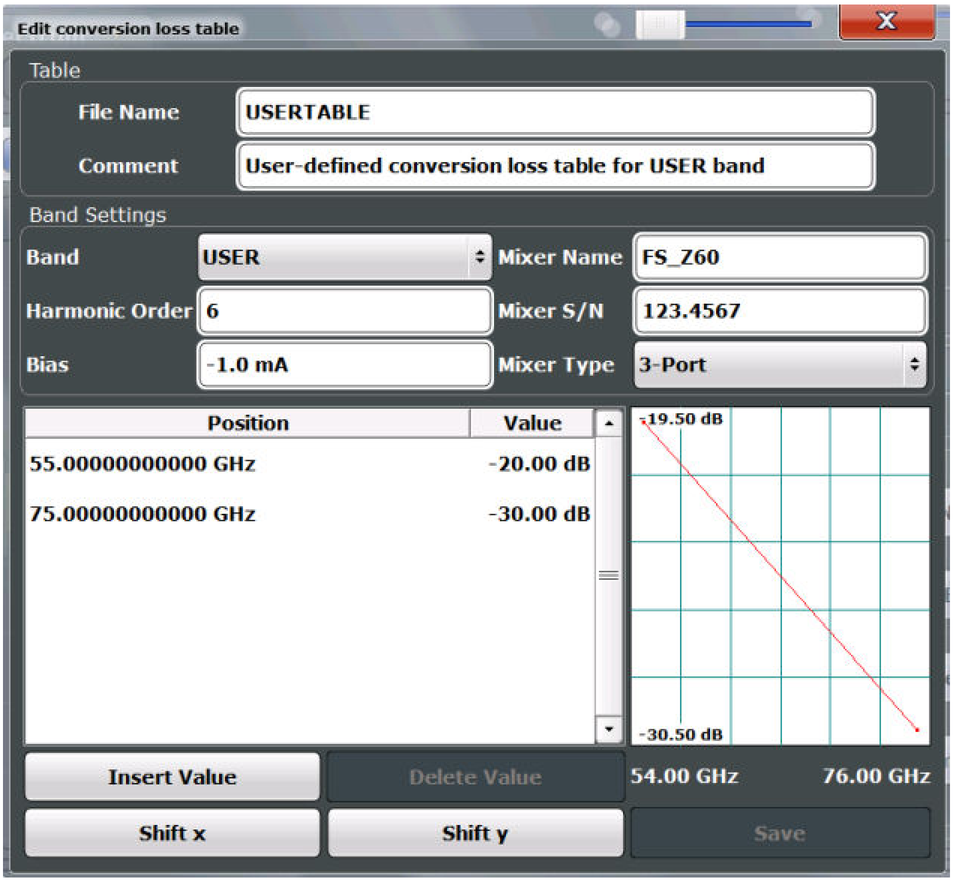
For more details, see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Creating and Editing Conversion Loss Tables

Access: INPUT/OUTPUT > "External Mixer Config" > "Conversion Loss Table" > "New Table" / "Edit Table"

Conversion loss tables can be newly defined and edited.

A preview pane displays the current configuration of the conversion loss function as described by the position/value entries.



File Name

Defines the name under which the table is stored in the `C:\R_S\INSTR\USER\cvl\` directory on the instrument. The name of the table is identical with the name of the file (without extension) in which the table is stored. This setting is mandatory. The `.ACL` extension is automatically appended during storage.

Note: When using the optional 2 GHz bandwidth extension (R&S FSW-B2000), special conversion loss tables are required. These tables are stored with the file extension `.b2g`.

Remote command:

`[SENSe:]CORRection:CVL:SELect` on page 199

Comment

An optional comment that describes the conversion loss table. The comment is user-definable.

Remote command:

`[SENSe:]CORRection:CVL:COMMent` on page 197

Band

The waveguide or user-defined band to which the table applies. This setting is checked against the current mixer setting before the table can be assigned to the range.

For a definition of the frequency range for the pre-defined bands, see table 11-3 on page 193.

Remote command:

`[SENSe:]CORRection:CVL:BAND` on page 196

Harmonic Order

The harmonic order of the range to which the table applies. This setting is checked against the current mixer setting before the table can be assigned to the range.

Remote command:

`[SENSe:]CORRection:CVL:HARMonic` on page 198

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 85.

Remote command:
[SENSe:]CORRection:CVL:BIAS on page 196

Mixer Name
Specifies the name of the external mixer to which the table applies. This setting is checked against the current mixer setting before the table can be assigned to the range.

Remote command:
[SENSe:]CORRection:CVL:MIXer on page 198

Mixer S/N
Specifies the serial number of the external mixer to which the table applies.

The specified number is checked against the currently connected mixer number before the table can be assigned to the range.

Remote command:
[SENSe:]CORRection:CVL:SNUMber on page 199

Mixer Type
Specifies whether the external mixer to which the table applies is a two-port or three-port type. This setting is checked against the current mixer setting before the table can be assigned to the range.

Remote command:
[SENSe:]CORRection:CVL:PORTs on page 199

Position/Value
Each position/value pair defines the conversion loss value in dB for a specific frequency. The reference values must be entered in order of increasing frequencies. A maximum of 50 reference values can be entered. To enter a new value pair, select an empty space in the "Position/Value" table, or select the Insert Value button.

Correction values for frequencies between the reference values are interpolated. Linear interpolation is performed if the table contains only two values. If it contains more than two reference values, spline interpolation is carried out. Outside the frequency range covered by the table, the conversion loss is assumed to be the same as that for the first and last reference value.

The current configuration of the conversion loss function as described by the position/value entries is displayed in the preview pane to the right of the table.

Remote command:
[SENSe:]CORRection:CVL:DATA on page 198

Insert Value
Inserts a new position/value entry in the table.

If the table is empty, a new entry at 0 Hz is inserted.

If entries already exist, a new entry is inserted above the selected entry. The position of the new entry is selected such that it divides the span to the previous entry in half.

Delete Value
Deletes the currently selected position/value entry.

Shift x
Shifts all positions in the table by a specific value. The value can be entered in the edit dialog box. The conversion loss function in the preview pane is shifted along the x-axis.

Shift y
Shifts all conversion loss values by a specific value. The value can be entered in the edit dialog box. The conversion loss function in the preview pane is shifted along the y-axis.

Save
The conversion loss table is stored under the specified file name in the `C:\R_S\INSTR\USER\cvl\` directory of the instrument.

6.3.1.4 Settings for 2 GHz Bandwidth Extension (R&S FSW-B2000)

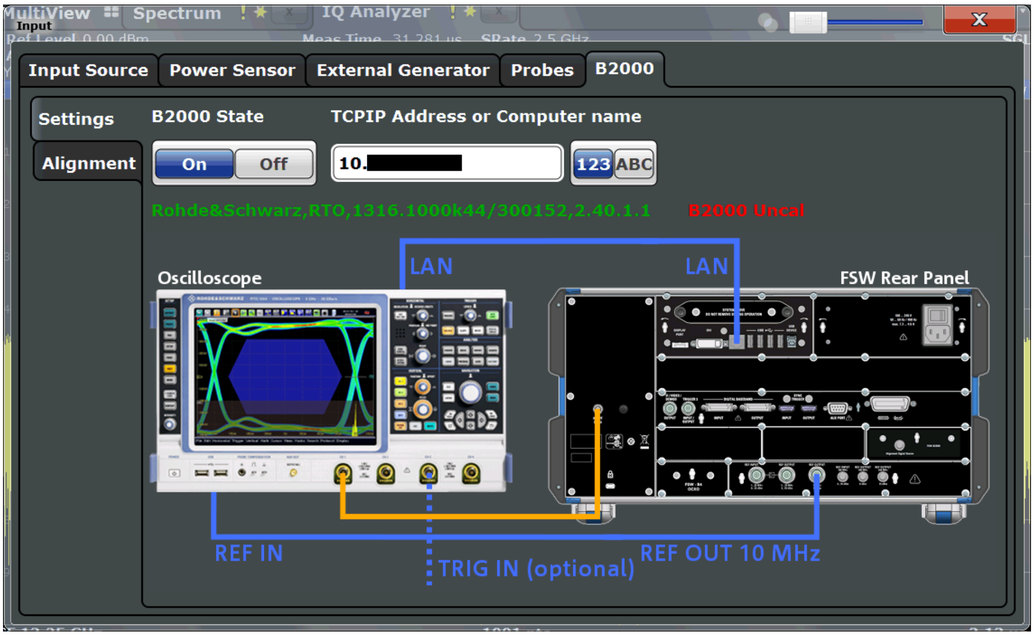
Access: INPUT/OUTPUT > "B2000 Config"

The R&S FSW Transient Analysis application supports the optional 2 GHz bandwidth extension (R&S FSW-B2000), if installed.

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

General Settings

Access: INPUT/OUTPUT > "B2000 Config" > "Settings"



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

B2000 State

Activates the optional 2 GHz bandwidth extension (R&S FSW-B2000).

Note: Manual operation on the connected oscilloscope, or remote operation other than by the R&S FSW, is not possible while the B2000 option is active.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe]` on page 203

TCPIP Address or Computer name

When using the optional 2 GHz bandwidth extension (R&S FSW-B2000), the entire measurement via the IF OUT 2 GHZ connector and an oscilloscope, as well as both instruments, are controlled by the R&S FSW. Thus, the instruments must be connected via LAN, and the TCPIP address or computer name of the oscilloscope must be defined on the R&S FSW.

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

As soon as a name or address is entered, the R&S FSW attempts to establish a connection to the oscilloscope. If it is detected, the oscilloscope's identity string is queried and displayed in the dialog box. The alignment status is also displayed (see "Alignment" on page 91).

Note: The IP address / computer name is maintained after a PRESET, and is transferred between applications.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip` on page 205
`SYSTem:COMMunicate:RDEVice:OSCilloscope:IDN?` on page 205

Alignment

Access: INPUT/OUTPUT > "B2000 Config" > "Alignment"

An initial alignment of the output to the oscilloscope is required once after setup. It need only be repeated if a new oscilloscope is connected to the IF OUT 2 GHZ connector of the R&S FSW, or if new firmware is installed on the oscilloscope.

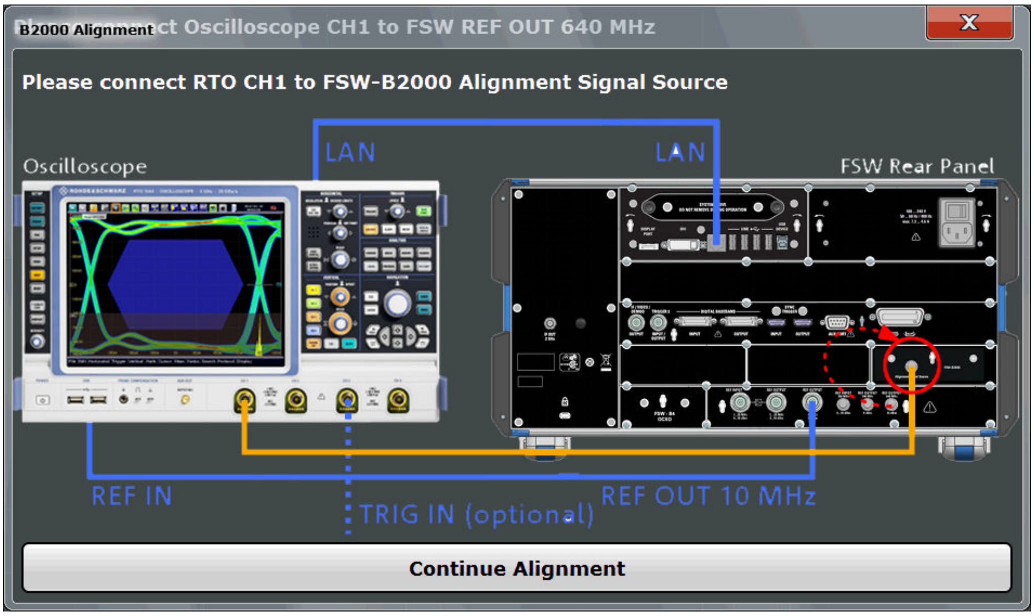
The required connections between the R&S FSW and the oscilloscope are illustrated in the dialog box.

Alignment consists of two steps. The first step requires a (temporary) connection from the REF OUTPUT 640 MHZ connector on the R&S FSW to the CH1 input on the oscilloscope.

To perform the alignment, select the "Alignment" button.

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

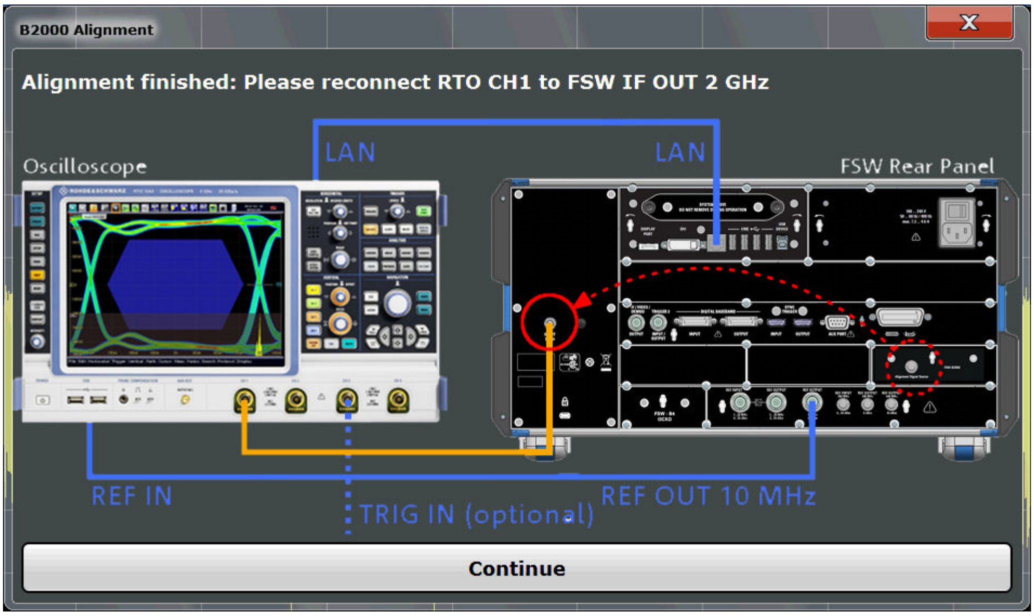
If the oscilloscope and the oscilloscope ADC are aligned successfully, a new dialog box is displayed.



For the second alignment step, the connector must be disconnected from the REF OUTPUT 640 MHZ connector and instead connected to the FSW B2000 ALIGNMENT SIGNAL SOURCE connector on the R&S FSW.

To continue the alignment, select the "Continue Alignment" button.

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



In order to switch from alignment mode to measurement mode, move the cable from the FSW B2000 ALIGNMENT SIGNAL SOURCE back to the IF OUT 2 GHZ connector, so that it is then connected to the CH1 input on the oscilloscope.

If UNCAL is displayed, alignment was not yet performed (successfully).

If both alignment steps were performed successfully, the date of alignment is indicated.

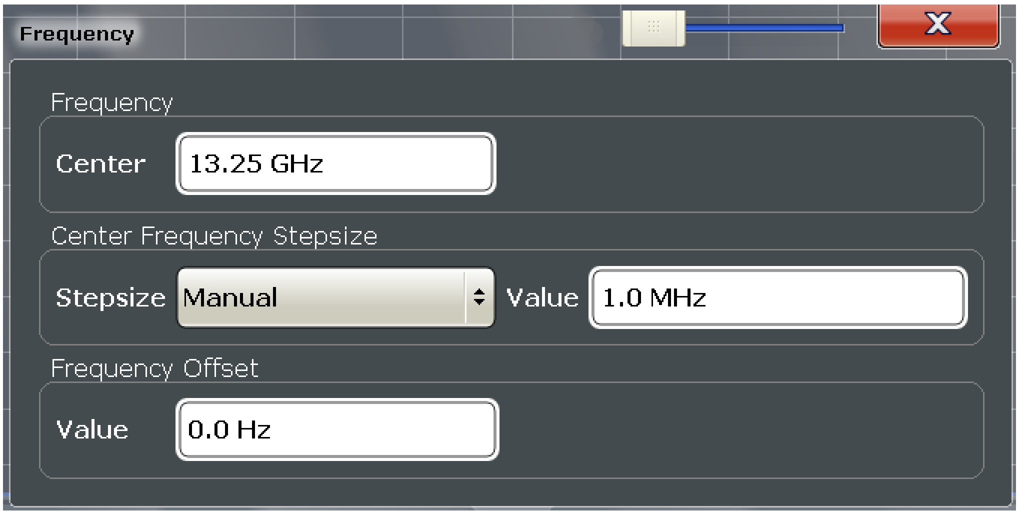
Remote commands:

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:STEP[:STATe]?
on page 204

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:DATE?
on page 204

6.3.2 Frequency Settings

Access: "Overview" > "Input/Frontend" > "Frequency" tab



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

Remote command:
[SENSe:]FREQuency:CENTer on page 208

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

When you use the rotary knob the center frequency changes in steps of only 1/10 of the span.

The step size can be coupled to another value or it can be manually set to a fixed value.

"= Center" Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.

"Manual" Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
[SENSe:]FREQuency:CENTer:STEP on page 209

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

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

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

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

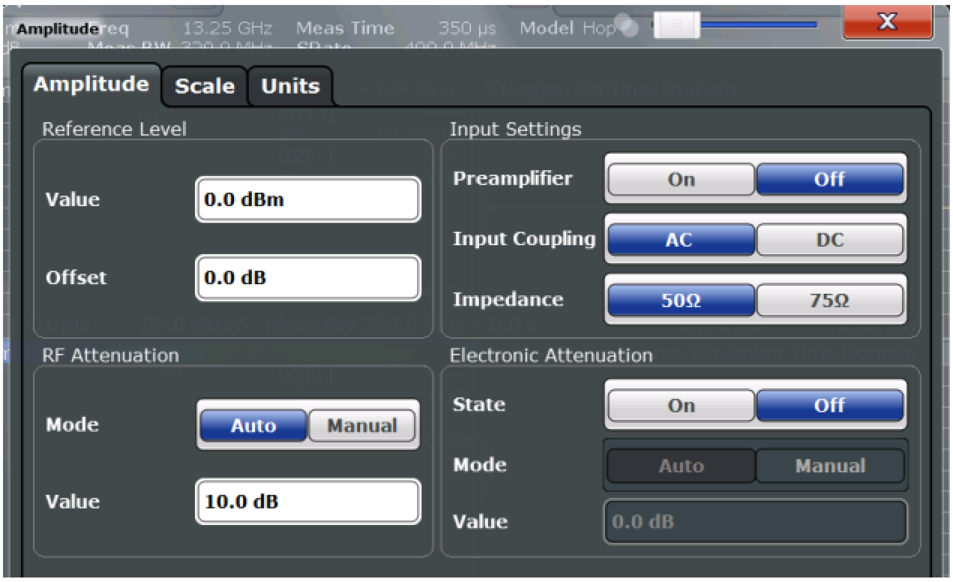
Note: In MSRA/MSRT mode, this function is only available for the MSRA/MSRT Master.

Remote command:
[SENSe:]FREQuency:OFFSet on page 209

6.3.3 Amplitude Settings

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

Amplitude settings affect the signal power or error levels.



Note that amplitude settings are not window-specific, as opposed to the scaling and unit settings.

Reference Level

Defines the expected maximum input signal level. Signal levels above this value may not be measured correctly, which is indicated by the "IF OVLD" status display.

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 210

Shifting the Display (Offset) ← Reference Level

Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis is changed accordingly.

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

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 210

RF Attenuation

Defines the mechanical attenuation for 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 no overload occurs at the RF INPUT connector for the current reference level. It is the default setting.

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

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

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

Remote command:
INPut:ATTenuation on page 211
INPut:ATTenuation:AUTO on page 212

Using Electronic Attenuation

If the (optional) Electronic Attenuation hardware is installed on the R&S FSW, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

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 can 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.

For the R&S FSW85, the mechanical attenuation can be varied only in 10 dB steps.

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

Remote command:
INPut:EATT:STATe on page 213
INPut:EATT:AUTO on page 212
INPut:EATT on page 212

Input Settings

Some input settings affect the measured amplitude of the signal, as well.

For information on other input settings see Chapter 6.3.1.1, "Radio Frequency Input", on page 77.

Preamplifier ← Input Settings

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

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

For R&S FSW26 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW8 or 13 models, the following settings are available:

"Off" Deactivates the preamplifier.

"15 dB"	The RF input signal is amplified by about 15 dB.
"30 dB"	The RF input signal is amplified by about 30 dB.

Remote command:
INPut:GAIN:STATe on page 211
INPut:GAIN[:VALue] on page 211

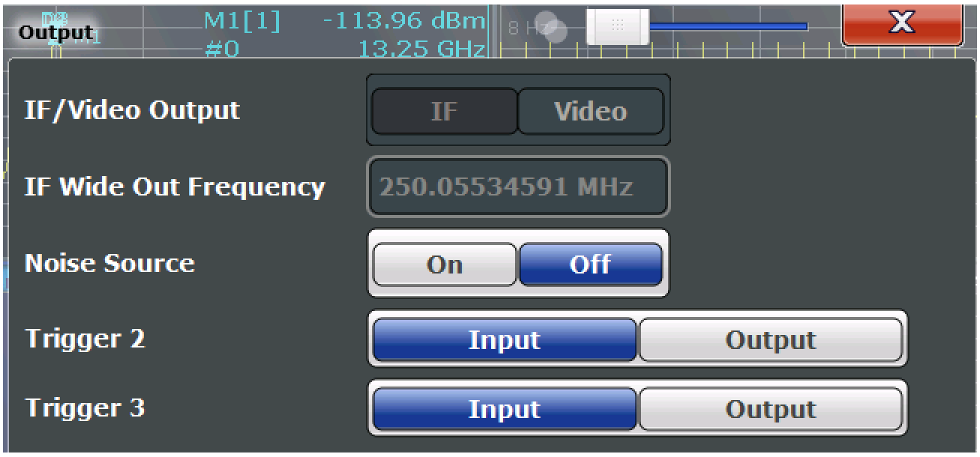
6.3.4 Output Settings

Access: INPUT/OUTPUT > "Output"

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

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

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



IF/Video Output
Defines the type of signal available at the IF/VIDEO/DEMOD on the rear panel of the R&S FSW.

For restrictions and additional information, see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

"IF"	The measured IF value is available at the IF/VIDEO/DEMOD output connector.
"IF 2 GHz Out"	The measured IF value is provided at the IF OUT 2 GHZ output connector, if available, at a frequency of 2 GHz. If the optional 2 GHz bandwidth extension (R&S FSW-B2000) option is installed and active, this is the *only* option available for IF output. When the B2000 option is activated, the basic IF OUT 2 GHZ output is automatically deactivated. It is not reactivated when the B2000 option is switched off.

Remote command:
`OUTPut:IF[:SOURce]` on page 207

IF (Wide) Out Frequency

Defines or indicates the frequency at which the IF signal level is provided at 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).

Remote command:
`OUTPut:IF:IFFRequency` on page 208

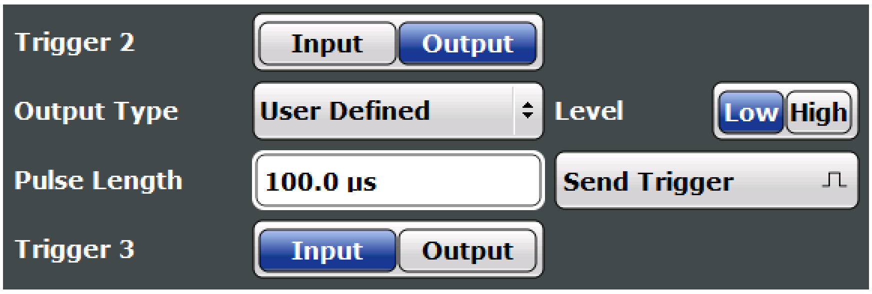
Noise Source

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

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 207

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. Trigger input parameters are available in the "Trigger" dialog box.

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

Remote command:
`OUTPut:TRIGger<port>:DIRection` on page 219

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.

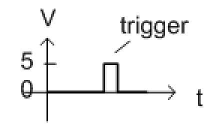
"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the AUX port (pin 9).

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

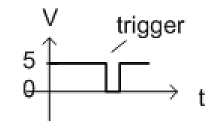
Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 219

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector.

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



low-level constant, high-level trigger



high-level constant, low-level trigger

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 219

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 220

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level = High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

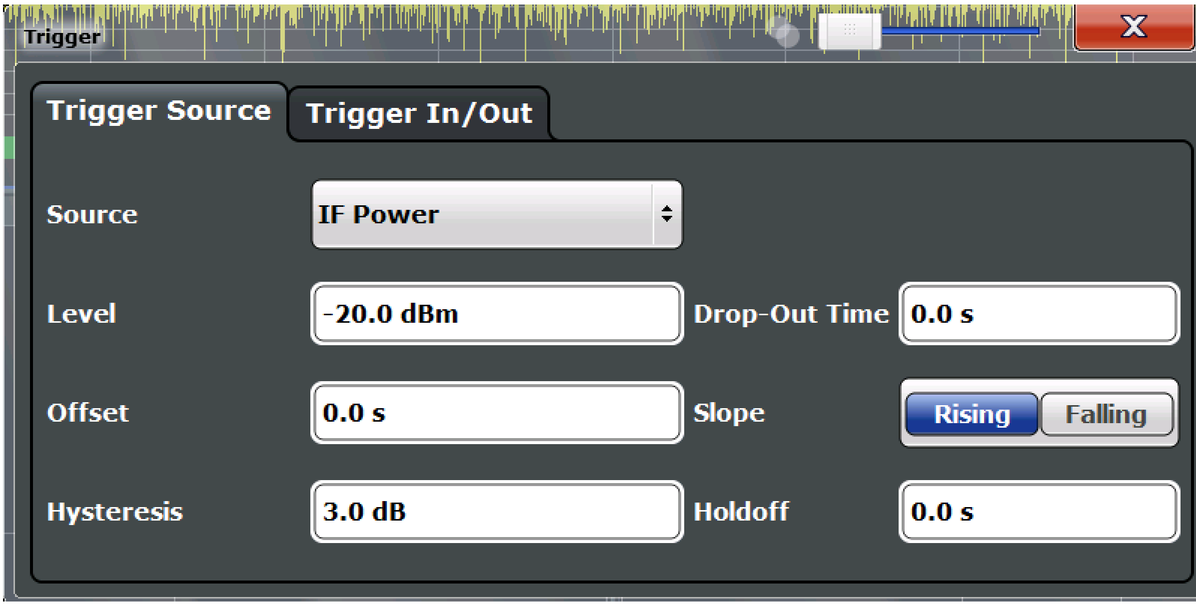
Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 220

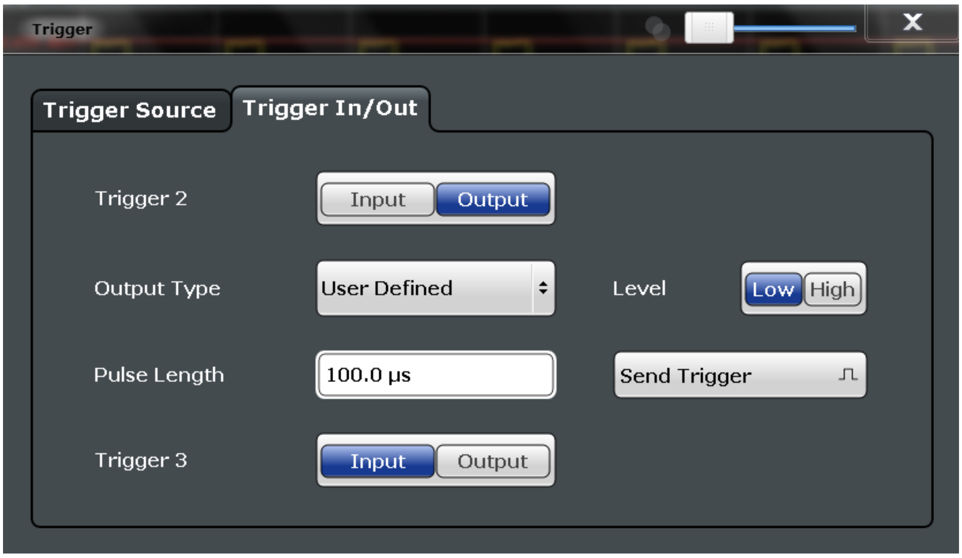
6.4 Trigger Settings

Access: "Overview" > "Trigger" > "Trigger Source"/"Trigger In/Out"

Trigger settings determine when the input signal is measured. Note that gating is not available for hop measurements.



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 measurements, see the R&S FSW User Manual.

MSRA/MSRT operating mode

In MSRA/MSRT operating mode, only the MSRA/MSRT Master channel actually captures data from the input signal. Thus, no trigger settings are available in the Transient Analysis application in MSRA/MSRT operating mode. However, a **capture offset** can be defined with a similar effect as a trigger offset. It defines an offset from the start of the captured data (from the MSRA/MSRT Master) to the start of the application data for transient analysis. (See Capture Offset.)

For details on the MSRA operating mode see the R&S FSW MSRA User Manual. For details on the MSRT operating mode see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

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.

Note: When triggering is activated, the squelch function is automatically disabled.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 217

Free Run ← Trigger Source ← Trigger Settings

No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 217

External Trigger 1/2/3 ← Trigger Source ← Trigger Settings

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

(See "Trigger Level" on page 105).

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT connector on the front panel.
If the optional 2 GHz bandwidth extension (R&S FSW-B2000) is active, only External CH3 is supported.

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

"External Trigger 1"
Trigger signal from the TRIGGER 1 INPUT connector.

"External Trigger 2"
Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector.

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

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
`TRIG:SOUR EXT3`
See `TRIGger[:SEQuence]:SOURce` on page 217

External CH3 ← Trigger Source ← Trigger Settings

Data acquisition starts when the signal fed into the CH3 input connector on the oscilloscope meets or exceeds the specified trigger level.

Note: In previous firmware versions, the external trigger was connected to the CH2 input on the oscilloscope. As of firmware version R&S FSW 2.30, the **CH3** input on the oscilloscope must be used!

This signal source is only available if the optional 2 GHz bandwidth extension (R&S FSW-B2000) is active (see Chapter 6.3.1.4, "Settings for 2 GHz Bandwidth Extension (R&S FSW-B2000)", on page 90).

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

Remote command:
`TRIG:SOUR EXT`, see `TRIGger[:SEQuence]:SOURce` on page 217

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

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

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

This trigger source is only available for RF input.

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

When using the optional 2 GHz bandwidth extension (R&S FSW-B2000) with an IF power trigger, the IF power trigger corresponds to a "width" trigger on the oscilloscope, with a negative polarity and the range "longer". Thus, data acquisition starts when both of the following conditions apply to the signal fed into the CH1 input connector on the oscilloscope:

- The power level has remained below the specified trigger level for a duration longer than the drop-out time.
- The power level then rises above the specified trigger level.

For details, see "Basics on the 2 GHz Bandwidth Extension" in the R&S FSW I/Q Analyzer and I/Q Input User Manual.

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

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 217

I/Q Power ← Trigger Source ← Trigger Settings
This trigger source is not available if the optional Digital Baseband Interface or optional Analog Baseband Interface is used for input. It is also not available for analysis bandwidths ≥ 160 MHz.

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

Remote command:
`TRIG:SOUR IQP`, see `TRIGger[:SEQuence]:SOURce` on page 217

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 instrument's data sheet.

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

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

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 217

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

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

Remote command:
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 215

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

When using the optional 2 GHz bandwidth extension (R&S FSW-B2000) with an IF power trigger, the drop-out time defines the width of the robust width trigger. By default it is set to 1 µs. For external triggers, no drop-out time is available when using the B2000 option.

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

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 214

Coupling ← Trigger Settings
If the selected trigger source is "IF Power" or External CH3, you can configure the coupling of the external trigger to the oscilloscope.

This setting is only available if the optional 2 GHz bandwidth extension is active (see "B2000 State" on page 91).

"DC 50 Ω"	Direct connection with 50 Ω termination, passes both DC and AC components of the trigger signal.
"DC 1 MΩ"	Direct connection with 1 MΩ termination, passes both DC and AC components of the trigger signal.
"AC"	Connection through capacitor, removes unwanted DC and very low-frequency components.

Remote command:
TRIGger[:SEQuence]:OSCilloscope:COUPling on page 206

Trigger Offset ← Trigger Settings
Defines the time offset between the trigger event and the start of the measurement.

Offset > 0:	Start of the measurement is delayed
Offset < 0:	Measurement starts earlier (pretrigger)

Remote command:
TRIGger[:SEQuence]:HOLDoff[:TIME] on page 214

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.

When using the optional 2 GHz bandwidth extension (R&S FSW-B2000) with an IF power trigger, only rising slopes can be detected.

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

Remote command:
TRIGger[:SEQuence]:SLOPe on page 216

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

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

When using the optional 2 GHz bandwidth extension (R&S FSW-B2000) with an IF power trigger, the hysteresis refers to the robust width trigger.

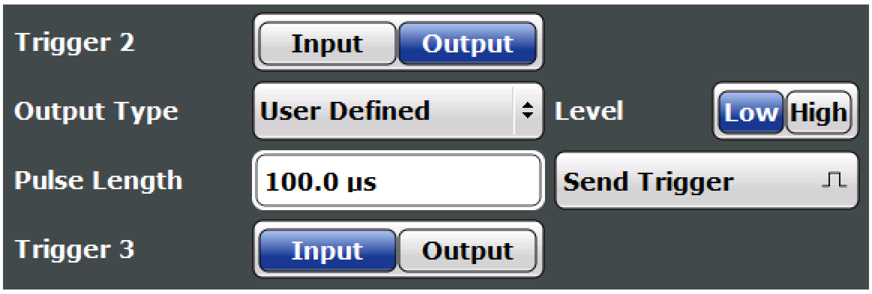
(For details see the R&S FSW I/Q Analyzer and I/Q Input User Manual.)

Remote command:
TRIGger[:SEQuence]:IFPower:HYSTeresis on page 215

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.

Remote command:
TRIGger[:SEQuence]:IFPower:HOLDoff on page 214

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. Trigger input parameters are available in the "Trigger" dialog box.

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

Remote command:
`OUTPut:TRIGger<port>:DIRection` on page 219

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.

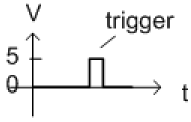
"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the AUX port (pin 9).

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

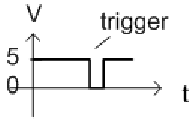
Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 219

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector.

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



low-level constant, high-level trigger



high-level constant, low-level trigger

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 219

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 220

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level = High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

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

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 220

Capture Offset
This setting is only available for slave applications in **MSRA/MSRT operating mode**. It has a similar effect as the trigger offset in other measurements: it defines the time offset between the capture buffer start and the start of the extracted slave application data.

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

In MSRT mode, the offset can be negative if a pretrigger time is defined.

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

For details on the MSRT operating mode, see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

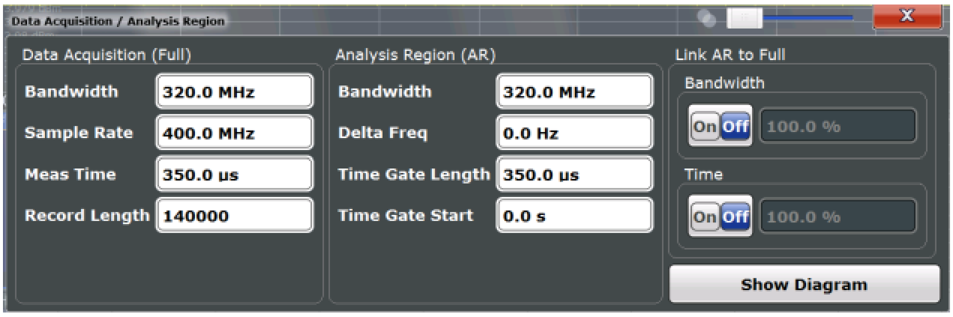
Remote command:
MSRT mode:
`[SENSe:]RTMS:CAPTure:OFFSet` on page 339

6.5 Data Acquisition and Analysis Region

Access: "Overview" > "Data Acquisition"

You must define how much and how data is captured from the input signal, and which part of the captured data is to be analyzed.

For details see Chapter 4.1, "Data Acquisition", on page 16.



MSRA/MSRT operating mode

In MSRA/MSRT operating mode, only the MSRA/MSRT Master channel actually captures data from the input signal. The data acquisition settings for Transient Analysis in MSRA/MSRT mode define the **application data extract** and **analysis interval**.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual. For details on the MSRT operating mode see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

Measurement Bandwidth

The measurement bandwidth and Sample Rate are interdependent and define the range of data to be captured. For information on supported sample rates and bandwidths see the data sheet. All bandwidth extension options (including the 2 GHz bandwidth extension R&S FSW-B2000) are supported.

Note: Data acquisition in MSRT mode. By default, the R&S FSW Transient Analysis application uses the largest possible measurement bandwidth. Depending on which bandwidth extension options are installed (if any), this may be up to 500 MHz. However, in MSRT mode a maximum of 160 MHz bandwidth is available. Thus, you must ensure the measurement bandwidth for Transient Analysis is available in MSRT mode. Otherwise you will not obtain useful results.

Remote command:
[SENSe:]BANDwidth|BWIDth:DEMod on page 221

Sample Rate

The Measurement Bandwidth and sample rate are interdependent and define the range of data to be captured. For information on supported sample rates and bandwidths see the data sheet.

Remote command:
[SENSe:]SRATe on page 222

Measurement Time

The measurement time and Record Length are interdependent and define the amount of data to be captured.

The maximum measurement time in the R&S FSW Transient Analysis application is limited only by the available memory ("memory limit reached" message is shown in status bar). Note, however, that increasing the measurement time (and thus reducing the available memory space) may restrict the number of measurement channels that can be activated simultaneously on the R&S FSW.

Remote command:
[SENSe:]MTIMe on page 221

Record Length

The Measurement Time and record length are interdependent and define the amount of data to be captured.

The maximum record length in the R&S FSW Transient Analysis application is limited only by the available memory ("memory limit reached" message is shown in status bar). Note, however, that increasing the record length (and thus reducing the available memory space) may restrict the number of measurement channels that can be activated simultaneously on the R&S FSW.

Remote command:
[SENSe:]RLENgth on page 222

Analysis Region

The analysis region determines which data is displayed on the screen (see also Chapter 4.5, "Analysis Region", on page 23).

The region is defined by a frequency span and a time gate for which the results are displayed. The time and frequency spans can be defined either as absolute values or relative to the full capture buffer.

Both methods can be combined, for example by defining an absolute frequency span and a relative time gate.

Analysis Bandwidth ← Analysis Region

Defines the absolute width of the frequency span for the analysis region. It is centered around the point defined by the Delta Frequency.

Remote command:
CALCulate<n>:AR:FREQuency:BANDwidth on page 240

Delta Frequency ← Analysis Region
Defines the center of the frequency span for the analysis region. It is defined as an offset from the center frequency.

Remote command:
`CALCulate<n>:AR:FREQuency:DELTa` on page 240

Time Gate Length ← Analysis Region
Defines the absolute length of the time gate, that is, the duration (or height) of the analysis region.

Remote command:
`CALCulate<n>:AR:TIME:LENGth` on page 241

Time Gate Start ← Analysis Region
Defines the starting point of the time span for the analysis region. The starting point is defined as a time offset from the capture start time.

Remote command:
`CALCulate<n>:AR:TIME:STARt` on page 242

Linked analysis bandwidth ← Analysis Region
If activated, the width of the frequency span for the analysis region is defined as a percentage of the full capture buffer. It is centered around the point defined by the Delta Frequency.

Remote command:
`CALCulate<n>:AR:FREQuency:PERCent` on page 241
`CALCulate<n>:AR:FREQuency:PERCent:STATe` on page 241

Linked analysis time span ← Analysis Region
If activated, the length of the time gate, that is, the duration (or height) of the analysis region, is defined as a percentage of the full measurement time. The time gate start is the start of the capture buffer plus an offset defined by the Time Gate Start.

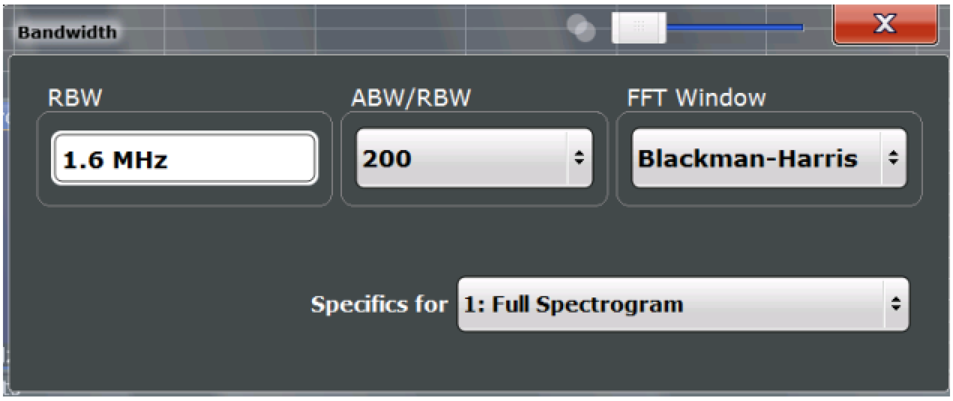
Remote command:
`CALCulate<n>:AR:TIME:PERCent` on page 242
`CALCulate<n>:AR:TIME:PERCent:STATe` on page 242

Visualizing the Analysis Region Parameters (Show Diagram) ← Analysis Region
If enabled, the "Data Acquisition / Analysis Region" dialog box shows a visualization of the parameters that define the analysis region (as shown in Figure 4-9).

6.6 Bandwidth Settings

Access: BW/SPAN

Some of these settings are also available in the "Data Acquisition and Analysis Region" dialog box.



RBW

Defines the resolution bandwidth. Numeric input is always rounded to the nearest possible bandwidth.

The resolution bandwidth is coupled to the selected span (see "ABW / RBW" on page 112).

For more information see "Resolution bandwidth" on page 18.

Remote command:
`[SENSe:]BANDwidth|BWIDth[:WINDow<n>]:RESolution` on page 223

ABW / RBW

The resolution bandwidth is coupled to the selected analysis bandwidth (ABW). The ABW can be the full measurement bandwidth, the bandwidth of the analysis region, or the length of the result range, depending on the evaluation basis of the result display. If the ABW is changed, the resolution bandwidth is automatically adjusted. This setting defines the coupling ratio. Which coupling ratios are available depends on the selected FFT Window.

For more information see "Resolution bandwidth" on page 18.

Remote command:
`[SENSe:]BANDwidth|BWIDth[:WINDow<n>]:RATio` on page 223

FFT Window

In the Transient Analysis application you can select one of several FFT window types.

The following window types are available:

- Blackman-Harris
- Flattop
- Gauss
- Rectangular
- Hanning

- Hamming
- Chebyshev

Remote command:
[SENSe:]SWEep:FFT:WINDow:TYPE on page 309

Measurement Bandwidth
The measurement bandwidth and Sample Rate are interdependent and define the range of data to be captured. For information on supported sample rates and band-widths see the data sheet. All bandwidth extension options (including the 2 GHz band-width extension R&S FSW-B2000) are supported.

Note: Data acquisition in MSRT mode. By default, the R&S FSW Transient Analysis application uses the largest possible measurement bandwidth. Depending on which bandwidth extension options are installed (if any), this may be up to 500 MHz. How-ever, in MSRT mode a maximum of 160 MHz bandwidth is available. Thus, you must ensure the measurement bandwidth for Transient Analysis is available in MSRT mode. Otherwise you will not obtain useful results.

Remote command:
[SENSe:]BANDwidth|BWIDth:DEMod on page 221

FM Video Bandwidth
Additional filters applied after demodulation help filter out unwanted signals, or correct pre-emphasized input signals.

The "FM Video Bandwidth" is available from the "Bandwidth" or "Span" menu.

- Relative low pass filters:
  Relative filters (3 dB) can be selected in % of the analysis (demodulation) band-width. The filters are designed as 5th-order Butterworth filters (30 dB/octave) and active for all demodulation bandwidths.
- "None" deactivates the FM video bandwidth (default).

Remote command:
SENSe:DEMod:FMVF:TYPE on page 239

Time Resolution
The time resolution determines the size of the bins used for each FFT calculation. The shorter the time span used for each FFT, the shorter the resulting span, and thus the higher the resolution in the spectrum becomes.

In "Auto" mode, the optimal resolution is determined automatically according to the data acquisition settings.

In "Manual" mode, you must define the time resolution in seconds.

Remote command:
CALCulate<n>:SGRam|SPECtrogram:TRESolution:AUTO on page 306
CALCulate<n>:SGRam|SPECtrogram:TRESolution on page 306

Measurement Time
The measurement time and Record Length are interdependent and define the amount of data to be captured.

The maximum measurement time in the R&S FSW Transient Analysis application is limited only by the available memory ("memory limit reached" message is shown in status bar). Note, however, that increasing the measurement time (and thus reducing the available memory space) may restrict the number of measurement channels that can be activated simultaneously on the R&S FSW.

Remote command:
[SENSe:]MTIMe on page 221

6.7 Hop / Chirp Measurement Settings

Access: "Overview" > "Measurement"

For some frequency, phase or power calculations, it may be useful not to take the entire dwell time of the hop or length of the chirp into consideration, but only a certain range within the dwell time/length. Thus, it is possible to eliminate settling effects, for instance. For such cases, a *measurement range* can be defined for power and frequency/phase results, in relation to specific hop or chirp characteristics.

These settings are only available if at least one of the additional options R&S FSW-K60C/-K60H are installed.

The "Power" settings, for example, determine which part of the hop/chirp is used to calculate the average power in one hop/chirp. The "Frequency/Phase" settings determine which part of the hop/chirp is used to calculate the average frequency/phase in one hop/chirp.

The ranges for both frequency/phase and power measurements are defined by a reference point, an offset from the reference point, and the range length.

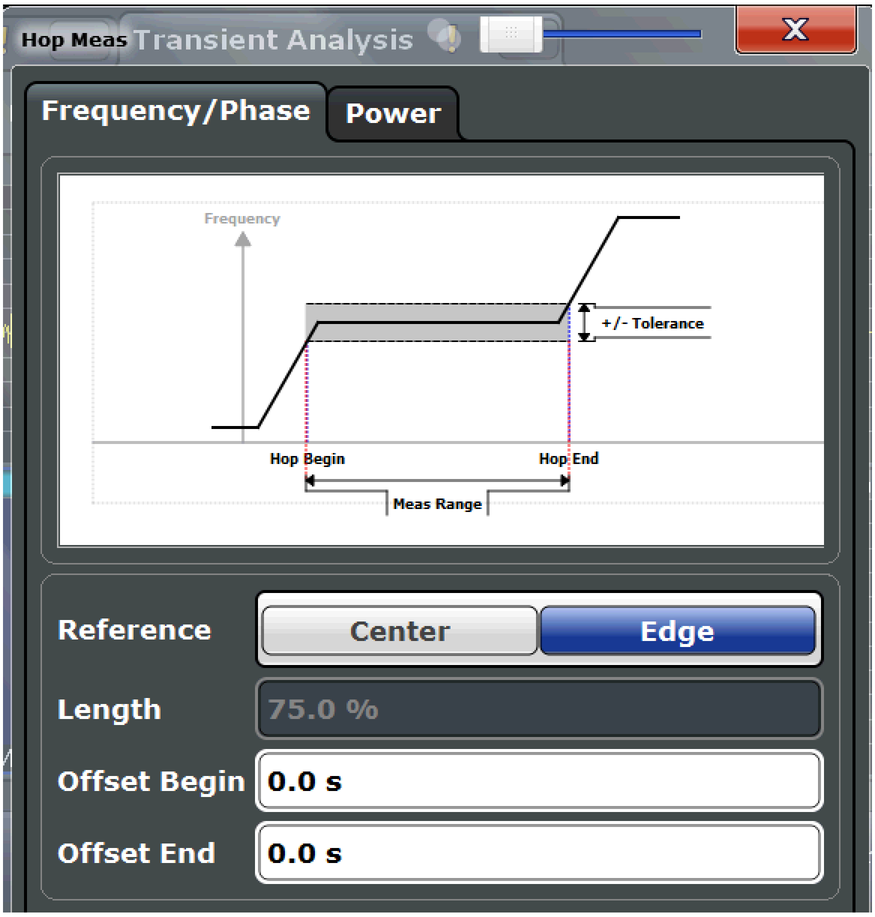


Figure 6-3: Measurement range settings for hop frequency/phase results

For details on the measurement range parameters see Chapter 4.7, "Measurement Range", on page 27.

Reference

Defines the reference point for positioning the frequency/phase/power measurement range. The Offset Begin / Offset End is given with respect to this value.

"Edge" The measurement range is defined in reference to the rising or falling edge.

"Center" The measurement range is defined in reference to the center of the hop/chirp.

Remote command:

`CALCulate<n>:CHRDetection:FREQuency:REFerence` on page 234

`CALCulate<n>:CHRDetection:POWer:REFerence` on page 235

`CALCulate<n>:HOPDetection:FREQuency:REFerence` on page 237

`CALCulate<n>:HOPDetection:POWer:REFerence` on page 238

Length
Defines the length or duration of the frequency/phase/power measurement range.

Remote command:
CALCulate<n>:CHRDetection:FREQuency:LENGth on page 233
CALCulate<n>:CHRDetection:POWer:LENGth on page 234
CALCulate<n>:HOPDetection:FREQuency:LENGth on page 236
CALCulate<n>:HOPDetection:POWer:LENGth on page 237

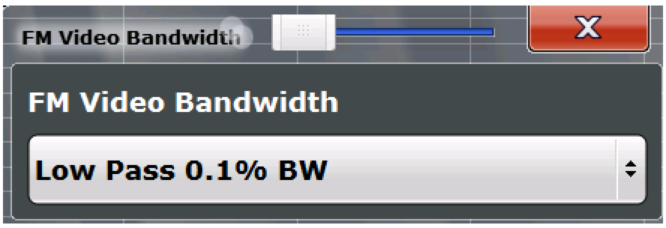
Offset Begin / Offset End
The offset in seconds from the beginning or end of the Reference.

Remote command:
CALCulate<n>:CHRDetection:FREQuency:OFFSet:BEGin on page 233
CALCulate<n>:CHRDetection:FREQuency:OFFSet:END on page 234
CALCulate<n>:CHRDetection:POWer:OFFSet:BEGin on page 235
CALCulate<n>:CHRDetection:POWer:OFFSet:END on page 235
CALCulate<n>:HOPDetection:FREQuency:OFFSet:BEGin on page 236
CALCulate<n>:HOPDetection:FREQuency:OFFSet:END on page 237
CALCulate<n>:HOPDetection:POWer:OFFSet:BEGin on page 238
CALCulate<n>:HOPDetection:POWer:OFFSet:END on page 238

6.8 FM Video Bandwidth

Access: BW > "FM Video BW"

A video filter applied during demodulation can filter out unwanted signals.



FM Video Bandwidth
Additional filters applied after demodulation help filter out unwanted signals, or correct pre-emphasized input signals.

The "FM Video Bandwidth" is available from the "Bandwidth" or "Span" menu.

- Relative low pass filters:
  Relative filters (3 dB) can be selected in % of the analysis (demodulation) bandwidth. The filters are designed as 5th-order Butterworth filters (30 dB/octave) and active for all demodulation bandwidths.
- "None" deactivates the FM video bandwidth (default).

Remote command:
SENSe:DEMod:FMVF:TYPE on page 239

6.9 Sweep Settings

Access: SWEEP

The sweep settings define how often data from the input signal is acquired and then evaluated.

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

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 245

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.
Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

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

Remote command:
`INITiate<n>[:IMMediate]` on page 246

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

Remote command:
`INITiate<n>:CONMeas` on page 245

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

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

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

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

Remote command:
`INITiate<n>:REFResh` on page 246

Measurement Time
The measurement time and Record Length are interdependent and define the amount of data to be captured.

The maximum measurement time in the R&S FSW Transient Analysis application is limited only by the available memory ("memory limit reached" message is shown in status bar). Note, however, that increasing the measurement time (and thus reducing the available memory space) may restrict the number of measurement channels that can be activated simultaneously on the R&S FSW.

Remote command:
`[SENSe:]MTIMe` on page 221

Sweep / Average Count
Defines the number of measurements to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one measurement is performed.

Remote command:
`[SENSe:]SWEep:COUNt` on page 304

Selecting a frame to display
Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see Chapter 4.9.1, "Time Frames", on page 34.

For more information see Chapter 4, "Measurement Basics", on page 16.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect` on page 305

6.10 Adjusting Settings Automatically

Access: AUTO SET

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings. In order to do so, a measurement is performed. The duration of this measurement can be defined automatically or manually.

Setting the Reference Level Automatically (Auto Level)

Automatically determines a reference level which ensures that no overload occurs at the R&S FSW for the current input data. At the same time, the internal attenuators and the preamplifier (for analog baseband input: the full scale level) are adjusted so the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S FSW.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

When using the optional 2 GHz bandwidth extension (R&S FSW-B2000), the level measurement is performed on the connected oscilloscope. Y-axis scaling on the oscilloscope is limited to a minimum of 5mV per division.

Remote command:
`[SENSe:]ADJust:LEVel` on page 243

7 Analysis

Access: "Overview" > "Analysis"

General result analysis settings concerning the trace, markers, windows etc. can be configured via the "Analysis" button in the "Overview". They are identical to the analysis functions in the base unit except for the special window functions.

7.1 Display Configuration

Access: "Overview" > "Display Config"

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the Transient Analysis application are displayed in the evaluation bar in SmartGrid mode.

Up to six evaluation methods can be displayed simultaneously in separate windows. The evaluation methods available for Transient Analysis are described in Chapter 5.3, "Evaluation Methods for Transient Analysis", on page 59.

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

7.2 Result Configuration

Access: "Overview" > "Result Config"

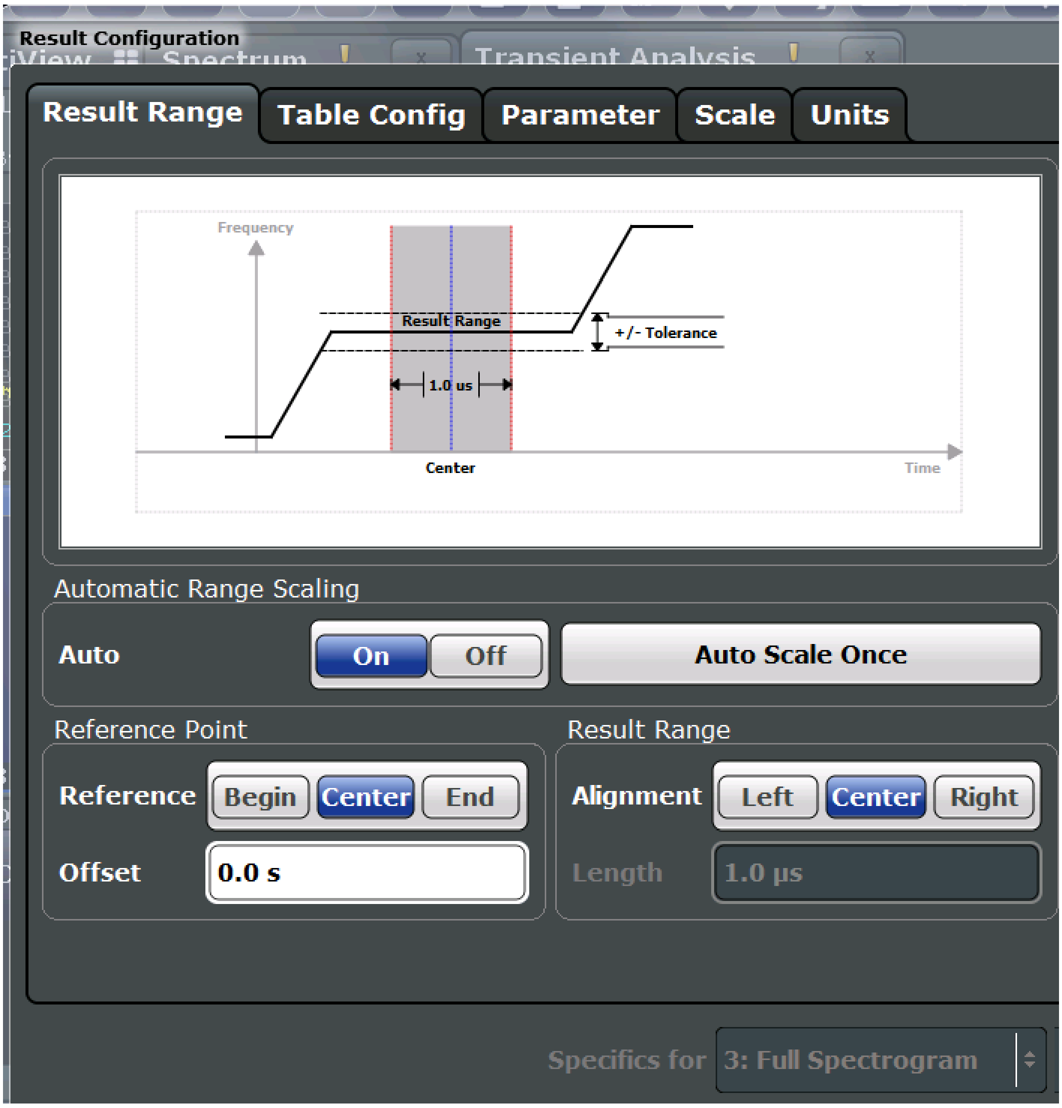
Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window (see "Specifics for" on page 71).

7.2.1 Result Range

Access: "Overview" > "Result Config" > "Result Range" tab

The result range determines which data is displayed on the screen (see also "Measurement range vs result range" on page 45). This range applies to the hop/chirp magnitude, frequency and phase vs time displays.

These settings are only available if at least one of the additional options R&S FSW-K60C/-K60H are installed.



The range is defined by a reference point, alignment and the range length.

Automatic Range Scaling
Defines whether the result range length is determined automatically according to the width of the selected hop/chirp (see "Select Hop / Select Chirp" on page 130).

"OFF" Switches automatic range scaling off

"ON" Switches automatic range scaling on

Remote command:
`CALCulate<n>:RESult:RANGe:AUTO` on page 260

Result Range Reference Point
Defines the reference point for positioning the result range. The Offset is given with respect to this value.

"Rise" The result range is defined in reference to the rising edge.

"Center" The result range is defined in reference to the center of the hop/chirp top.

"Fall" The result range is defined in reference to the falling edge.

Remote command:
`CALCulate<n>:RESult:REFerence` on page 260

Offset
The offset in seconds from the hop/chirp edge or center at which the result range reference point occurs.

Remote command:
`CALCulate<n>:RESult:OFFSet` on page 260

Alignment
Defines the alignment of the result range in relation to the selected Result Range Reference Point.

"Left" The result range starts at the hop/chirp center or selected edge.

"Center" The result range is centered around the hop/chirp center or selected edge.

"Right" The result range ends at the hop/chirp center or selected edge.

Remote command:
`CALCulate<n>:RESult:ALIGnment` on page 259

Length
Defines the length or duration of the result range.

Remote command:
`CALCulate<n>:RESult:LENGth` on page 259

7.2.2 Table Configuration

Access: "Overview" > "Result Config" > "Table Config" tab > "Parameters" tab

During each measurement, a large number of statistical and characteristic values are determined. The "Hop/Chirp Statistics" and "Hop/Chirp Results" tables display an overview of the parameters selected here. Note that the table configuration applies to both result tables, it is not window-specific.

These settings are only available if at least one of the additional options R&S FSW-K60C/-K60H are installed.

Select the parameters to be included in the table, and the required unit scaling, if available. For a description of the individual parameters see Chapter 5.1, "Hop Parameters", on page 46/ Chapter 5.2, "Chirp Parameters", on page 52.

Remote command:

`CALCulate<n>:CHRDetection:TABLe:COLumn` on page 262

`CALCulate<n>:HOPDetection:TABLe:COLumn` on page 268

7.2.2.1 Table Export Settings

Access: "Overview" > "Result Config" > "Table Config" tab > "Table Export" tab

Table results can be exported to an ASCII file for further evaluation in other (external) applications. Table export settings can be configured in the "Result Configuration" dialog box, in the "Table Configuration" tab, in the vertical "Table Export" tab.

The settings are window-specific and only available for result tables.

The result tables can be exported either directly in the "Table Config" dialog box or via the "Export" function in the "Save/Recall" menu (via the toolbar).

Columns to Export
Defines which of the result table columns are to be included in the export file.

"Visible" Only the currently visible columns in the result display are exported.

"All" All columns, including currently hidden ones, for the result display are exported.

Remote command:
`MMEMory:STORe<n>:TABLe` on page 376

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 377

Export Table to ASCII File
Opens a file selection dialog box and saves the selected result table in ASCII format (**.DAT**) to the specified file and directory.

Note: To store the measurement results for **all** traces and tables in **all** windows, use the Export Trace to ASCII File command in the "Save/Recall" > "Export" menu.
(See also Chapter 7.5, "Trace / Data Export Configuration", on page 133.)

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Remote command:
`MMEMory:STORe<n>:TABLe` on page 376

7.2.3 Parameter Configuration for Result Displays

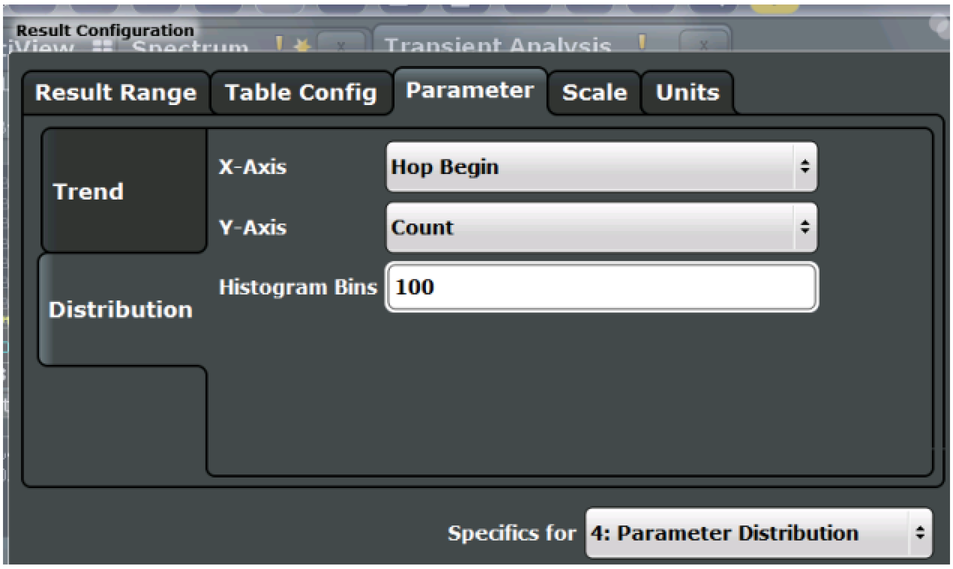
Access: "Overview" > "Result Config" > "Parameter" tab

For parameter trend or distribution displays you can define which parameters are to be evaluated in each window.

7.2.3.1 Parameter Distribution Configuration

Access: "Overview" > "Result Config" > "Parameter" tab > "Distribution" tab

The parameter distribution evaluations allow you to visualize the number of occurrances for a specific parameter value within the current capture buffer. For each parameter distribution window you can configure which measured parameter is to be displayed.



Note that this tab is only available for windows with a Parameter Distribution evaluation.

X-Axis

Defines the parameter for which the values are displayed on the x-axis. For a description of the parameters see Chapter 5.1, "Hop Parameters", on page 46/ Chapter 5.2, "Chirp Parameters", on page 52.

Remote command:

`CALCulate<n>:DISTribution:X?` on page 281

Y-Axis
Defines the scaling of the y-axis.

"Count" Number of hops/chirps in which the value occurred.

"Occurrence" Number of occurrences in percent of all measured values.

Remote command:
CALCulate<n>:DISTribution:Y? on page 282

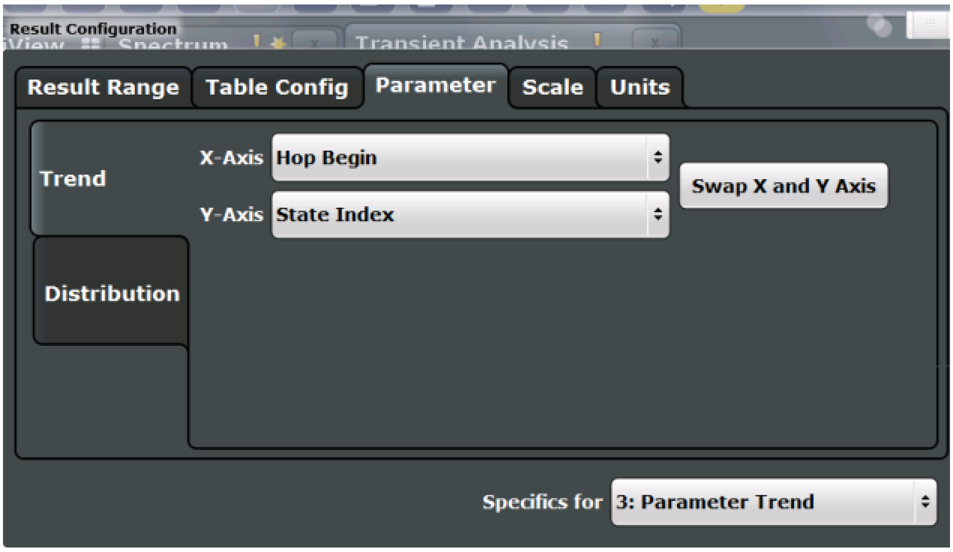
Histogram Bins
Number of columns on the x-axis, i.e. the number of measurement value ranges for which the occurrences are determined.

Remote command:
CALCulate<n>:DISTribution:NBINs on page 281

7.2.3.2 Parameter Trend Configuration

Access: "Overview" > "Result Config" > "Parameter" tab > "Trend" tab

The parameter trend result displays allow you to visualize changes in a specific parameter for all measured hops/chirps within the current capture buffer. For each parameter trend window you can configure which measured parameter is to be displayed on the x-axis and which on the y-axis.



Note that this tab is only available for windows with a Parameter Trend evaluation.

X-Axis
Defines the parameter for the trend which is displayed on the x-axis. For a description of the parameters see Chapter 5.1, "Hop Parameters", on page 46/ Chapter 5.2, "Chirp Parameters", on page 52.

Remote command:
`CALCulate<n>:TRENd:X?` on page 283

Y-Axis
Defines the parameter for the trend which is displayed on the y-axis. For a description of the parameters see Chapter 5.1, "Hop Parameters", on page 46/ Chapter 5.2, "Chirp Parameters", on page 52.

Remote command:
`CALCulate<n>:TRENd:Y?` on page 283

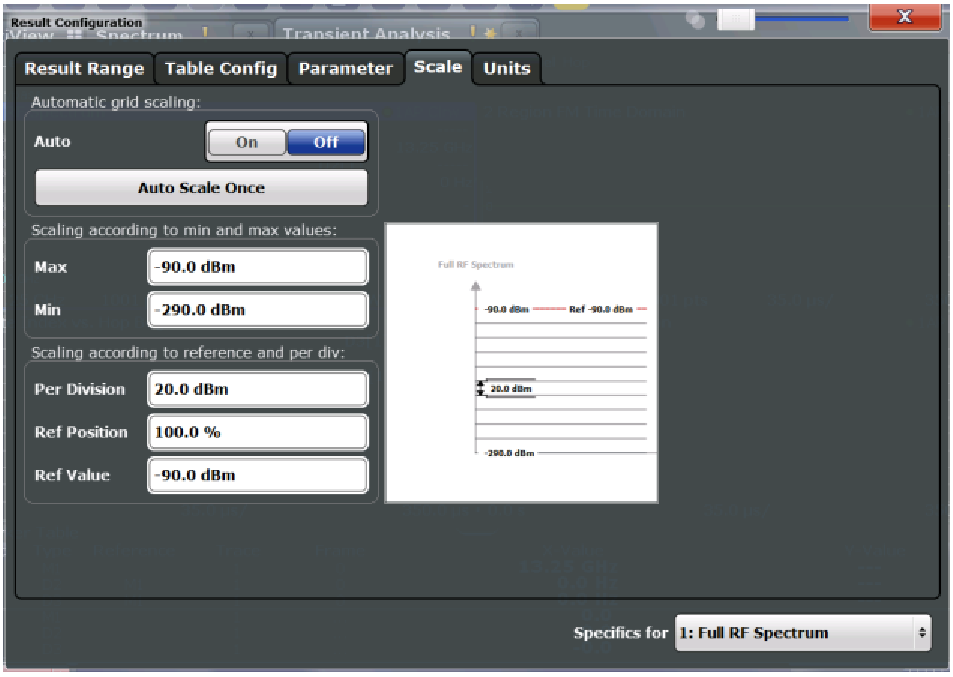
Swap X and Y Axis
Swaps the paramters on the x-axis and y-axis in a Parameter Trend result display.

Remote command:
`CALCulate<n>:TRENd:SWAP:XY` on page 282

7.2.4 Y-Axis Scaling

Access: "Overview" > "Result Config" > "Scale" tab

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These settings are described here.



Automatic Grid Scaling

The y-axis is scaled automatically according to the current measurement settings and results (continuously).

Note: Tip: To update the scaling automatically *once* when this setting for continuous scaling is off, use the "Auto Scale Once" on page 128 button or the softkey in the AUTO SET menu.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO` on page 298

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.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO` on page 298

Absolute Scaling (Min/Max Values)

Define the scaling using absolute minimum and maximum values.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 298
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum` on page 299

Relative Scaling (Reference/ per Division)

Define the scaling relative to a reference value, with a specified value range per division.

Per Division ← Relative Scaling (Reference/ per Division)

Defines the value range to be displayed per division of the diagram (1/10 of total range).

Note: The value defined per division refers to the default display of 10 divisions on the y-axis. If fewer divisions are displayed (e.g. because the window is reduced in height), the range per division is increased in order to display the same result range in the smaller window. In this case, the per division value does not correspond to the actual display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision` on page 299

Ref Position ← Relative Scaling (Reference/ per Division)

Defines the position of the reference value in percent of the total y-axis range.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 300

Ref Value ← Relative Scaling (Reference/ per Division)
Defines the reference value to be displayed at the specified reference position.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 300

Spectrogram y-scaling
For spectrograms, the displayed y-levels are defined as a range below the reference level.

Range ← Spectrogram y-scaling
Defines the full value span in dB that can be displayed by the color map. Note that the span actually used for the color map definition may be restricted (see "Start / Stop" on page 141).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 298

Ref Level Position ← Spectrogram y-scaling
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.

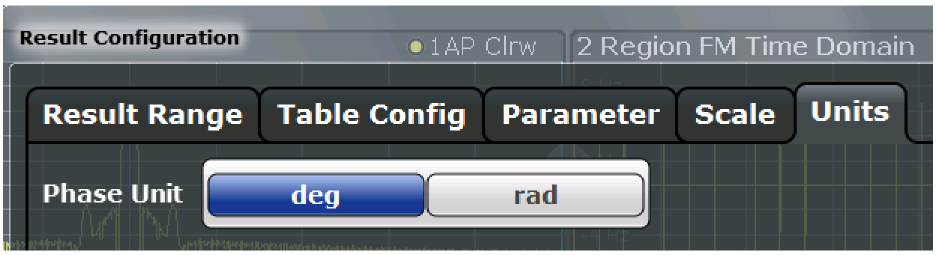
For spectrograms, this value defines the position of the reference level value within the span covered by the color map. In this case, the value is given in %, where 0 % corresponds to the maximum (right end) and 100 % to the minimum (left end) of the color map.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 300

7.2.5 Units

Access: "Overview" > "Result Config" > "Units" tab

The unit for phase display is configurable. This setting is described here.



Phase Unit
Defines the unit in which phases are displayed (degree or rad).

Remote command:
`CALCulate<n>:UNIT:ANGLe` on page 298

7.3 Evaluation Basis

Access: MEAS

Depending on the measurement task, not all of the measured data in the capture buffer may be of interest. In some cases it may be useful to restrict analysis to a specific user-definable region, or to a selected individual chirp rate or hop.

Which evaluation basis is available for which result display is indicated in Table 5-1.

Some of these settings are only available if at least one of the additional options R&S FSW-K60C/-K60H are installed.

Full Capture / Region Analysis / Hop / Chirp
For some result displays you can select the basis used for analysis:
- the full capture buffer
- the selected Analysis Region
- an individual selected hop / chirp (only available if at least one of the additional options R&S FSW-K60C/-K60H are installed)

To select a hop / chirp for the latter case, select the "Selected Hop"/"Selected Chirp" softkey in the "Meas Config" menu (see "Select Hop / Select Chirp" on page 130).

The currently selected hop / chirp is highlighted blue in the "Result Table" and "Statistic Table" displays.

As soon as a new hop / chirp is selected, all hop/chirp-specific displays are automatically updated.

Remote command:
`DISPlay:[WINDow<n>:]EVAL` on page 258

Select Hop / Select Chirp
Defines the individual hop or chirp from the current capture buffer for which results are calculated and displayed.

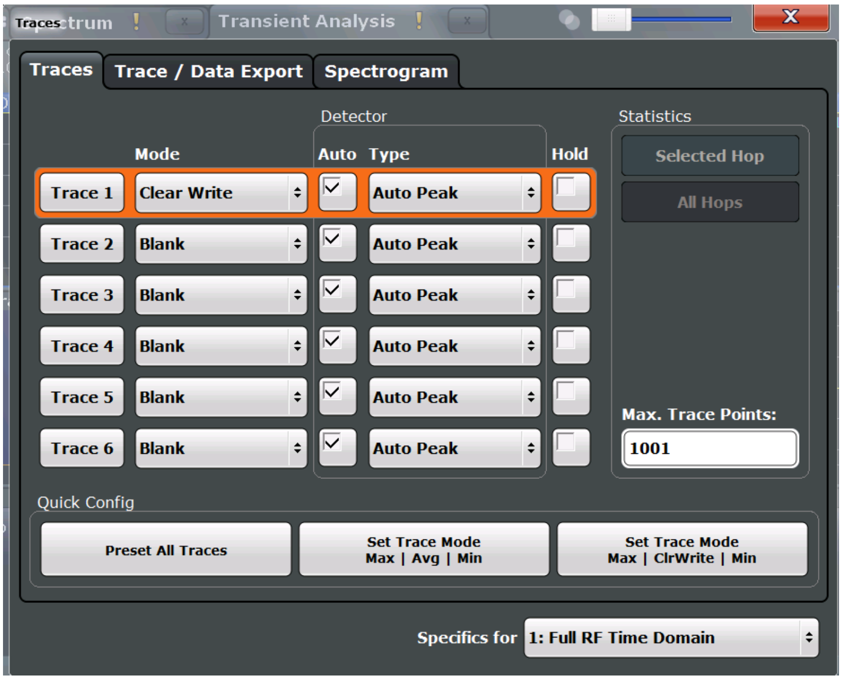
Remote command:
`CALCulate<n>:CHRDetection:SELected` on page 261
`CALCulate<n>:HOPDetection:SELected` on page 261

7.4 Trace Settings

Access: "Overview" > "Analysis" > "Traces" tab

The trace settings determine how the measured data is analyzed and displayed in the window. Depending on the result display, between 1 and 6 traces may be displayed.

Trace data can also be exported to an ASCII file for further analysis. For details see Chapter 7.5, "Trace / Data Export Configuration", on page 133.



Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6

Selects the corresponding trace for configuration. The currently selected trace is highlighted orange.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 302

Selected via numeric suffix of `TRACe<t>` commands

Mode

Defines the update mode for subsequent traces.

"Clear Write"	Overwrite mode: the trace is overwritten by each sweep. This is the default setting.
"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.
"View"	The current contents of the trace memory are frozen and displayed.
"Blank"	Removes the selected trace from the display.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:MODE on page 301

Detector

Defines the trace detector to be used for trace analysis.

Detectors perform a data reduction from the swept values to the displayed trace points. The detector type determines which of the samples are displayed for each trace point.

Note: The detector activated for the specific trace is indicated in the corresponding trace information in the window title bar by an abbreviation.

The trace detector can analyze the measured data using various methods:

"Auto" Selects the optimum detector for the selected trace and filter mode. This is the default setting.

"Positive Peak" Determines the largest of all positive peak values from the levels measured at the individual x-values which are displayed in one trace point

"Negative Peak" Determines the smallest of all negative peak values from the levels measured at the individual x-values which are displayed in one trace point

"Average" 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). 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" Selects the last measured value of the levels measured at the individual x-values which are displayed in one trace point; all other measured values for the x-axis range are ignored

Remote command:
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO on page 303

Hold

If activated, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started again after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous on page 302

Statistical Evaluation

If the trace modes "Average", "Max Hold" or "Min Hold" are set, you can define how many hops or chirp rates are included in the statistical evaluation.

For details see Chapter 4.8.3, "Trace Statistics", on page 32.

Selected Hop / Selected Chirp vs All Hops / All Chirps ← Statistical Evaluation

Defines which hops/chirps are included in the statistical evaluation.

"Selected hop/ chirp"	Only the selected hop/chirp from each sweep (capture) is included in the statistical evaluation.
"All Hops/ Chirps"	All measured hops/chirps from each sweep (capture) are included in the statistical evaluation.

Remote command:
`[SENSe:]STATistic:TYPE` on page 303

Sweep / Average Count ← Statistical Evaluation

Defines the number of measurements to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one measurement is performed.

Remote command:
`[SENSe:]SWEep:COUNt` on page 304

Maximum number of trace points ← Statistical Evaluation

If the number of samples within the result range (see Chapter 7.2.1, "Result Range", on page 121) is larger than this value, the trace data is reduced to the defined maximum number of trace points using the selected detector.

For details see also Chapter 4.8.1, "Mapping Samples to Measurement Points with the Trace Detector", on page 29.

Restricting this value can improve performance during statistical evaulation of large result range lengths.

Remote command:
`[SENSe:]MEASure:POINts` on page 303

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)

Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 302

7.5 Trace / Data Export Configuration

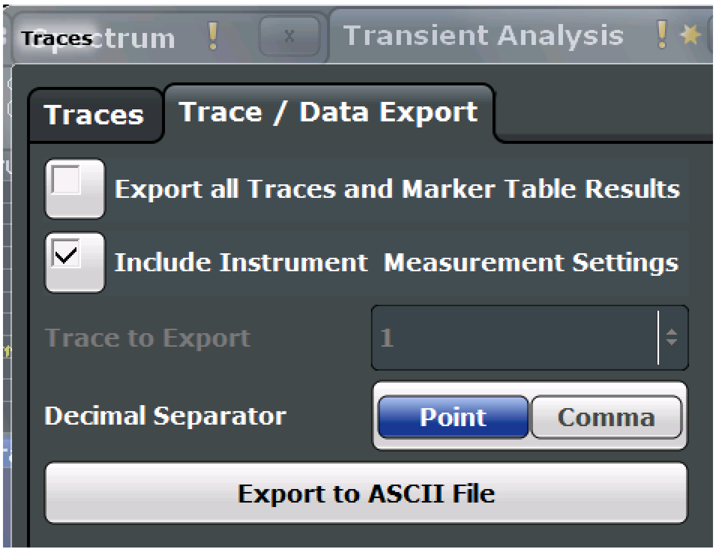
Access: "Save" > "Export" > "(Trace) Export Config"

Or: TRACE > "Trace Config" > "Trace/Data Export"

The R&S FSW provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with other, external applications. In this case, you can export the measurement data to a standard format file (ASCII or CSV).

The standard data management functions (e.g. saving or loading instrument settings) that are available for all R&S FSW applications are not described here.

See the R&S FSW User Manual for a description of the standard functions.



Export all Traces and all Table Results

Selects all displayed traces and result tables (e.g. Result Summary, marker table etc.) in the current application for export to an ASCII file.

Alternatively, you can select one specific trace only for export (see Trace to Export).

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Remote command:

`FORMat:DEXPort:TRACes` on page 378

Include Instrument Measurement Settings

Includes additional instrument and measurement settings in the header of the export file for result data.

Remote command:

`FORMat:DEXPort:HEADer` on page 378

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.

Remote command:
`FORMat:DEXPort:DSEParator` on page 377

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 for 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.

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 379

7.6 Spectrogram Settings

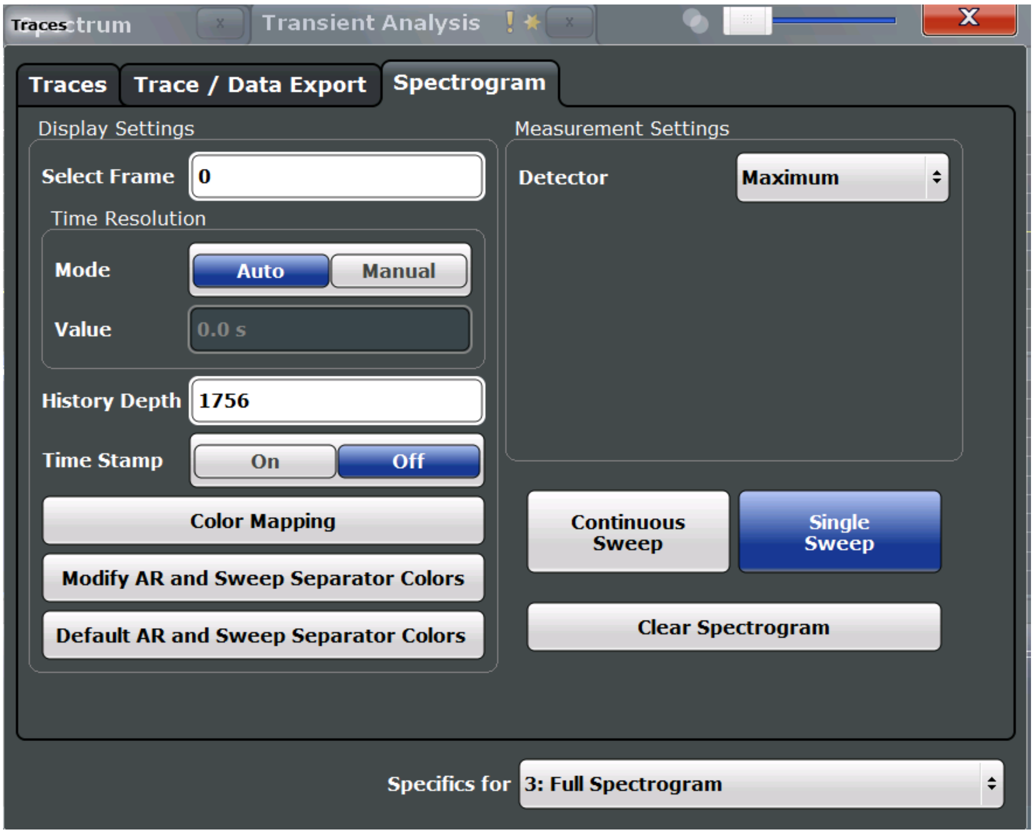
Access: MEAS CONFIG > "Spectrogram Config"

The individual settings available for spectrogram display are described here. For settings on color mapping, see Chapter 7.6.2, "Color Map Settings", on page 140.

7.6.1 General Spectrogram Settings

Access: MEAS CONFIG > "Spectrogram Config"

This section describes general settings for spectrogram display.



The FFT analysis used to create the spectrogram is configurable, in order to improve detection of transient signal effects or minimize the duration of the calculation. For details on FFT calculation see Chapter 4.2, "Signal Processing", on page 16.

Selecting a frame to display

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see Chapter 4.9.1, "Time Frames", on page 34.

For more information see Chapter 4, "Measurement Basics", on page 16.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect` on page 305

Time Resolution

The time resolution determines the size of the bins used for each FFT calculation. The shorter the time span used for each FFT, the shorter the resulting span, and thus the higher the resolution in the spectrum becomes.

In "Auto" mode, the optimal resolution is determined automatically according to the data acquisition settings.

In "Manual" mode, you must define the time resolution in seconds.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:TRESolution:AUTO` on page 306
`CALCulate<n>:SGRam|SPECtrogram:TRESolution` on page 306

History Depth

Sets the number of frames that the R&S FSW stores in its memory.

If the memory is full, the R&S FSW deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:HDEPth` on page 305

Timestamp

Activates and deactivates the timestamp. The timestamp shows the system time while the measurement is running. In single sweep mode or if the measurement is stopped, the timestamp shows the time and date of the end of the measurement.

When active, the timestamp replaces the display of the frame number.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:TSTamp[:STATe]` on page 307
`CALCulate<n>:SGRam|SPECtrogram:TSTamp:DATA?` on page 307

Color Mapping

Opens the "Color Map" dialog.

Modifying Analysis Region and Sweep Separator Colors

For each color scheme (see "Hot/Cold/Radar/Grayscale" on page 141) you can configure the colors used to indicate the analysis range and sweep separator lines in spectrograms.

For details on the analysis range and sweep separator lines see Chapter 4.5, "Analysis Region", on page 23 and Chapter 4.9.1, "Time Frames", on page 34.

Selecting the Object ← Modifying Analysis Region and Sweep Separator Colors
Selects the object for which the color is to be defined. Colors can be defined for each combination of:

color scheme + analysis region

color scheme + sweep separator

Preview ← Modifying Analysis Region and Sweep Separator Colors
Indicates the currently selected color that will be used for the selected object.

Predefined Colors ← Modifying Analysis Region and Sweep Separator Colors
Displays the available colors from the predefined color set that can be used for the selected object.

Defining User-specific Colors ← Modifying Analysis Region and Sweep Separator 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.

Restoring Default AR and Sweep Separator Colors
Restores the default colors used to indicate the analysis range and sweep separator lines in spectrograms.

Detector
Defines the detector used to combine overlapping FFT frames for the spectrogram result display.

"Sum"	Calculates the sum of all values in one sample point
"Average"	Calculates the linear average of all values in one sample point
"RMS"	Calculates the RMS of all values in one sample point
"Maximum"	Determines the largest of all values in one sample point
"Minimum"	Determines the minimum of all values in one sample point
"Sample"	Selects the last measured value for each sample point

Remote command:
`[SENSe:][WINDow<n>:]SGRam|SPECtrogram:DETector:FUNCtion`
on page 308

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

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 245

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.
Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

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

Remote command:
`INITiate<n>[:IMMediate]` on page 246

Clear Spectrogram
Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SGRam:CLEar` on page 305

7.6.2 Color Map Settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

or: TRACE > "Spectrogram Config" > "Color Mapping"

For more information on color maps see Chapter 4.9.2, "Color Maps", on page 35.

For details on changing color mapping settings see Chapter 8.1, "How to Configure the Color Mapping", on page 160.

In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.

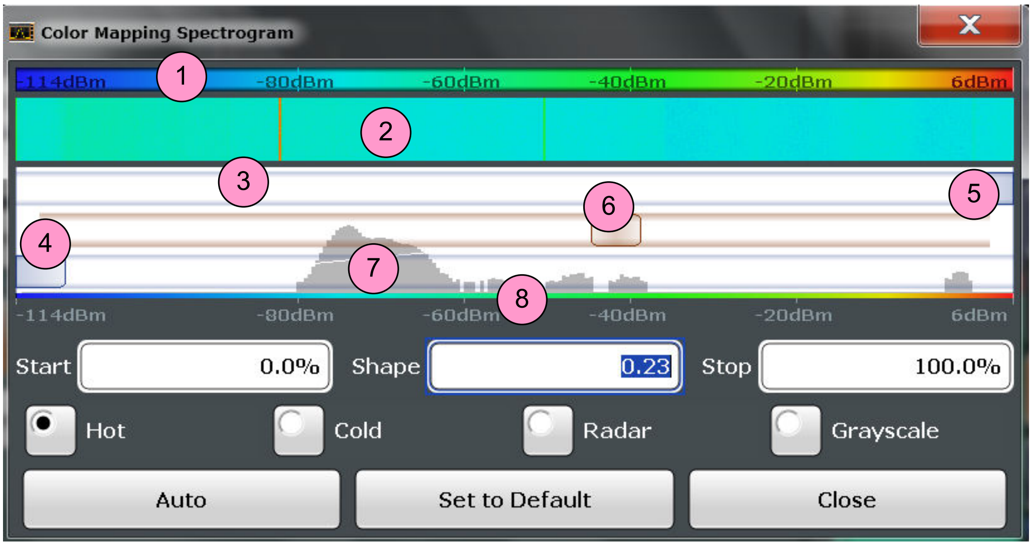


Figure 7-1: Color Mapping dialog box

1 = Color map: shows the current color distribution
2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
3 = Color curve pane: graphical representation of all settings available to customize the color scheme
4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
6 = Color curve slider: adjusts the focus of the color curve
7 = Histogram: shows the distribution of measured values
8 = Scale of the horizontal axis (value range)

Start / Stop

Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer` on page 309
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer` on page 310

Shape

Defines the shape and focus of the color curve for the spectrogram result display.

"-1 to <0"	More colors are distributed among the lower values
"0"	Colors are distributed linearly among the values
">0 to 1"	More colors are distributed among the higher values

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe` on page 310

Hot/Cold/Radar/Grayscale

Sets the color scheme for the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]` on page 310

Auto
Defines the color range automatically according to the existing measured values for optimized display.

Set to Default
Sets the color mapping to the default settings.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault` on page 309

7.7 Export Functions

Access: "Save" > "Export"

The standard data management functions (e.g. saving or loading instrument settings) that are available for all R&S FSW applications are not described here.

See the R&S FSW User Manual for a description of the standard functions.

Export Table to ASCII File
Opens a file selection dialog box and saves the selected result table in ASCII format (`.DAT`) to the specified file and directory.

Note: To store the measurement results for **all** traces and tables in **all** windows, use the Export Trace to ASCII File command in the "Save/Recall" > "Export" menu.
(See also Chapter 7.5, "Trace / Data Export Configuration", on page 133.)

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Remote command:
`MMEMory:STORe<n>:TABLe` on page 376

Table Export Configuration
Table results can be exported to an ASCII file for further evaluation in other (external) applications. Table export settings can be configured in the "Result Configuration" dialog box, in the "Table configuration" tab, in the vertical "Table Export" tab.

The settings are window-specific and only available for result tables.

Columns to Export ← Table Export Configuration
Defines which of the result table columns are to be included in the export file.

"Visible"	Only the currently visible columns in the result display are exported.
"All"	All columns, including currently hidden ones, for the result display are exported.

Decimal Separator ← Table Export Configuration
Defines the decimal separator for floating-point numerals for the data export files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 377

Export Table to ASCII File ← Table Export Configuration
Opens a file selection dialog box and saves the selected result table in ASCII format (**`.DAT`**) to the specified file and directory.

Note: To store the measurement results for **all** traces and tables in **all** windows, use the Export Trace to ASCII File command in the "Save/Recall" > "Export" menu.
(See also Chapter 7.5, "Trace / Data Export Configuration", on page 133.)

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Remote command:
`MMEMory:STORe<n>:TABLe` on page 376

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 for 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.

Note: Secure user mode.

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 379

Trace Export Configuration
Opens the "Traces" dialog box to configure the trace and data export settings. See Chapter 7.5, "Trace / Data Export Configuration", on page 133.

I/Q Export
Opens a file selection dialog box to define an export file name to which the I/Q data is stored. This function is only available in single sweep mode.

Note: Storing large amounts of I/Q data (several Gigabytes) can exceed the available (internal) storage space on the R&S FSW. In this case, it can be necessary to use an external storage medium.

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Export Range ← I/Q Export
Defines the range of the I/Q data to store.

"Entire Capture"	The entire capture buffer is exported.

7.8 Marker Settings

Access: "Overview" > "Analysis" > "Marker" tab

7.8.1 Individual Marker Setup

Access: "Overview" > "Analysis" > "Marker" tab > "Markers" tab

Up to 17 markers or delta markers can be activated for each window simultaneously.

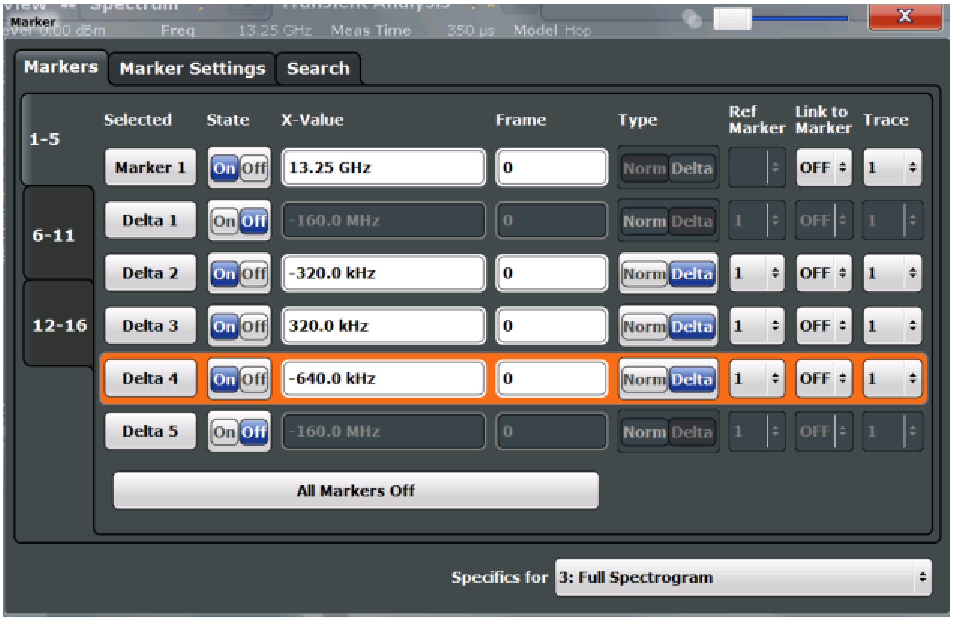


Figure 7-2: Marker settings for spectrogram display

The markers are distributed among 3 tabs for a better overview. By default, the first marker is defined as a normal marker, whereas all others are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is active.

Selected Marker

Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State

Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 312
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 315

Marker Position (X-value)
Defines the position (x-value) of the marker in the diagram. For normal markers, the absolute position is indicated. For delta markers, the position relative to the reference marker is provided.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 313
`CALCulate<n>:DELTamarker<m>:X` on page 316

Frame (for Spectrograms only)
Spectrogram frame number the marker is assigned to. The most recently swept frame is number 0, all previous frames have negative numbers.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 324

Marker Type
Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal"	A normal marker indicates the absolute value at the defined position in the diagram.
"Delta"	A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 312
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 315

Reference Marker
Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If the reference marker is deactivated, the delta marker referring to it is also deactivated.

Remote command:
`CALCulate<n>:DELTamarker<m>:MREF` on page 315

Linking to Another Marker
Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:
`CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>` on page 312
`CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m>` on page 315
`CALCulate<n>:DELTamarker<m>:LINK` on page 314

Assigning the Marker to a Trace

The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 313

Select Marker

The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 312
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 315

All Markers Off

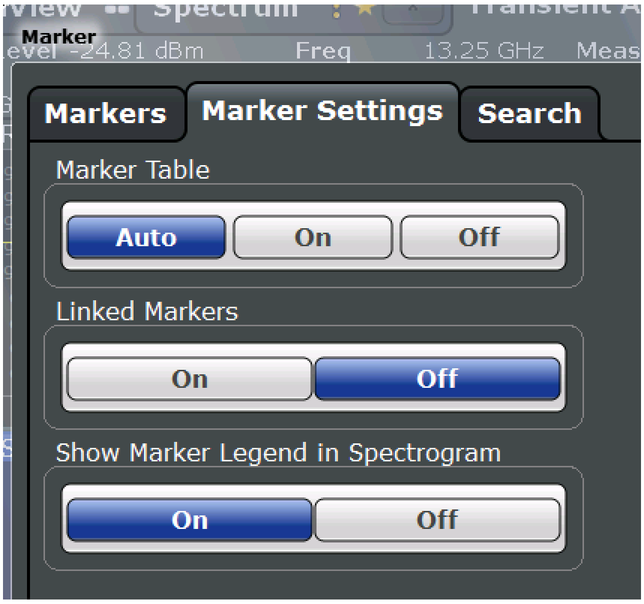
Deactivates all markers in one step.

Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 312

7.8.2 General Marker Settings

Access: "Overview" > "Analysis" > "Marker" tab > "Marker Settings" tab

Some general marker settings allow you to influence the marker behavior for all markers.



Marker Table Display

Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area. No separate marker table is displayed.

"Auto" (Default) Up to two markers are displayed in the diagram area. If more markers are active, the marker table is displayed automatically.

Remote command:
`DISPlay:MTABle` on page 318

Linked Markers

If enabled, the markers in all diagrams with the same x-axis are linked, i.e. when you move a marker in one window, the markers in all other windows are moved to the same x-value.

Remote command:
`CALCulate<n>:MARKer<m>:LINK` on page 318

Show Marker Legend in Spectrogram

Hides or shows marker information within the spectrogram diagram area (as opposed to the separate marker table, see also "Marker Table Display" on page 148). This setting only takes effect if a marker is active.

7.8.3 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).

7.8.3.1 Marker Search Settings

Access: "Overview" > "Analysis" > "Marker" tab > "Search Config" tab

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.

Depending on the type of result display, different settings are available.

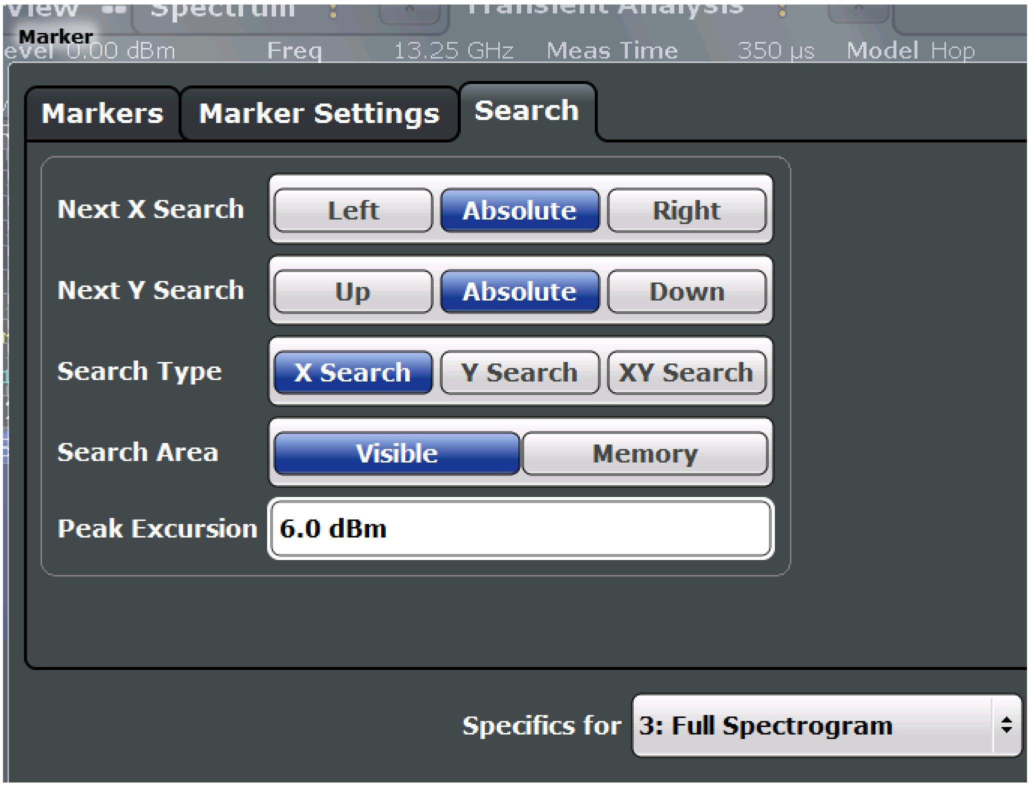


Figure 7-3: Marker search settings for spectrogram

Search Mode for Next Peak in X Direction

Selects the search mode for the next peak.

For spectrograms:

Selects the search mode for the next peak search within the currently selected frame.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
Chapter 11.6.12.4, "Positioning the Marker", on page 319

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.

This function is available for spectrograms only.

"Up" Determines the next maximum/minimum above the current peak (in more recent frames).

"Absolute" Determines the next maximum/minimum above or below the current peak (in all frames).

"Down" Determines the next maximum/minimum below the current peak (in older frames).

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe` on page 326
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe` on page 331
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow` on page 326
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow` on page 331
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT` on page 326
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT` on page 331
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe` on page 327
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe` on page 332
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow` on page 327
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow` on page 332
`CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT` on page 328
`CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT` on page 333

Marker Search Type
Defines the type of search to be performed in the spectrogram.

"X-Search" Searches only within the currently selected frame.

"Y-Search" Searches within all frames but only at the current frequency position.

"XY-Search" Searches in all frames at all positions.

Remote command:
Defined by the search function, see Chapter 11.6.12.5, "Marker Search (Spectrograms)", on page 323

Marker Search Area
Defines which frames the search is performed in.

This function is available for spectrograms only.

"Visible" Only the visible frames are searched.

"Memory" All frames stored in the memory are searched.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:SARea` on page 325
`CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea` on page 330

Peak Excursion
Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 318

7.8.3.2 Positioning Functions

Access: MKR ->

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value. These functions are available as softkeys in the menu, which is displayed when you press the key.

Peak Search
Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 319
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 322

Search Next Peak
Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 319
CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 320
CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 319
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 322
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 322
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 321

Search Minimum
Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 321
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 323

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.

Remote command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 320
CALCulate<n>:MARKer<m>:MINimum:LEFT on page 320
CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 321
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 323
CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 322
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 323

7.9 Zoom Functions

Access: "Zoom" icons in 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.

Remote command:
DISPlay[:WINDow<n>]:ZOOM:STATe on page 334
DISPlay[:WINDow<n>]:ZOOM:AREA on page 333

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.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 335
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA` on page 334

Restore Original Display

Restores the original display, that is, the originally calculated displays for the entire capture buffer, and closes all zoom windows.

Remote command:
Single zoom:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 334
Multiple zoom:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 335 (for each multiple zoom window)

Data Shift

Shifts the data to be evaluated in the result display (analysis region or hop/chirp) and re-evaluates the new data. *ALL* result displays based on the same data (analysis region or hop/chirp) are updated.

Currently, this function is only available in the Transient Analysis application.

Tip: Result tables are also re-evaluated for each data shift, which can take some time. Close the result tables during a data shift/zoom to improve the screen update speed.

After selecting the "Data Shift" ( ) function, swipe the screen in the result display to shift the data base. When the required data base is evaluated, select the "Deactivating Zoom (Selection mode)" ( ) to return to normal touchscreen behavior.

For more information, see Chapter 4.6, "Zooming and Shifting Results", on page 26.

Data Zoom

Decreases the amount of data to be evaluated in the result display (analysis region or hop/chirp) and re-evaluates the new data, thus enlarging the display of the remaining data.

ALL result displays based on the same data (analysis region or hop/chirp) are updated.

Currently, this function is only available in the Transient Analysis application.

Tip: result tables are also re-evaluated for each data zoom, which can take some time. Close the result tables during a data shift/zoom to improve the screen update speed.

After selecting the "Data Zoom" ( ) function, pinch or spread the area in the result display to zoom into or out of the data base. When the required data base is evaluated, select the "Deactivating Zoom (Selection mode)" ( ) to return to normal touchscreen behavior.

For more information, see Chapter 4.6, "Zooming and Shifting Results", on page 26.

Deactivating Zoom (Selection mode)
Deactivates any zoom mode.

Tapping the screen no longer invokes a zoom, but selects an object.

Remote command:
Single zoom:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 334
Multiple zoom:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 335 (for each multiple zoom window)

7.10 Analysis in MSRA/MSRT Mode

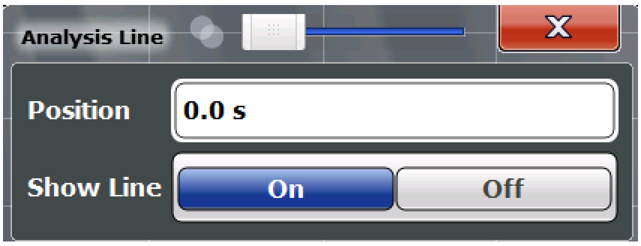
The data that was captured by the MSRA/MSRT Master can be analyzed in the Transient Analysis application.

The analysis settings and functions available in MSRA/MSRT mode are those described for common Signal and Spectrum Analyzer mode.

Analysis line settings

In addition, an analysis line can be positioned. The analysis line is a common time marker for all MSRA/MSRT applications.

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



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

Remote command:
CALCulate<n>:MSRA:ALINe[:VALue] on page 336
CALCulate<n>:RTMS:ALINe[:VALue] on page 338

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

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

Remote command:
CALCulate<n>:MSRA:ALINe:SHOW on page 336
CALCulate<n>:RTMS:ALINe:SHOW on page 338

8 How to Perform Transient Analysis

The following step-by-step instructions demonstrate how to analyze transient signal effects with the R&S FSW-K60 option.

To perform a basic transient analysis measurement

1. Press the MODE key on the front panel and select the "Transient" application.
2. Select the "Overview" softkey to display the "Overview" for Transient Analysis.
3. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's center frequency.
4. Select the "Data Acquisition" button to define the Data Acquisition (Full) and Analysis Region (AR) parameters for the input signal:
   (In MSRA/MSRT mode, define the application data instead, see Chapter 4.11, "Transient Analysis in MSRA/MSRT Mode", on page 42).
   - "(Full) Measurement Bandwidth": the amount of signal bandwidth to be captured
   - "(Full) Measurement Time": how long the input signal is to be captured
   - "(AR) Bandwidth": the amount of signal bandwidth to be analyzed
   - "(AR) Delta Frequency": the offset from the center frequency
   - "(AR) Time Gate Length"": the absolute length of the time gate
   - "(AR) Time Gate Start"": the starting point of the time span for analysis

   Optionally, you can link the size of the analysis region to the size of the full capture buffer.
5. If necessary, filter out unwanted signals using an FM video filter (in the "BW" settings).
6. Select the "Result Config" button and configure the data basis for evaluation and display.
   - In the "Scale" and "Units" tabs, configure the value range for the y-axis in the individual result displays. (See Chapter 7.2.4, "Y-Axis Scaling", on page 127.)
7. Select the "Display Config" button and select the displays that are of interest to you (up to 16, see Chapter 7.1, "Display Configuration", on page 120).
   Arrange them on the display to suit your preferences.
8. Exit the SmartGrid mode.
9. 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.

10. Select the "Analysis" button in the "Overview" to make use of the advanced analysis functions in the displays.
    - Configure a trace to display the average over a series of sweeps (on the "Traces" tab, see Chapter 7.4, "Trace Settings", on page 130).
    - Configure markers and delta markers to determine deviations and offsets within the signal (on the "Marker" tab, see Chapter 7.8, "Marker Settings", on page 144).
    - Configure the Spectrogram display or FFT parameters (on the "Spectrogram" tab, see Chapter 7.6, "Spectrogram Settings", on page 135).
11. Optionally, export the trace data of the demodulated signal to a file.
    a) In the "Traces" tab of the "Analysis" dialog box, switch to the "Trace Export" tab.
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

To detect hops in a transient measurement

This procedure requires the additional option R&S FSW-K60H to be installed.

1. Press the MODE key on the front panel and select the "Transient" application.
2. Select the "Overview" softkey to display the "Overview" for Transient Analysis.
3. Select the "Signal Description" button and configure the expected signal characteristics.
    - In the "Signal Model" tab, select the "Hop" signal model.
    - In the "Signal States" tab, define the known hop states and the conditions for detection (see Chapter 6.2.2, "Signal States", on page 72).

    To generate multiple regularly-spaced hop states easily, do the following:

    a) In the "Signal States" tab, select "More".
    b) Define the "Start Frequency" for the first hop state.
    c) Define the "Step Size" between two hop states.
    d) Define the number of hop states to be generated in the "No of Steps" field.
    e) Select "Add to Table" to add the generated states to the existing table, or select "Replace Table" to overwrite the existing table.
    f) Optionally, define a "Tolerance Value" or "Frequency Offset" (or both) to all hop states and select "Apply to Table" to adapt the hop state settings.
4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's center frequency.
5. Select the "Data Acquisition" button to define the Data Acquisition (Full) and Analysis Region (AR) parameters for the input signal:
    (In MSRA/MSRT mode, define the application data instead, see Chapter 4.11, "Transient Analysis in MSRA/MSRT Mode", on page 42).
    - "(Full) Measurement Bandwidth": the amount of signal bandwidth to be captured

- "(Full) Measurement Time": how long the input signal is to be captured
- "(AR) Bandwidth": the amount of signal bandwidth to be analyzed
- "(AR) Delta Frequency": the offset from the center frequency
- "(AR) Time Gate Length"": the absolute length of the time gate
- "(AR) Time Gate Start"": the starting point of the time span for analysis

Optionally, you can link the size of the analysis region to the size of the full capture buffer.

6. Select the "Measurement" button and in the "Frequency/Phase" and "Power" tabs, define which parts of the hop will be considered when calculating frequency, phase and power parameters.
7. If necessary, filter out unwanted signals using an FM video filter (in the "BW" settings).
8. Select the "Display Config" button and select the displays that are of interest to you (up to 16, see Chapter 7.1, "Display Configuration", on page 120).
Arrange them on the display to suit your preferences.
9. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
10. Select the "Result Config" button and configure the data basis for evaluation and display.
    - In the "Result Range" tab, define the area of the hop to be analyzed in the result display. Define the area by a reference point, a length, and its alignment in relation to the hop's center or edges. (See Chapter 7.2.1, "Result Range", on page 121.)
    - In the "Table Config" tab, define which parameters are to be displayed in the hop result tables.
    - In the "Parameters" tab, define parameters for which a trend or distribution is to be displayed
    - In the "Scale" and "Units" tabs, configure the value range for the y-axis in the individual result displays. (See Chapter 7.2.4, "Y-Axis Scaling", on page 127.)
11. 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.
12. Select the "Analysis" button in the "Overview" to make use of the advanced analysis functions in the displays.
    - Configure a trace to display the average over a series of sweeps or calculate hop statistics (on the "Traces" tab, see Chapter 7.4, "Trace Settings", on page 130).

- Configure markers and delta markers to determine deviations and offsets within the signal (on the "Marker" tab, see Chapter 7.8, "Marker Settings", on page 144).
- Configure the Spectrogram display or FFT parameters (on the "Spectrogram" tab, see Chapter 7.6, "Spectrogram Settings", on page 135).

13. Optionally, export the trace data of the demodulated signal to a file.
    a) In the "Traces" tab of the "Analysis" dialog box, switch to the "Trace Export" tab.
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

To detect chirps in a transient measurement

This procedure requires the additional option R&S FSW-K60C to be installed.

1. Press the MODE key on the front panel and select the "Transient" application.
2. Select the "Overview" softkey to display the "Overview" for Transient Analysis.
3. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's center frequency.
4. Select the "Data Acquisition" button and define the bandwidth parameters for the input signal:
   (In MSRA/MSRT mode, define the application data instead, see Chapter 4.11, "Transient Analysis in MSRA/MSRT Mode", on page 42).
   - In the "Data Acquisition" area, define:
     – "Measurement Bandwidth": the amount of signal bandwidth to be captured
     – "Measurement Time": how long the input signal is to be captured
   - In the "Analysis Region" area, define the frequency range and time gate (within the captured data) which is to be analyzed, that is, which hops are to be detected. (See Analysis Region.)
     Optionally, you can link the size of the analysis region to the size of the full capture buffer.
5. Select the "Signal Description" button and configure the expected signal characteristics.
   - In the "Signal Model" tab, select the "Chirp" signal model.
   - In the "Signal States" tab, define the known chirp states and the conditions for detection. (See Chapter 6.2.2, "Signal States", on page 72)
6. Select the "Measurement" button and in the "Frequency/Phase" and "Power" subtabs, define which parts of the chirp will be considered when calculating frequency, phase and power parameters.
7. If necessary, filter out unwanted signals using an FM video filter (in the "BW" settings).
8. Select the "Display Config" button and select the displays that are of interest to you (up to 16, see Chapter 7.1, "Display Configuration", on page 120).

Arrange them on the display to suit your preferences.

9. Exit the SmartGrid mode.
10. Select the "Result Config" button and configure the data basis for evaluation and display.
    - In the "Result Range" tab, define the area of the chirp to be analyzed in the result display. Define the area by a reference point, a length, and its alignment in relation to the chirp's center or edges. (See Chapter 7.2.1, "Result Range", on page 121.)
    - In the "Table Config" tab, define which parameters are to be displayed in the chirp result tables.
    - In the "Parameters" tab, define parameters for which a trend or distribution is to be displayed
    - In the "Scale" and "Units" tabs, configure the value range for the y-axis in the individual result displays. (See Chapter 7.2.4, "Y-Axis Scaling", on page 127.)
11. 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.
12. Select the "Analysis" button in the "Overview" to make use of the advanced analysis functions in the displays.
    - Configure a trace to display the average over a series of sweeps or calculate chirp statistics (on the "Traces" tab, see Chapter 7.4, "Trace Settings", on page 130).
    - Configure markers and delta markers to determine deviations and offsets within the signal (on the "Marker" tab, see Chapter 7.8, "Marker Settings", on page 144).
    - Configure the Spectrogram display or FFT parameters (on the "Spectrogram" tab, see Chapter 7.6, "Spectrogram Settings", on page 135).
13. Optionally, export the trace data of the demodulated signal to a file.
    a) In the "Traces" tab of the "Analysis" dialog box, switch to the "Trace Export" tab.
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

8.1 How to Configure the Color Mapping

The color display is highly configurable to adapt the spectrogram 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:

- Select the color map in the window title bar of the Spectrogram result display.
- Select 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. To cover the entire measurement value range, make sure the first and last bar of the histogram are included.

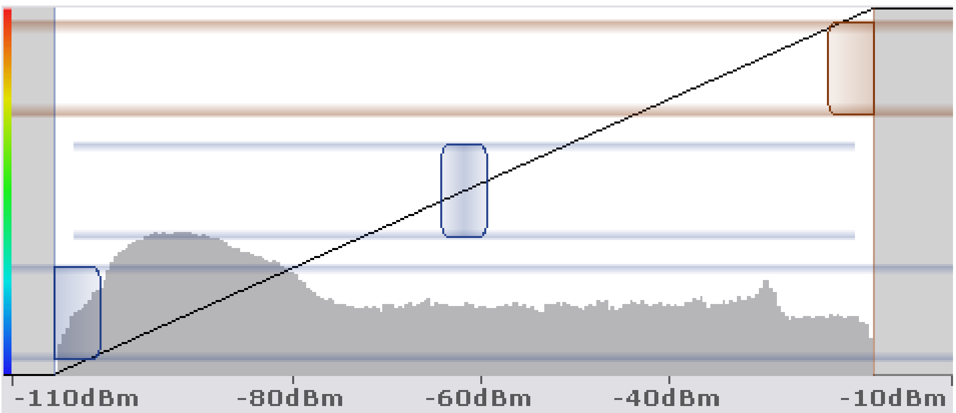
To ignore noise in a spectrogram, for example, exclude the lower power levels from the histogram.

The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram, that means, the difference between the start and stop values must be at least 10%.

The value range of the color map 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 of the color map 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 -110 dBm and ends at -10 dBm (that is: 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

Since the color map is configured using percentages of the total value range, changing the reference level and level range of the measurement (and thus the power value range) also affects the color mapping in the spectrogram.

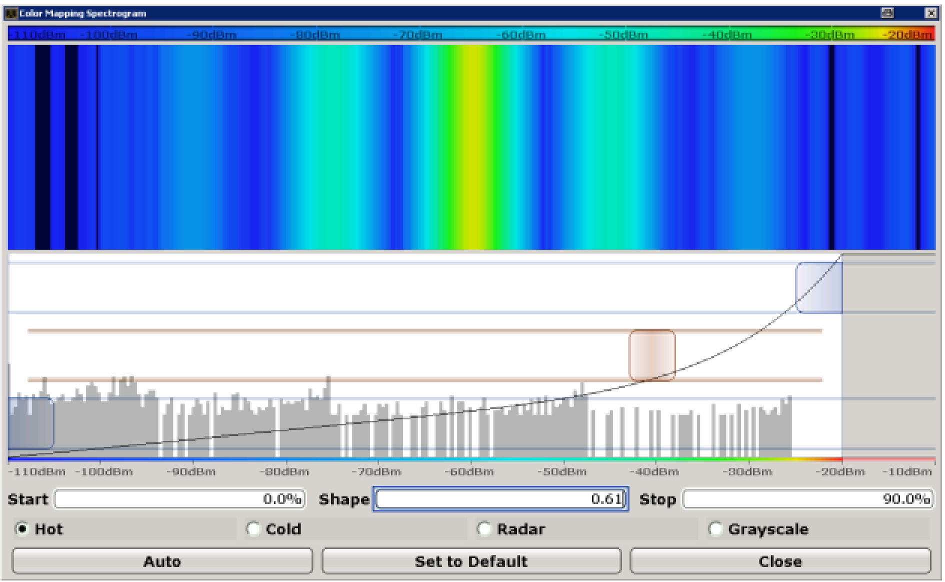
Editing the shape of the color curve

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 number 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 focused, 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) focuses the lower values
- 0 defines a linear distribution
- A positive value (>0 to 1) focuses the higher values

8.2 How to Export Table Data

The measured result table data can be exported to an ASCII file. For each parameter, the measured values are output.

For details on the storage format see Chapter A.1, "Reference: ASCII File Export Format", on page 389.

Table data can be exported either from the "Result Configuration" dialog box, or from the "Save/Recall" menu.

To export from the "Save/Recall" menu

1. Select an active result table whose data you want to export.
2. Select the "Save" icon in the toolbar.
3. Select the "Export" softkey.
4. If necessary, change the decimal separator to be used for the ASCII export file.

5. Select the "ASCII Table Export" softkey.
6. In the file selection dialog box, select the storage location and file name for the export file.
7. Select "Save" to close the dialog box and export the table data to the file.

To export from the "Result configuration" dialog box

1. Press the "Overview" softkey.
2. Select the "Result Config" button.
3. Select the window that contains the result table in the "Specifics for" selection box.
4. Select the "Table Config" tab.
5. Select the vertical "Table Export" tab.
6. Select whether you want to export all columns or only the currently visible columns of the table.
7. If necessary, change the decimal separator to be used for the ASCII export file.
8. Select the "Export Table to ASCII File" 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 table data to the file.

9 Measurement Examples

The following measurement examples demonstrate some basic functions and measurement tasks, assuming the additional options R&S FSW-K60C/-K60H are installed.

9.1 Example: Hopped FM Signal

A practical example for a basic transient analysis measurement is provided here. It demonstrates how to identify a hopped signal, how to detect hops, and how to analyze an individual hop.

The measurement is performed using the following devices:

- An R&S FSW with application firmware R&S FSW-K60: Transient Analysis+ K60H (Hopped Transient Analysis) and bandwidth extension option R&S FSW-B160
- A vector signal generator, e.g. R&S SMBV100A

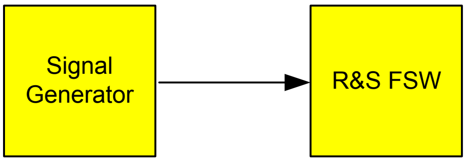


Figure 9-1: Test setup

Signal generator settings (e.g. R&S SMBV100A):

Frequency:	4 GHz
Level:	-30 dBm
Channels	CW-Hopping channel: 0 dB DC carrier: +20 dB
Hops	20.0 / 20.2 / 20.4 / 20.6 / 20.8 / 21.0 MHz
Dwell time	200 µs
Sample rate	100 MHz

Settings in the R&S FSW Transient Analysis application

To identify a hopped FM signal

1. Preset the R&S FSW.
2. Set the center frequency to *4 GHz*.
3. Set the reference level to *-30 dBm*.

4. Select the MODE key and then the "Transient Analysis" button.
5. Select the signal model *Hop*.
6. From the "Meas Config" menu, select "Data Acquisition".
7. Set the measurement time to *5 ms*.
8. Set the measurement bandwidth to *160 MHz*.
9. The RF Spectrum and Full Spectrogram displays are dominated by the DC carrier. Define an analysis region to extract the hopped FM signal. Make sure that a sufficient number of hops are inside the analysis region. A second spectrogram showing the analysis region helps with fine tuning.

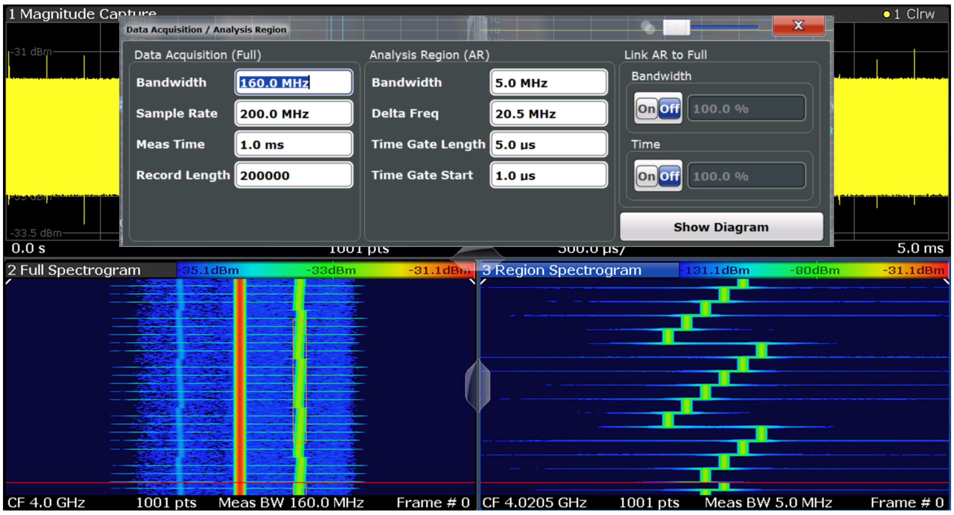


Figure 9-2: Configuring an analysis region for a hopped FM signal

a) From the "Meas Config" menu, select "Display Config".
b) Drag a second spectrogram display to the right of the existing one on the screen.
c) Exit the SmartGrid mode.
d) Press the MEAS key, then select "Analysis Region" to restrict the Spectrogram display to the analysis region.
   By default, the analysis region corresponds to the entire capture buffer.

10. From the "Meas Config" menu, select "Data Acquisition".
    a) Define the starting point of the analysis region as an offset from the center frequency ("Delta Freq").
    b) Define the width of the analysis region as a "Bandwidth". Be sure to include several hops in the frequency range.
    c) Define the starting point and the length of the time gate. Again, be sure to include several hops in the time gate.
11. Since the signal model is set to "Hop" and the "Auto Mode" for detection is on, the hops are detected automatically. The detected hop states are listed in the order of

their occurrence in the "Signal States" table. From the "Meas Config" menu, select "Signal Description" to check them.

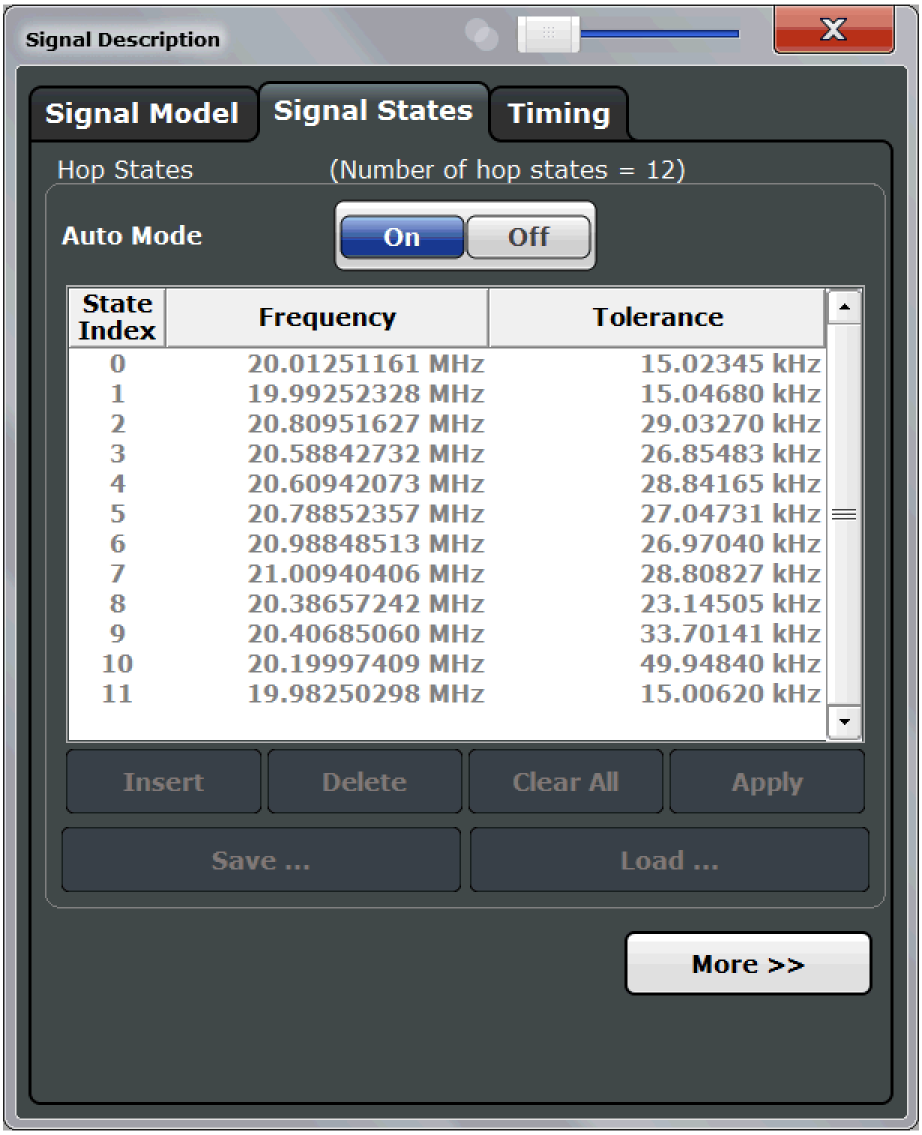


Figure 9-3: Detected hop states

To analyze an individual hop

All detected hops are indicated in the Hop Results Table. To analyze an individual hop in detail, open a Frequency Deviation display and reduce the spectrogram to a single hop.

1. From the "Meas Config" menu, select "Display Config".
2. Replace the Full Spectrogram display by a Frequency Deviation Time Domain display.
3. Exit the SmartGrid mode.

4. Select the Spectrogram display.
5. Press the MEAS key, then select "Hop" to restrict the Spectrogram display to a single hop.
6. Select "Select hop" and enter *7* to show the results for the hop number 7.

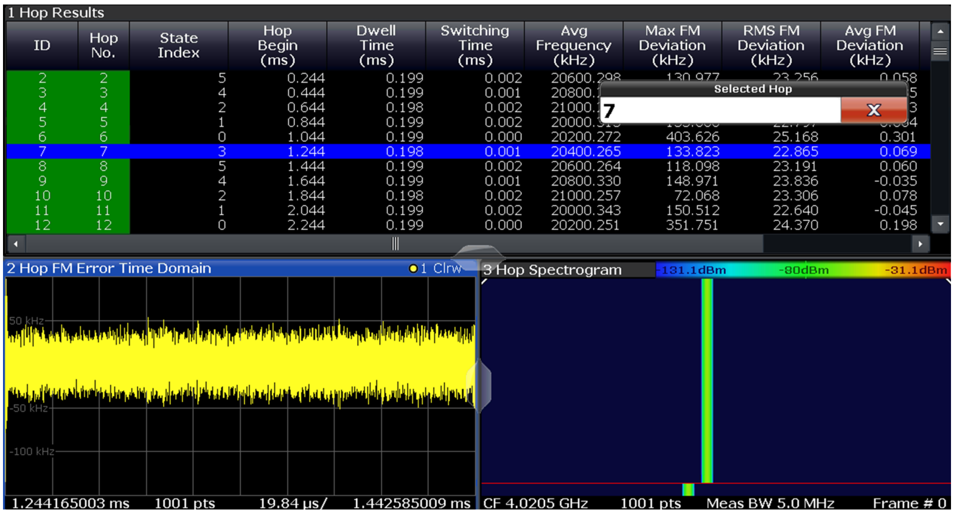


Figure 9-4: Results for a single hop

By default, both the Frequency Deviation and the Spectrogram displays show 100 % of the dwell time of the selected hop.

To analyze settling effects using a VBW filter

One possibility to remove noise from the Frequency Deviation trace is using a video filter with a smaller VBW.

1. From the "Bandwidth" menu, select "FM Video BW".
2. As the "FM Video Bandwidth", select *Low Pass 1% BW*.

   Note the impact on the Frequency Deviation trace. Settling effects on the hop FM are now clearly visible.

Figure 9-5: Effect of the FM video bandwidth

To analyze settling effects by defining a result range

Another possibility to analyze the settling effects is by defining a result range. Move the result range to the hop begin to see the settling in more detail.

1. From the "Meas Config" menu, select "Result Config".
2. In the "Result Range" tab, set "Automatic Range Scaling" to *Off*.
3. Set the reference point of the result range to *Rise*.
4. Set the result range "Length" to *100 µs*.

   Note that fewer spectrogram frames may be calculated as the result range length gets smaller.

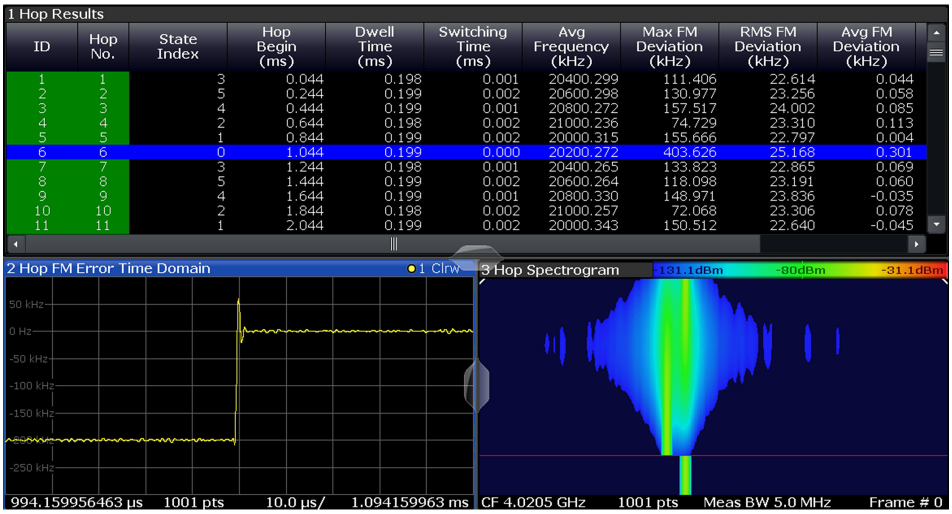


Figure 9-6: Hop displays for a result range at the beginning of the hop

9.2 Example: Chirped FM Signal

The following example demonstrates how to detect chirps and how to analyze an individual chirp.

The measurement is performed using the following devices:

- An R&S FSW with application firmware R&S FSW-K60: Transient Analysis +K60C (Chirped Transient Analysis) and bandwidth extension option R&S FSW-B160
- A vector signal generator, e.g. R&S SMF

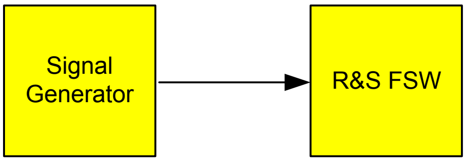


Figure 9-7: Test setup

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

Frequency:	4 GHz
Level:	-30 dBm
Channels	Linear FM up/down chirp channel:±40 MHz (trapezoidal shape) Sinusoidal interference on FM with 10 kHz deviation and FM spike in up-chirp with 1 MHz deviation
Chirp length	100 µs (= chirp rate 800 kHz/µs)
Sample rate	100 MHz

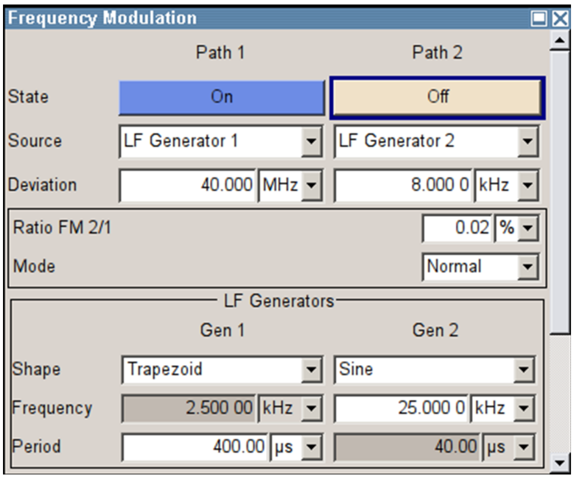


Figure 9-8: R&S® SMF frequency modulation configuration for chirped FM signal example

Settings in the R&S FSW Transient Analysis application

To detect chirps in an FM signal

1. Preset the R&S FSW.
2. Set the center frequency to *4 GHz*.
3. Set the reference level to *-30 dBm*.
4. Select the MODE key and then the "Transient Analysis" button.
5. Select "Signal Description > Signal Model" and select the signal model *Chirp*.
6. From the "Meas Config" menu, select "Data Acquisition".
7. Set the measurement time to *1 ms*.
8. Set the measurement bandwidth to *160 MHz*.
9. Define an analysis region to extract the chirped FM signal. Make sure that a sufficient number of chirps are inside the analysis region.

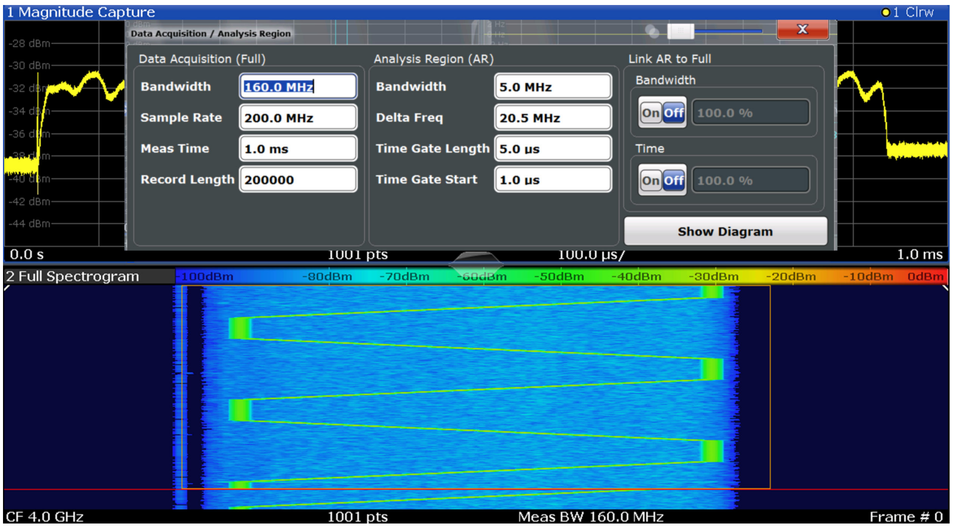


Figure 9-9: Configuring an analysis region for a chirped FM signal

   a) Define the starting point of the analysis region as an offset from the center frequency ("Delta Freq").
   b) Define the width of the analysis region as a "Bandwidth". Be sure to include several chirps in the frequency range.
   c) Define the starting point and the length of the time gate. Again, be sure to include several chirps in the time gate.

10. The chirps are detected automatically. The detected chirp states are listed in the order of their occurrence in the "Signal States" table. From the "Meas Config" menu, select "Description" to check them.

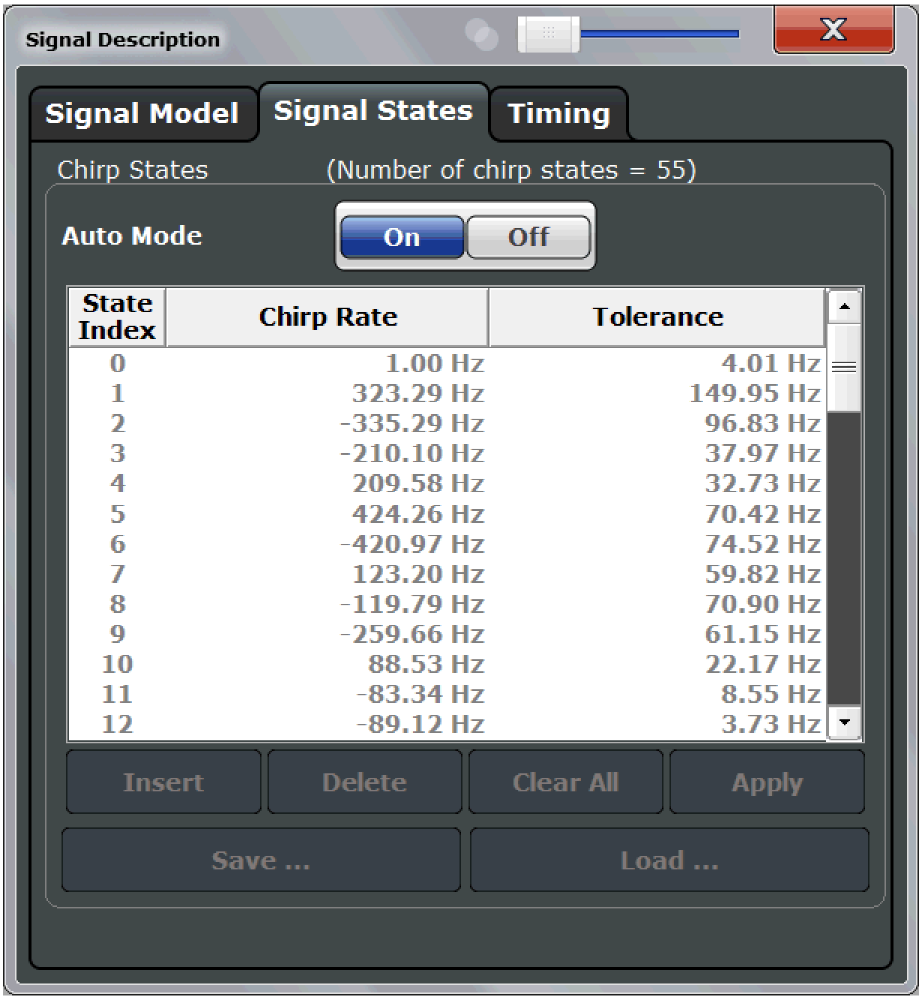


Figure 9-10: Detected chirp states

To analyze the chirp results

All detected chirps are indicated in the Results Table.

3 Chirp Results

ID	Chirp No.	State Index	Chirp Begin (ms)	Chirp Length (ms)	Chirp Rate (kHz/us)	Chirp Rate Deviation (kHz/us)	Avg Frequency (kHz)	Max FM Deviation (kHz)	RMS FM Deviation (kHz)
1	1	0	0.055	0.049	800.528	1.055	-20035.613	1178.163	197.366
2	2	0	0.105	0.049	799.235	-0.238	20079.712	767.851	139.397
3	3	1	0.255	0.099	-800.053	-1.411	-36.153	1112.765	170.175
4	4	0	0.455	0.049	800.527	1.055	-20047.582	1059.921	195.962
5	5	0	0.505	0.049	799.236	-0.237	20083.774	877.547	141.517
6	6	1	0.655	0.099	-800.055	-1.413	-38.264	1271.343	167.509
7	7	0	0.856	0.049	800.537	1.064	-19933.468	1207.126	194.168
8	8	0	0.905	0.049	799.228	-0.245	20081.857	684.792	135.391

Figure 9-11: Detected chirps

Note that the up-chirp is split up into two smaller chirps for some reason.

► Increase the detection tolerance for the up-chirp and note the impact on the detected chirp length in the Results Table.

a) From the "Meas Config" menu, select "Signal Description > Signal States".

b) Set the "Auto Mode" for the Chirp States to *Off*.

c) Select the "Tolerance" for the state index 0 and enter *200 kHz*.

To analyze FM linearity

For radar systems using chirped FM signals, FM linearity is an important measurement.

The FM Time Domain and the Frequency Deviation Time Domain displays are useful to investigate interference of the chirp FM.

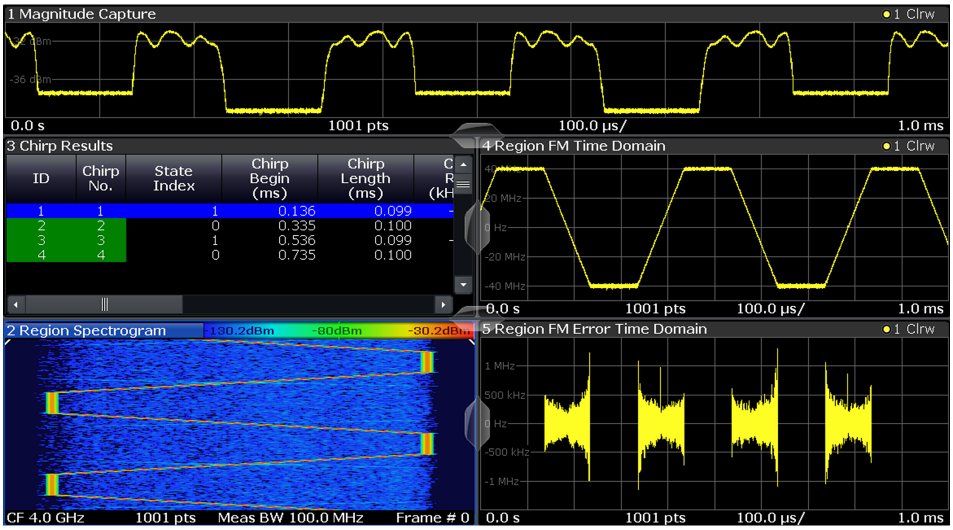


Figure 9-12: Typical display arrangement for FM linearity measurement

The Frequency Deviation display is dominated by noise, but a spike in the up-chirp is already clearly visible (this spike caused the up-chirp to be detected as two individual chirps).

To remove noise using trace averaging

Noise can be removed by averaging the Frequency Deviation Time Domain trace over multiple chirps.

1. To restrict trace statistics to the up-chirp, discard all down-chirps by deleting the corresponding chirp state from the chirp state list.
   a) From the "Meas Config" menu, select "Signal Description > Signal States".
   b) Select the state index 1.
   c) Select "Delete".
2. Restrict the Frequency Deviation Time Domain display to a single chirp.
   a) Select the Frequency Deviation Time Domain display.
   b) Press the MEAS key, then select "Chirp" to restrict the Frequency Deviation Time Domain display to a single chirp.
3. Enable trace averaging for the Frequency Deviation Time Domain display.
   a) Press the TRACE key, then select "Trace Config".
   b) For trace 1, select the "Mode": *Max Hold*.

c) For trace 2, select the "Mode": *Average*.
d) For trace 3, select the "Mode": *Min Hold*.
e) Define an average count of *1000*.

The display now shows the trace statistics as output of an auto peak detector of one chirp.

4. For statistics over multiple chirps you must define a common result range to make sure that statistics are calculated over time intervals of a constant length.

a) From the "Meas Config" menu, select "Result Config".
b) In the "Result Range" tab, set "Automatic Range Scaling" to *Off*.
c) Set the result range "Alignment" to the *Center* of the chirp.
d) Set the result range "Length" to *90 µs*.

After averaging 1000 chirps, you see not only the the FM spike on the max trace, but also a sinusoidal interference on the average trace.

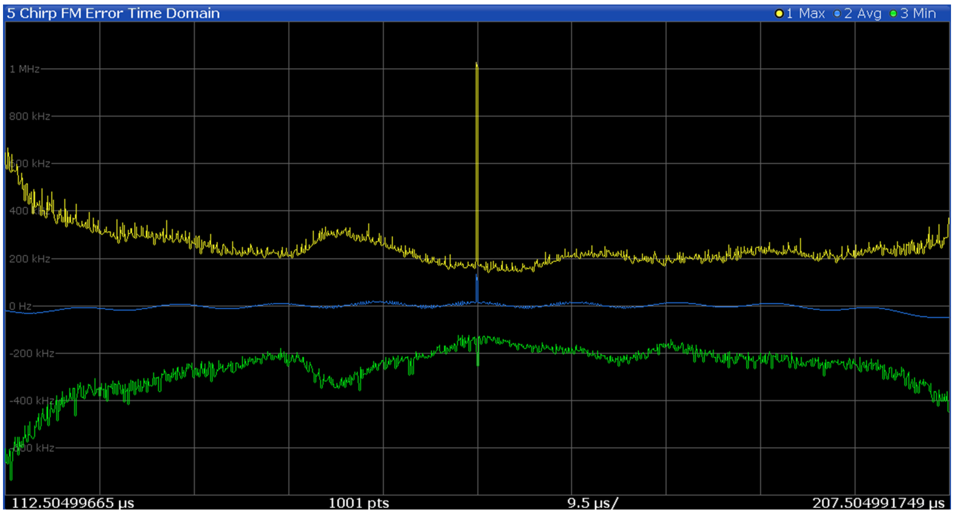


Figure 9-13: Min/average/max traces for chirp Frequency Deviation

To limit the noise bandwidth using a video filter

The noise bandwidth can be reduced using a video filter.

1. Disable trace averaging for the Frequency Deviation Time Domain display.

a) Press the TRACE key, then select "Trace Config".
b) For trace 1, select the "Mode": *Clr/Write*.
c) For trace 2 and 3, select the "Mode": *Blank*.

2. From the "Bandwidth" menu, select "FM Video Bandwidth".

3. As the "FM Video Bandwidth", select *Low Pass 1% BW*.

Note the different behavior of limiting the noise bandwidth by VBW filtering and trace averaging.

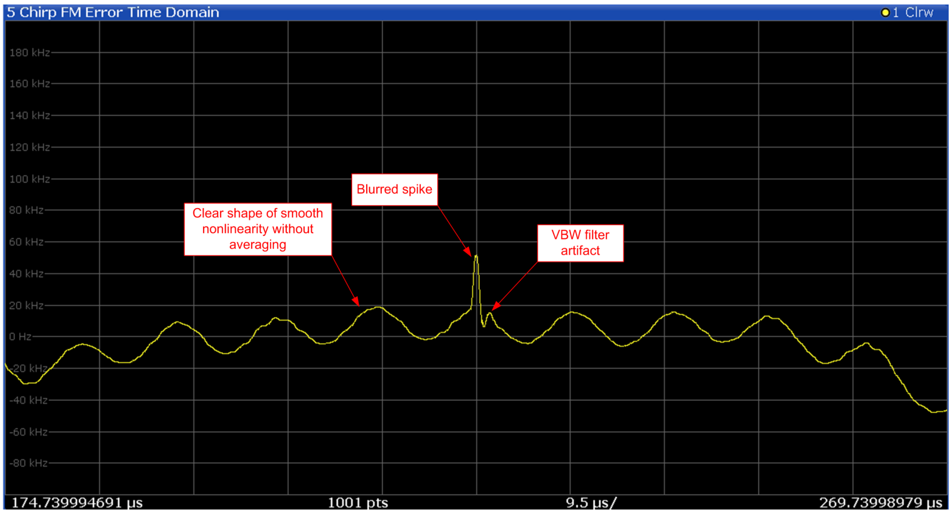


Figure 9-14: Chirp Frequency Deviation clear/write trace with 1% VBW filter

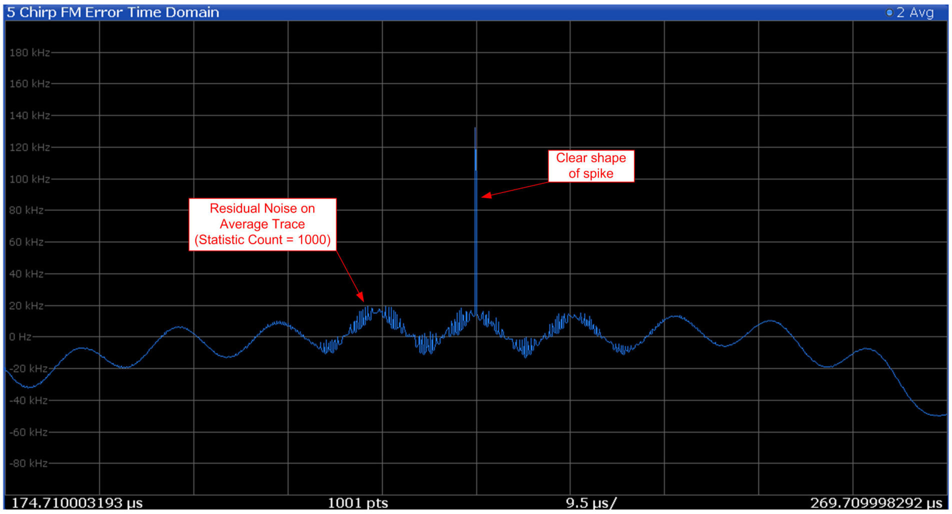


Figure 9-15: Chirp Frequency Deviation average trace (statistic count = 1000)

10 Optimizing and Troubleshooting

If the results do not meet your expectations, or if problems occur during measurement, try the following solutions.

Too many hop/chirp states have been detected in auto mode
Switch auto mode off and edit hop/chirp state table manually (see Chapter 6.2.2, "Signal States", on page 72).

Usually, these unwanted hop/chirp states will not appear in the Results Table.

The desired hop/chirp states are not detected
Make sure that a sufficient number of hops/chirps are inside the analysis region (see Analysis Region).

Instead of one hop/chirp, several shorter hop/chirps of the same hop/chirp state are detected
Increase the detection tolerance of the corresponding hop/chirp state (see "Tolerance" on page 74).

Use a video filter with a smaller VBW (see "FM Video Bandwidth" on page 113).

Instead of one hop/chirp, several shorter hop/chirps of a different hop/chirp state are detected
Adjust the detection tolerance of the corresponding hop/chirp states to make sure that tolerance ranges do not overlap (see "Tolerance" on page 74).

Use a video filter with a smaller VBW (see "FM Video Bandwidth" on page 113).

One or more shorter hops/chirps are detected directly before or after the desired hop/chirp
Specify a minimum and maximum dwell time/chirp length corresponding to the desired hop/chirp (see "Length" on page 116).

Spectrogram of a selected hop/chirp is empty
Increase the result range length (see "Length" on page 122).

11 Remote Commands to Perform Transient Analysis

The following commands are required to perform measurements in the Transient Analysis application in a remote environment. It is assumed that the R&S FSW has already been set up for remote operation in a network as described in the R&S FSW User Manual.

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

In particular, this includes:

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

The following tasks specific to the Transient Analysis application are described here:

11.1 Introduction

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

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

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank).

If there is more than one parameter for a command, these are separated by a comma from one another.

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

Remote command examples

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

11.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSW follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

11.1.2 Long and Short Form

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

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

Example:

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

11.1.3 Numeric Suffixes

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

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

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

Example:

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

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

11.1.4 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

11.1.5 Alternative Keywords

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

Example:

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

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

11.1.6 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters may have different forms of values.

11.1.6.1 Numeric Values

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

Example:

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

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

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

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

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

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.

- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

11.1.6.2 Boolean

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

Querying boolean parameters

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

Example:

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

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

11.1.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see Chapter 11.1.2, "Long and Short Form", on page 179.

Querying text parameters

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

Example:

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

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

11.1.6.4 Character Strings

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

Example:

`INSTRument:DELete 'Spectrum'`

11.1.6.5 Block Data

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

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

11.2 Common Suffixes

In the R&S FSW Transient Analysis application, the following common suffixes are used in remote commands:

Table 11-1: Common suffixes used in remote commands in the R&S FSW Transient Analysis application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 16	Window (**in the currently selected measurement channel**)
<t>	1 to 6	Trace
<k>	not applicable	Limit line

11.3 Activating Transient Analysis

Transient Analysis requires a special application on the R&S FSW. A measurement is started immediately with the default settings.

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

This command adds an additional measurement channel.

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

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 184.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 184).

Example: `INST:CRE IQ, 'IQAnalyzer2'`
Adds an additional I/Q Analyzer channel named "IQAnalyzer2".

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

This command replaces a measurement channel with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 184.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 184).

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named 'IQAnalyzer2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

Usage: Setting only

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 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Event

INSTrument:LIST?

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

Return values:

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

Example: `INST:LIST?`
Result for 3 measurement channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

Table 11-2: Available measurement channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
802.11ad (R&S FSW-K95)	WIGIG	802.11ad
Amplifier Measurements (R&S FSW-K18)	AMPLifier	Amplifier
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
*) 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.		

Application	<ChannelType> Parameter	Default Channel Name*)
Avionics (R&S FSW-K15)	AVIonics	Avionics
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
DOCSIS 3.1 (R&S FSW-K192/193)	DOCSis	DOCSIS 3.1
GSM (R&S FSW-K10)	GSM	GSM
I/Q Analyzer	IQ	IQ Analyzer
LTE (R&S FSW-K10x)	LTE	LTE
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
Pulse (R&S FSW-K6)	PULSE	Pulse
Real-Time Spectrum (R&S FSW-B160R/-K160RE)	RTIM	Real-Time Spectrum
Spurious Measurements (R&S FSW-K50)	SPUR	Spurious
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
Transient Analysis (R&S FSW-K60)	TA	Transient Analysis
VSA (R&S FSW-K70)	DDEM	VSA
WLAN (R&S FSW-K91)	WLAN	WLAN
*) 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: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 cannot assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

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

See also `INSTrument:CREate[:NEW]` on page 183.

For a list of available channel types see Table 11-2.

Parameters:

<ChannelType> **TA**
Transient Analysis application, R&S FSW–K60

SYSTem:PRESet:CHANnel[:EXECute]

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

Use `INST:SEL` to select the channel.

Example: `INST:SEL 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 71

11.4 Configuring Transient Analysis

The following commands are required to configure a measurement for transient analysis.

11.4.1 Input/Output Settings

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 noise or trigger signals). The following commands are required to configure data input and output.

11.4.1.1 RF Input

INPut:ATTenuation:PROTection:RESet

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

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

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType>

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 78

INPut:DPATh <State>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:

<State>

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

*RST: 1

Example: `INP:DPAT OFF`

Usage: SCPI confirmed

Manual operation: See "Direct Path" on page 79

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 an additional high-pass filter hardware option.

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

Parameters:

<State> ON | OFF

*RST: OFF

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

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 79

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

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG-preselector described in "YIG-Preselector" on page 79.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1 (0 for I/Q Analyzer, GSM, VSA, Pulse, Amplifier, Transient Analysis, DOCSIS and MC Group Delay measurements)

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

Manual operation: See "YIG-Preselector" on page 79

INPut:IMPedance <Impedance>

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

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

Parameters:
<Impedance> 50 | 75
*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 78

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 input options are installed, only RF input or file input is supported.

Parameters:
<Source>
RF
Radio Frequency ("RF INPUT" connector)
FIQ
I/Q data file (selected by `INPut:FILE:PATH` on page 202)
For details see Chapter 4.10.2, "Basics on Input from I/Q Data Files", on page 40.
*RST: RF

Manual operation: See "Radio Frequency State" on page 78
See "I/Q Input File State" on page 80

11.4.1.2 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/MSRT mode, external mixers are not supported.

For details on working with external mixers see the R&S FSW User Manual.

Basic Settings

The basic settings concern general usage of an external mixer.

[SENSe:]MIXer[:STATe] <State>

Activates or deactivates the use of a connected external mixer as input for the measurement. This command is only available if the optional External Mixer is installed and an external mixer is connected.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `MIX ON`

Manual operation: See "External Mixer State" on page 81

[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 190).

Parameters:

<BiasSetting> *RST: 0.0 A

Default unit: A

Manual operation: See "Bias Settings" on page 85

[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 190).

Parameters:

<BiasSetting> *RST: 0.0 A

Default unit: A

Manual operation: See "Bias Settings" on page 85

[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 operation: See "LO Level" on page 84

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 190).

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 operation: See "Handover Freq." on page 82

[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 operation: See "RF Start / RF Stop" on page 82

[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 operation: See "RF Start / RF Stop" on page 82

[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 operation: See "Preset Band" on page 83

[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 190).

Parameters:
<Band> KA | Q | U | V | E | W | F | D | G | Y | J | USER
Standard waveguide band or user-defined band.

Manual operation: See "Band" on page 82

Table 11-3: Frequency ranges for pre-defined bands

Band	Frequency start [GHz]	Frequency stop [GHz]
KA (A) *)	26.5	40.0
Q	33.0	50.0
U	40.0	60.0
V	50.0	75.0
E	60.0	90.0
W	75.0	110.0
F	90.0	140.0
D	110.0	170.0
G	140.0	220.0
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 operation: See "Range 1/2" on page 83

[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 operation: See "Harmonic Order" on page 83

[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 operation: See "Harmonic Type" on page 83

[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 operation: See "Harmonic Order" on page 83

[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 operation: See "Conversion loss" on page 84

[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 containing the path and name of the file.

Example: `MIX:LOSS:TABL:HIGH 'MyCVLTable'`

Manual operation: See "Conversion loss" on page 84

[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 containing the path and name of the file.

Example: `MIX:LOSS:TABL 'mix_1_4'`
Specifies the conversion loss table *mix_1_4*.

Manual operation: See "Conversion loss" on page 84

[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 operation: See "Conversion loss" on page 84

[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 operation: See "Mixer Type" on page 83

[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 operation: See "RF Overrange" on page 82

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 199).

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 11-3).

*RST: F (90 GHz - 140 GHz)

Example:

`CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:BAND KA`
Sets the band to KA (26.5 GHz - 40 GHz).

Manual operation: See "Band" on page 88

[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 199.

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 operation: See "Write to <CVL table name>" on page 85
See "Bias" on page 88

[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 199).

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 operation: See "Delete Table" on page 86

[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 199).

This command is only available with option B21 (External Mixer) installed.

Parameters:
<Text>

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:COMM 'Conversion loss table for FS_Z60'`

Manual operation: See "Comment" on page 88

[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 199).

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 operation: See "Position/Value" on page 89

[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 199.

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 operation: See "Harmonic Order" on page 88

[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 199).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<Type> string

Name of mixer with a maximum of 16 characters

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:MIX 'FS_Z60'`

Manual operation: See "Mixer Name" on page 89

[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 199).

This command is only available with option B21 (External Mixer) installed.

Parameters:

<PortType> 2 | 3

*RST: 2

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`
Selects the conversion loss table.
`CORR:CVL:PORT 3`

Manual operation: See "Mixer Type" on page 89

[SENSe:]CORRection:CVL:SELect <FileName>

This command selects the conversion loss table with the specified file name. If <file_name> is not available, a new conversion loss table is created.

This command is only available with option B21 (External Mixer) installed.

Parameters:

<FileName> String containing the path and name of the file.

Example: `CORR:CVL:SEL 'LOSS_TAB_4'`

Manual operation: See "New Table" on page 86
See "Edit Table" on page 86
See "File Name" on page 88

[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 199).

This command is only available with option B21 (External Mixer) installed.

Parameters:
<SerialNo> Serial number with a maximum of 16 characters

Example: CORR:CVL:SEL 'LOSS_TAB_4'
Selects the conversion loss table.
CORR:CVL:MIX '123.4567'

Manual operation: See "Mixer S/N" on page 89

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
```

11.4.1.3 Input from I/Q Data Files

The input for measurements can be provided from I/Q data files. The commands required to configure the use of such files are described here.

For details see Chapter 4.10.2, "Basics on Input from I/Q Data Files", on page 40.

Useful commands for retrieving results described elsewhere:

- INPut:SELect on page 189

Remote commands exclusive to input from I/Q data files:

INPut:FILE:PATH <FileName>

This command selects the I/Q data file to be used as input for further measurements.

The I/Q data must have a specific format as described in Chapter A.2, "I/Q Data File Format (iq-tar)", on page 390.

For details see Chapter 4.10.2, "Basics on Input from I/Q Data Files", on page 40.

Parameters:

<FileName> String containing the path and name of the source file. The file extension is `*.iq.tar`.

Example: `INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'`
Uses I/Q data from the specified file as input.

Usage: Setting only

Manual operation: See "Select I/Q Data File" on page 80

11.4.1.4 Configuring the 2 GHz Bandwidth Extension (R&S FSW-B2000)

The following commands are required to use the optional 2 GHz bandwidth extension (R&S FSW-B2000).

See also the command for configuring triggers while using the optional 2 GHz bandwidth extension (R&S FSW-B2000):

- `TRIGger[:SEQuence]:OSCilloscope:COUPling` on page 206

Remote commands exclusive to configuring the 2 GHz bandwidth extension:

EXPort:WAVeform:DISPlayoff <FastExport>

Enables or disables the display update on the oscilloscope during data acquisition with the **optional 2 GHz bandwidth extension (R&S FSW-B2000)**.

As soon as the R&S FSW-B2000 is activated (see "B2000 State" on page 91), the display on the oscilloscope is turned off to improve performance during data export. As soon as the R&S FSW closes the connection to the oscilloscope, the display is reactivated and the oscilloscope can be operated as usual. However, if the LAN connection is lost for any reason, the display of the oscilloscope remains deactivated. Use this command to re-activate it.

Parameters:

<FastExport> ON | OFF

ON: Disables the display update for maximum export speed.
OFF: Enables the display update. The export is slower.

*RST: ON

SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe] <State>

Activates the optional 2 GHz bandwidth extension (R&S FSW-B2000).

Note: Manual operation on the connected oscilloscope, or remote operation other than by the R&S FSW, is not possible while the B2000 option is active.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
Option is active.

OFF | 0
Option is disabled.

*RST: 0

Example: `SYST:COMM:RDEV:OSC ON`

Manual operation: See "B2000 State" on page 91

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:STEP[:STATe]?

Performs the alignment of the oscilloscope itself and the oscilloscope ADC for the optional 2 GHz bandwidth extension (R&S FSW-B2000). The correction data for the oscilloscope (including the connection cable between the R&S FSW and the oscilloscope) is recorded. As a result, the state of the alignment is returned.

Alignment is required only once after setup. If alignment was performed successfully, the alignment data is stored on the oscilloscope.

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

- A new oscilloscope is connected to the IF OUT 2 GHZ connector of the R&S FSW
- A new cable is used between the IF OUT 2 GHZ connector of the R&S FSW and the oscilloscope
- A new firmware is installed on the oscilloscope

Return values:

<State> Returns the state of the second alignment step.

ON | 1
Alignment was successful.

OFF | 0
Alignment was not yet performed (successfully).

Example:
```
SYST:COMM:RDEV:OSC:ALIG:STEP?
//Result: 1
```

Usage: Query only

SYSTem:COMMunicate:RDEVice:OSCilloscope:ALIGnment:DATE?

Returns the date of alignment of the IF OUT 2 GHZ to the oscilloscope for the optional 2 GHz bandwidth extension (R&S FSW-B2000).

Return values:

<Date> Returns the date of alignment.

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

Usage: Query only

SYSTem:COMMunicate:RDEVice:OSCilloscope:IDN?

Returns the identification string of the oscilloscope connected to the R&S FSW.

Return values:
<IDString>

Example:
```
SYST:COMM:RDEV:OSC:IDN?
//Result: Rohde&Schwarz,RTO,
1316.1000k14/200153,2.45.1.1
```

Usage: Query only

Manual operation: See "TCPIP Address or Computer name" on page 91

SYSTem:COMMunicate:RDEVice:OSCilloscope:LEDState?

Returns the state of the LAN connection to the oscilloscope for the optional 2 GHz bandwidth extension (R&S FSW-B2000).

Return values:
<Color>

GREEN
Connection to the instrument has been established successfully.

GREY
Configuration state unknown, for example if you have not yet started transmission.

RED
Connection to the instrument could not be established.
Check the connection between the R&S FSW and the oscilloscope, and make sure the IP address of the oscilloscope has been defined (see `SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip` on page 205).

Example:
```
SYST:COMM:RDEV:OSC:LEDS?
//Result: 'GREEN'
```

Usage: Query only

SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip <Address>

Defines the TCPIP address or computer name of the oscilloscope connected to the R&S FSW via LAN.

Note: The IP address is maintained after a PRESET, and is transferred between applications.

Parameters:
<Address> computer name or IP address

Example:
```
SYST:COMM:RDEV:OSC:TCP '192.0.2.0'
```

Example:
```
SYST:COMM:RDEV:OSC:TCP 'FSW43-12345'
```

Manual operation: See "TCPIP Address or Computer name" on page 91

SYSTem:COMMunicate:RDEVice:OSCilloscope:VDEVice?

Queries whether the connected instrument is supported by the 2 GHz bandwidth extension option(R&S FSW-B2000).

For details see the 2 GHz bandwidth extension basics chapter in the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Return values:

<State>

ON | 1
Instrument is supported

OFF | 0
Instrument is not supported

Example: `SYST:COMM:RDEV:OSC:VDEV?`

Usage: Query only

SYSTem:COMMunicate:RDEVice:OSCilloscope:VFIRmware?

Queries whether the firmware on the connected oscilloscope is supported by the 2 GHz bandwidth extension (R&S FSW-B2000) option.

Return values:

<State>

ON | 1
Firmware is supported

OFF | 0
Firmware is not supported

Example: `SYST:COMM:RDEV:OSC:VFIR?`

Usage: Query only

TRIGger[:SEQuence]:OSCilloscope:COUPling <CoupType>

Configures the coupling of the external trigger to the oscilloscope.

Parameters:

<CoupType> Coupling type

DC
Direct connection with 50 Ω termination, passes both DC and AC components of the trigger signal.

CDLimit
Direct connection with 1 MΩ termination, passes both DC and AC components of the trigger signal.

AC
Connection through capacitor, removes unwanted DC and very low-frequency components.

*RST: DC

Manual operation: See "Coupling" on page 105

11.4.1.5 Configuring the Outputs

Configuring trigger input/output is described in Chapter 11.4.4.2, "Configuring the Trigger Output", on page 218.

DIAGnostic:SERVice:NSOurce <State>

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

Suffix:

<n> Window

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source" on page 99

OUTPut:IF[:SOURce] <Source>

Defines the type of signal available at the IF/VIDEO/DEMOD or IF OUT 2 GHZ connector of the R&S FSW.

Parameters:

<Source>

IF
The measured IF value is available at the IF/VIDEO/DEMOD output connector.
The frequency at which the IF value is provided is defined using the `OUTPut:IF:IFFRequency` command.

IF2
The measured IF value is available at the IF OUT 2 GHZ output connector at a frequency of 2 GHz.
This setting is only available if the IF OUT 2 GHZ connector or the optional 2 GHz bandwidth extension (R&S FSW-B2000) is available.
It is automatically set if the optional 2 GHz bandwidth extension (R&S FSW-B2000) is installed and active.

VIDeo
The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output.

*RST: IF

Example:
`OUTP:IF VID`
Selects the video signal for the IF/VIDEO/DEMOD output connector.

Manual operation: See "IF/Video Output" on page 98

OUTPut:IF:IFFRequency <Frequency>

This command defines the frequency for the IF output of the R&S FSW. The IF frequency of the signal is converted accordingly.

This command is available in the time domain and if the IF/VIDEO/DEMOD output is configured for IF.

Parameters:

<Frequency> *RST: 50.0 MHz

Manual operation: See "IF (Wide) Out Frequency" on page 99

11.4.2 Frequency

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*RST: fmax/2
Default unit: Hz

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

Usage: SCPI confirmed

Manual operation: See "Center frequency" on page 94

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

This command defines the center frequency step size.

Parameters:

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

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

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

Manual operation: See "Center Frequency Stepsize" on page 94

[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.

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

Parameters:

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

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual operation: See "Frequency Offset" on page 95

11.4.3 Amplitude Settings

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

Useful commands for amplitude settings described elsewhere:

- `INPut:COUPling` on page 187
- `INPut:IMPedance` on page 189
- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO` on page 298

Remote commands exclusive to amplitude settings:

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

This command defines the reference level (for all traces in all windows).

Suffix:
<n>, <t> irrelevant

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 96

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

This command defines a reference level offset (for all traces in all windows).

Suffix:
<n>, <t> irrelevant

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

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 96

INPut:GAIN:STATe <State>

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

Parameters:

<State> ON | OFF

*RST: OFF

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

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 97

INPut:GAIN[:VALue] <Gain>

This command selects the gain if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 211).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> 15 dB | 30 dB

The availability of gain levels depends on the model of the R&S FSW.
R&S FSW8/13: 15dB and 30 dB
R&S FSW26 or higher: 30 dB
All other values are rounded to the nearest of these two.

*RST: OFF

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

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 97

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

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

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

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 96

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 | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 96

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 212).

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 operation: See "Using Electronic Attenuation" on page 97

INPut:EATT:AUTO <State>

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

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

Parameters:

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

Example: `INP:EATT:AUTO OFF`

Manual operation: See "Using Electronic Attenuation" on page 97

INPut:EATT:STATe <State>

This command turns the electronic attenuator on and off.

Parameters:

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

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

Manual operation: See "Using Electronic Attenuation" on page 97

11.4.4 Triggering

The following remote commands are required to configure a triggered measurement in a remote environment. More details are described for manual operation in Chapter 6.4, "Trigger Settings", on page 101.

MSRA/MSRT operating mode

In MSRA/MSRT operating mode, only the MSRA/MSRT Master channel actually captures data from the input signal. Thus, no trigger settings are available in the Transient Analysis application in MSRA/MSRT operating mode. However, a **capture offset** can be defined with a similar effect as a trigger offset. It defines an offset from the start of the captured data (from the MSRA/MSRT Master) to the start of the application data for transient analysis. (See Chapter 11.7, "Configuring an Analysis Interval and Line (MSRA mode only)", on page 336.)

For details on the MSRA operating mode see the R&S FSW MSRA User Manual. For details on the MSRT operating mode see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

*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.

11.4.4.1 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 operation: See "Drop-Out Time" on page 105

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

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

Parameters:

<Offset> *RST: 0 s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 106

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

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

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

Parameters:

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

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

Manual operation: See "Trigger Holdoff" on page 106

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

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

Parameters:

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

Example:
`TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 106

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

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

Suffix:

<port> Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on 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 operation: See "Trigger Level" on page 105

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

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

Parameters:

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

*RST: -10 dBm

Example: `TRIG:LEV:IFP -30DBM`

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

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

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

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

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

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

Parameters:

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

*RST: -20 dBm

Example: `TRIG:LEV:RFP -30dBm`

TRIGger[:SEQuence]:SLOPe <Type>

For external and time domain trigger sources you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Parameters:

<Type> POSitive | NEGative

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

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

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 106

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

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

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the TRIGGER INPUT connector.
If the optional 2 GHz bandwidth extension (R&S FSW-B2000) is installed and active, this parameter activates the CH3 input connector on the oscilloscope. Then the R&S FSW triggers when the signal fed into the CH3 input connector on the oscilloscope meets or exceeds the specified trigger level.
Note: In previous firmware versions, the external trigger was connected to the CH2 input on the oscilloscope. As of firmware version R&S FSW 2.30, the **CH3** input on the oscilloscope must be used!

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

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

*RST: IMMediate

Example:

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

Manual operation:

See "Trigger Source" on page 103
See "Free Run" on page 103
See "External Trigger 1/2/3" on page 103
See "External CH3" on page 103
See "IF Power" on page 104
See "I/Q Power" on page 104
See "RF Power" on page 105

11.4.4.2 Configuring the Trigger Output

The following commands are required to send the trigger signal to one of the variable TRIGGER INPUT/OUTPUT connectors on the R&S FSW.

OUTPut:TRIGger<port>:DIRection <Direction>

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

Suffix:

<port> Selects the used trigger port.
2 = trigger port 2 (front panel)
3 = trigger port 3 (rear panel)

Parameters:

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

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 2/3" on page 99

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the (TTL compatible) signal generated at the trigger output.

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

Suffix:

<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<Level> **HIGH**
5 V

LOW
0 V

*RST: LOW

Example: `OUTP:TRIG2:LEV HIGH`

Manual operation: See "Level" on page 100

OUTPut:TRIGger<port>:OTYPe <OutputType>

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

Suffix:

<port>	Selects the trigger port to which the output is sent. 2 = trigger port 2 (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 operation: See "Output Type" on page 100

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

<port>	Selects the trigger port to which the output is sent. 2 = trigger port 2 (front) 3 = trigger port 3 (rear)

Usage: Event

Manual operation: See "Send Trigger" on page 101

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

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

Suffix:

<port>	Selects the trigger port to which the output is sent. 2 = trigger port 2 (front) 3 = trigger port 3 (rear)

Parameters:

<Length>	Pulse length in seconds.

Example: `OUTP:TRIG2:PULS:LENG 0.02`

Manual operation: See "Pulse Length" on page 100

11.4.5 Data Acquisition

You must define how much and how data is captured from the input signal.

MSRA/MSRT operating mode

In MSRA/MSRT operating mode, only the MSRA/MSRT Master channel actually captures data from the input signal. The data acquisition settings for the Transient Analysis application in MSRA/MSRT mode define the **application data extract** and **analysis interval**.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual. For details on the MSRT operating mode see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

[SENSe:]BANDwidth|BWIDth:DEMod <Bandwidth>

Defines the measurement bandwidth in Hz.

Note that the sample rate and the measurement bandwidth are interdependent (see `[SENSe:]SRATe` on page 222). For information on supported sample rates and bandwidths see the data sheet.

Parameters:

<Bandwidth> Range: 80 Hz to depends on options installed
*RST: maximum allowed
Default unit: HZ

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Measurement Bandwidth" on page 109

[SENSe:]MTIMe <MeasTime>

This command defines the time data is captured. Note that the record length and the measurement time are interdependent (see `[SENSe:]RLENgth` on page 222).

Parameters:

<MeasTime> Range: 18.75 us to 1.298 ms
*RST: 350 us
Default unit: S

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Measurement Time" on page 110

[SENSe:]RLENgth <SampleCount>

This command defines the record length (in samples) for the current measurement. Note that the record length and the measurement time are interdependent (see `[SENSe:]MTIMe` on page 221).

Parameters:

<SampleCount>	The maximum record length is limited only by the available memory. *RST: 140000
Example:	See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.
Example:	See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.
Manual operation:	See "Record Length" on page 110

[SENSe:]SRATe <SampleRate>

This command defines the sample rate for the current measurement.

Note that the sample rate and the measurement bandwidth are interdependent (see `[SENSe:]BANDwidth|BWIDth:DEMod` on page 221). For information on supported sample rates and bandwidths see the data sheet.

Parameters:

<SampleRate>	Range: 100 Hz to depends on installed options *RST: maximum allowed
Example:	`SRATe 100e6`
Example:	See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.
Example:	See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.
Manual operation:	See "Sample Rate" on page 110

11.4.6 Bandwidth Settings

Useful commands for bandwidth settings described elsewhere:

- `[SENSe:]SWEep:FFT:WINDow:TYPE` on page 309
- `CALCulate<n>:SGRam|SPECtrogram:TRESolution` on page 306
- `CALCulate<n>:SGRam|SPECtrogram:TRESolution:AUTO` on page 306
- `[SENSe:]MTIMe` on page 221
- `[SENSe:]BANDwidth|BWIDth:DEMod` on page 221
- `SENSe:DEMod:FMVF:TYPE` on page 239

Remote commands exclusive to bandwidth settings:

[SENSe:]BANDwidth|BWIDth[:WINDow<n>]:RATio <Bandwidth Ratio>

This command sets the bandwidth ratio.

Parameters:
<Bandwidth Ratio>

Manual operation: See "ABW / RBW" on page 112

[SENSe:]BANDwidth|BWIDth[:WINDow<n>]:RESolution <Bandwidth Resolution>

This command sets the bandwidth resolution in HZ.

Parameters:
<Bandwidth Resolution>

Manual operation: See "RBW" on page 112

11.4.7 Selecting the Signal Model

The signal model defines which type of signal to expect (if known), thus determining the analysis method. These settings are only available if the additional options R&S FSW-K60C/-K60H are installed.

[SENSe:]SIGNal:MODel <Signal>

Defines which type of signal to expect (if known), thus determining the analysis method.

This command is only required if the additional options R&S FSW-K60C/-K60H are installed.

Parameters:

<Signal> HOP | CHIRp | NONE

HOP
Signals "hop" between random carrier frequencies in short intervals

CHIRp
The carrier frequency is either increased or decreased linearly over time

NONE
No specific signal model is used; this is the default setting if no additional options are installed

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Hop Model / Chirp Model" on page 71

11.4.8 Configuring Signal Detection

The signal detection settings define the conditions under which a hop/chirp is detected within the input signal.

These commands are only available if the additional options R&S FSW-K60C/-K60H are installed.

11.4.8.1 Chirp States

CALCulate<n>:CHRDetection:LENGth:AUTO <State>

This command activates and deactivates the auto length setting for chirp detection.

Suffix:
<n> irrelevant

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

Example: `CALC:CHRD:LENG:AUTO ON`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Auto Mode" on page 76

CALCulate<n>:CHRDetection:LENGth:MAXimum <Time>

This command sets the maximum time for chirp detection.

Suffix:

<n> irrelevant

Parameters:

<Time> Range: 0.000000752 to 0.00035
*RST: 0.00035
Default unit: S

Example: `CALC:CHRD:LENG:MAX 0.00035`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Minimum / Maximum" on page 76

CALCulate<n>:CHRDetection:LENGth:MINimum <time>

Defines the minimum chirp length for detection.

Suffix:

<n> irrelevant

Parameters:

<time> Range: 0.000000251 to 0.00035
*RST: 0.000000752
Default unit: S

Example: `CALC:CHRD:LENG:MIN 0.000001`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Minimum / Maximum" on page 76

CALCulate<n>:CHRDetection:STATes:AUTO <State>

This command activates and deactivates the auto chirp state detection. If deactivated, the states defined using `CALCulate<n>:CHRDetection:STATes[:DATA]` are used.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF
*RST: ON

Example: `CALC:CHRD:STAT:AUTO ON`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Auto Mode" on page 74

CALCulate<n>:CHRDetection:STATes[:DATA] {<ChirpRate>, <Tolerance>}...

This command sets and queries the chirp state detection table. It consists of a comma separated list of value pairs, one for each possible chirp state.

Note that the state table can only be configured manually if `CALCulate<n>:CHRDetection:STATes:AUTO` is `OFF`.

Suffix:

<n> irrelevant

Setting parameters:

<ChirpRate> Default unit: HZ

<Tolerance> Tolerance above or below the nominal chirp rate.
Default unit: HZ

Example: `CALC:CHRD:STAT 1e6, 0.3, 1e5, 0.4`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Frequency Offset / Chirp Rate" on page 74
See "Tolerance" on page 74

CALCulate<n>:CHRDetection:STATes:NUMBer?

This command queries the number of states in the state table.

Suffix:

<n> irrelevant

Return values:

<States> Range: 0 to 1000

Usage: Query only

Manual operation: See "Hop / Chirp State Index" on page 74

CALCulate<n>:CHRDetection:STATes:TABLe:LOAD <Filename>

Loads the signal state table configuration from the selected file.

Suffix:

<n> irrelevant

Parameters:

<FileName> String containing the path and name of the file.

Usage: Setting only

Manual operation: See "Loading a signal state table from a file" on page 75

CALCulate<n>:CHRDetection:STATes:TABLe:SAVE <Filename>

Saves the current signal state table configuration to a file for later use.

Suffix:

<n> irrelevant

Parameters:

<FileName> String containing the path and name of the file.

Example: `CALC:CHRD:STAT:TABL:SAVE 'C:\R_S\userdata\HopStates.csv'`

Usage: Setting only

Manual operation: See "Applying changes to the signal state table" on page 75
See "Saving the signal state table to a file" on page 75

11.4.8.2 Hop States

CALCulate<n>:HOPDetection:DWELl:AUTO <State>

This command activates and deactivates the auto dwell setting for hop detection.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: ON

Example: `CALC:HOPD:DWEL:AUTO ON`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Auto Mode" on page 76

CALCulate<n>:HOPDetection:DWELl:MAXimum <time>

This command sets the maximum time for hop detection.

Suffix:
<n> irrelevant

Parameters:
<time> Range: 0.000000052 to 0.00035
*RST: 0.00035
Default unit: S

Example: `CALC:HOPD:DWEL:MAX 0.00129822`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Minimum / Maximum" on page 76

CALCulate<n>:HOPDetection:DWELl:MINimum <time>

This command sets the minimum time for hop detection.

Suffix:
<n> irrelevant

Parameters:
<time> Range: 0.000000017 to 0.00035
*RST: 0.000000052
Default unit: S

Example: `CALC:HOPD:DWEL:MIN 0.000001`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Minimum / Maximum" on page 76

CALCulate<n>:HOPDetection:STATes:AUTO <State>

This command activates and deactivates the auto hop state detection. If deactivated, the states defined using `CALCulate<n>:HOPDetection:STATes[:DATA]` are used.

Suffix:
<n> irrelevant

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

Example: `CALC:HOPD:STAT:AUTO ON`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Auto Mode" on page 74

CALCulate<n>:HOPDetection:STATes[:DATA] {<FreqOffset>, <Tolerance>}...

This command sets and queries the hop state detection table. It consists of a comma separated list of value pairs, one for each possible hop state. A maximum of 1000 states can be defined.

Note that the state table can only be configured manually if `CALCulate<n>:HOPDetection:STATes:AUTO` is `OFF`.

Suffix:

<n>	irrelevant

Parameters:

<FreqOffset>	Frequency offsets from the center frequency Default unit: HZ
<Tolerance>	Tolerance above or below the nominal frequency. Default unit: HZ

Example: `CALC:HOPD:STAT 1e6, 0.3, 1e5, 0.4`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Frequency Offset / Chirp Rate" on page 74
See "Tolerance" on page 74

CALCulate<n>:HOPDetection:STATes:NUMBer?

This command returns the number of hop states in the state table.

Suffix:

<n>	irrelevant

Return values:

<TotalHops>	Range: 0 to 1000

Usage: Query only

Manual operation: See "Hop / Chirp State Index" on page 74

CALCulate<n>:HOPDetection:STATes:TABLe:ADD {<start>, <step>, <number>}...

This command adds multiple generated states to the state table.

Note that a maximum of 1000 states can be defined in one table. To determine how many states are currently defined, use the `CALCulate<n>:HOPDetection:STATes:NUMBer?` command.

Suffix:

<n>	irrelevant

Setting parameters:

<start> [HZ]
The frequency at which the first hop state will be generated.
Default unit: HZ

<step> [HZ]
The distance between two hop states.
Default unit: HZ

<number> Number of hop states to be generated.
Range: 0 to 1000 - (number of existing states)

Example: `CALC:HOPD:STAT:TABL:ADD 1 MHZ, 500 KHZ, 10`

Usage: Setting only

Manual operation: See "Add to Table" on page 75

CALCulate<n>:HOPDetection:STATes:TABLe:LOAD <Filename>

Loads the signal state table configuration from the selected file.

Suffix:

<n> irrelevant

Parameters:

<FileName> String containing the path and name of the file.

Example:
```
CALC:HOPD:STAT:TABL:LOAD 'C:
\R_S\userdata\HopStates.csv'
```

Usage: Setting only

Manual operation: See "Loading a signal state table from a file" on page 75

CALCulate<n>:HOPDetection:STATes:TABLe:NSTates?

This command queries the number of hop states to be generated by a subsequent `CALCulate<n>:HOPDetection:STATes:TABLe:ADD` or `CALCulate<n>:HOPDetection:STATes:TABLe:REPLace` command.

Suffix:

<n> irrelevant

Return values:

<NoOfStates> Range: 0 to 1000

Usage: Query only

Manual operation: See "Hop / Chirp State Index" on page 74
See "No of States" on page 75

CALCulate<n>:HOPDetection:STATes:TABLe:OFFSet <Offset>

This command adds an offset to all states in the state table.

Suffix:

<n>	irrelevant

Parameters:

<Offset>	Default unit: HZ

Manual operation: See "Applying a global frequency offset" on page 76

CALCulate<n>:HOPDetection:STATes:TABLe:REPLace {<start>, <step>, <number>}...

This command replaces the state table's current states with a new set of generated states.

Suffix:

<n>	irrelevant

Setting parameters:

<start>	[HZ] The frequency at which the first hop state will be generated. Default unit: HZ
<step>	[HZ] The distance between two hop states. Default unit: HZ
<number>	Number of hop states to be generated.

Example: `CALC:HOPD:STAT:TABL:REPL 1 MHZ, 500 KHZ, 10`

Usage: Setting only

Manual operation: See "Replace Table" on page 76

CALCulate<n>:HOPDetection:STATes:TABLe:SAVE <Filename>

Saves the current signal state table configuration to a file for later use.

Suffix:

<n>	irrelevant

Parameters:

<FileName>	String containing the path and name of the file.

Example: `CALC:HOPD:STAT:TABL:SAVE 'C:\R_S\userdata\HopStates.csv'`

Usage: Setting only

Manual operation: See "Applying changes to the signal state table" on page 75
See "Saving the signal state table to a file" on page 75

CALCulate<n>:HOPDetection:STATes:TABLe:STARt?

This command queries the last stored starting value for generating multiple states

Suffix:
<n> irrelevant

Return values:
<Start>

Usage: Query only

Manual operation: See "Start Frequency" on page 75

CALCulate<n>:HOPDetection:STATes:TABLe:STEP?

This command queries the last stored step size for generating multiple states

Suffix:
<n> irrelevant

Return values:
<Step>

Usage: Query only

Manual operation: See "Step Size" on page 75

CALCulate<n>:HOPDetection:STATes:TABLe:TOLerance <Tolerance>

This command applies a tolerance to all states in the state table.

Suffix:
<n> irrelevant

Parameters:
<Tolerance> Default unit: HZ

Manual operation: See "Applying a global tolerance value" on page 76

11.4.9 Configuring the Measurement Range

For some frequency or power calculations, it may be useful not to take the entire dwell time of the hop or length of the chirp into consideration, but only a certain range within the dwell time/length.

These settings are only available if the additional options R&S FSW-K60C/-K60H are installed.

CALCulate<n>:CHRDetection:FREQuency:LENGth <Percent>

Defines the length of the measurement range for frequency results in percent of the chirp length. This command is only available if the reference is `CENT` (see `CALCulate<n>:CHRDetection:POWer:REFerence` on page 235).

Suffix:

<n>	irrelevant

Parameters:

<Percent>	percent of the chirp length Range: 0 to 100 *RST: 100

Example: `CALC:CHRD:FREQ:LENG 10`

Manual operation: See "Length" on page 116

CALCulate<n>:CHRDetection:FREQuency:OFFSet:BEGin <Time>

Defines the beginning of the measurement range for power results as an offset in seconds from the chirp start. This command is only available if the reference is `EDGE` (see `CALCulate<n>:CHRDetection:FREQuency:REFerence` on page 234).

Suffix:

<n>	Window

Parameters:

<Time>	Default unit: S

Example: `CALC:CHRD:FREQ:OFFS:BEG 3e-6`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:CHRDetection:FREQuency:OFFSet:END <Time>

Defines the end of the measurement range for frequency results as an offset in seconds from the chirp end. This command is only available if the reference is EDGE (see CALCulate<n>:CHRDetection:FREQuency:REFerence on page 234).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:CHRDetection:FREQuency:REFerence <Reference>

Defines the reference point for positioning the frequency measurement range.

Suffix:
<n> irrelevant

Setting parameters:
<Reference> CENTer | EDGE

EDGE
The measurement range is defined in reference to the chirp's rising or falling edge (see CALCulate<n>:CHRDetection:FREQuency:OFFSet:BEGin on page 233 and CALCulate<n>:CHRDetection:FREQuency:OFFSet:END on page 234).

CENTer
The measurement range is defined in reference to the center of the chirp.

Example: `CALC:CHRD:FREQ:REF CENTer`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Reference" on page 115

CALCulate<n>:CHRDetection:POWer:LENGth <Percent>

Defines the length of the measurement range for power results in percent of the chirp length. This command is only available if the reference is CENT (see CALCulate<n>:CHRDetection:POWer:REFerence on page 235).

Suffix:
<n> irrelevant

Parameters:
<Percent> percent of the chirp length

Example: `CALC:CHRD:POW:LENG 2e-4`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Length" on page 116

CALCulate<n>:CHRDetection:POWer:OFFSet:BEGin <Time>

Defines the beginning of the measurement range for power results as an offset in seconds from the chirp start. This command is only available if the reference is `EDGE` (see `CALCulate<n>:CHRDetection:POWer:REFerence` on page 235).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: `CALC:CHRD:POW:OFFS 50`

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:CHRDetection:POWer:OFFSet:END <Time>

Defines the end of the measurement range for power results as an offset in seconds from the chirp end. This command is only available if the reference is `EDGE` (see `CALCulate<n>:CHRDetection:POWer:REFerence` on page 235).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: `CALC:CHRD:POW:OFFS 50`

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:CHRDetection:POWer:REFerence <Reference>

Defines the reference point for positioning the power measurement range.

Suffix:
<n> irrelevant

Setting parameters:

<Reference> CENTer | EDGE

EDGE
The measurement range for power results is defined in reference to the chirp's rising or falling edge (see CALCulate<n>:CHRDetection:POWer:OFFSet:BEGin on page 235 and CALCulate<n>:CHRDetection:POWer:OFFSet:END on page 235).

CENTer
The measurement range is defined in reference to the center of the chirp.

Example: `CALC:CHRD:POW:REF EDGE`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Reference" on page 115

CALCulate<n>:HOPDetection:FREQuency:LENGth <Percent>

Defines the length of the measurement range for frequency results in percent of the hop's dwell time. This command is only available if the reference is `CENT` (see CALCulate<n>:HOPDetection:FREQuency:REFerence on page 237).

Suffix:

<n> irrelevant

Parameters:

<Percent> percent of the hop dwell time

Range: 0 to 100
*RST: 100

Example: `CALC:HOPD:FREQ:LENG 10`

Manual operation: See "Length" on page 116

CALCulate<n>:HOPDetection:FREQuency:OFFSet:BEGin <time>

Defines the beginning of the measurement range for frequency results as an offset in seconds from the hop start. This command is only available if the reference is `EDGE` (see CALCulate<n>:HOPDetection:FREQuency:REFerence on page 237).

Suffix:

<n> irrelevant

Parameters:

<Time> Default unit: S

Example: `CALC:HOPD:FREQ:OFFS:BEG 3e-6`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:HOPDetection:FREQuency:OFFSet:END <Time>

Defines the end of the measurement range for frequency results as an offset in seconds from the hop end. This command is only available if the reference is `EDGE` (see `CALCulate<n>:HOPDetection:FREQuency:REFerence` on page 237).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: `CALC:HOPD:FREQ:OFFS:END 3e-6`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:HOPDetection:FREQuency:REFerence <Reference>

Defines the reference point for positioning the frequency measurement range.

Suffix:
<n> irrelevant

Setting parameters:
<Reference> CENTer | EDGE

EDGE
The measurement range is defined in reference to the hop' rising or falling edge (see `CALCulate<n>:HOPDetection:FREQuency:OFFSet:BEGin` on page 236 and `CALCulate<n>:HOPDetection:FREQuency:OFFSet:END` on page 237).

CENTer
The measurement range is defined in reference to the center of the hop.

Example: `CALC:HOPD:FREQ:REF CENTer`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Reference" on page 115

CALCulate<n>:HOPDetection:POWer:LENGth <Percent>

Defines the length of the measurement range in percent of the dwell time. This command is only available if the reference is `CENT` (see `CALCulate<n>:HOPDetection:POWer:REFerence` on page 238).

Suffix:
<n> irrelevant

Parameters:
<Percent>

Example: `CALC:HOPD:POW:LENG 2e-4`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Length" on page 116

CALCulate<n>:HOPDetection:POWer:OFFSet:BEGin <Time>

Defines the beginning of the measurement range as an offset in seconds from the hop start. This command is only available if the reference is `EDGE` (see `CALCulate<n>:HOPDetection:POWer:REFerence` on page 238).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: `CALC:HOPD:POW:OFFS 50`

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:HOPDetection:POWer:OFFSet:END <time>

Defines the end of the measurement range as an offset in seconds from the hop end. This command is only available if the reference is `EDGE` (see `CALCulate<n>:HOPDetection:POWer:REFerence` on page 238).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: `CALC:HOPD:POW:OFFS 50`

Manual operation: See "Offset Begin / Offset End" on page 116

CALCulate<n>:HOPDetection:POWer:REFerence <Reference>

Defines the reference point for positioning the frequency/power measurement range.

Suffix:
<n> irrelevant

Setting parameters:

<Reference> CENTer | EDGE

EDGE
The measurement range is defined in reference to the hop' rising or falling edge (see CALCulate<n>:HOPDetection:POWer:OFFSet:BEGin on page 238 and CALCulate<n>:HOPDetection:POWer:OFFSet:END on page 238).

CENTer
The measurement range is defined in reference to the center of the hop.

Example: `CALC:HOPD:POW:REF EDGE`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Reference" on page 115

11.4.10 Configuring Demodulation

SENSe:DEMod:FMVF:TYPE <Filter>

Activates or deactivates additional filters applied after demodulation to filter out unwanted signals, or correct pre-emphasized input signals.

Parameters:

<Filter> NONE | LP01 | LP1 | LP5 | LP10 | LP25

NONE
No video filter applied

LP01
Low pass filter 0.1 % bandwidth

LP1
Low pass filter1 % bandwidth

LP5
Low pass filter 5 % bandwidth

LP10
Low pass filter 10 % bandwidth

LP25
Low pass filter 25 % bandwidth

Example: `SENS:DEM:FMVF:TYPE LP01`

Manual operation: See "FM Video Bandwidth" on page 113

11.4.11 Selecting the Analysis Region

The analysis region determines which data is displayed on the screen (see also Chapter 4.5, "Analysis Region", on page 23).

CALCulate<n>:AR:FREQuency:BANDwidth <Frequency>

This command defines the analysis region's bandwidth.

Suffix:

<n>	irrelevant

Parameters:

<Frequency>	Default unit: HZ
Example:	See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.
Example:	See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.
Manual operation:	See "Analysis Bandwidth" on page 110

CALCulate<n>:AR:FREQuency:DELTa <Frequency>

Defines the center of the frequency span for the analysis region. It is defined as an offset from the center frequency.

Suffix:

<n>	irrelevant

Parameters:

<Frequency>	Default unit: HZ
Example:	See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.
Example:	See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.
Manual operation:	See "Delta Frequency" on page 111

CALCulate<n>:AR:FREQuency:PERCent <BWPercent>

For `CALCulate<n>:AR:FREQuency:PERCent:STATe` `TRUE`, the width of the frequency span for the analysis region is defined as a percentage of the full capture buffer. It is centered around the point defined by `CALCulate<n>:AR:FREQuency:DELTa` on page 240.

Suffix:

<n> irrelevant

Parameters:

<BWPercent> percentage of the full analysis bandwidth

Manual operation: See "Linked analysis bandwidth" on page 111

CALCulate<n>:AR:FREQuency:PERCent:STATe <State>

If activated, the width of the frequency span for the analysis region is defined as a percentage of the full capture buffer (using `CALCulate<n>:AR:FREQuency:PERCent` on page 241).

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Linked analysis bandwidth" on page 111

CALCulate<n>:AR:TIME:LENGth <Length>

Defines the length of the time gate, that is, the duration (or height) of the analysis region.

Suffix:

<n> irrelevant

Parameters:

<Length> Default unit: S

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Time Gate Length" on page 111

CALCulate<n>:AR:TIME:PERCent <TimePercent>

For `CALCulate<n>:AR:TIME:PERCent:STATe` `TRUE`,the length of the time gate, that is, the duration (or height) of the analysis region, is defined as a percentage of the full measurement time. The time gate start is the start of the capture buffer plus an offset defined by `CALCulate<n>:AR:TIME:STARt` on page 242.

Suffix:

<n>	irrelevant

Parameters:

<TimePercent>	percentage of the full measurement time

Manual operation: See "Linked analysis time span" on page 111

CALCulate<n>:AR:TIME:PERCent:STATe <State>

If activated, the length of the time gate, that is, the duration (or height) of the analysis region, is defined as a percentage of the full measurement time (using `CALCulate<n>:AR:TIME:PERCent` on page 242).

Suffix:

<n>	irrelevant

Parameters:

<ON|OFF>

<State>	ON | OFF *RST: OFF

Manual operation: See "Linked analysis time span" on page 111

CALCulate<n>:AR:TIME:STARt <StartTime>

Defines the starting point of the time span for the analysis region. The starting point is defined as a time offset from the capture start time.

Suffix:

<n>	irrelevant

Parameters:

<StartTime>	Default unit: S

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Time Gate Start" on page 111

11.4.12 Adjusting Settings Automatically

The following remote commands are required to adjust settings automatically in a remote environment.

[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 operation: See "Setting the Reference Level Automatically (Auto Level)" on page 119

11.5 Capturing Data and Performing Sweeps

When you activate a Real-Time Spectrum measurement channel, a measurement is started immediately with the default settings. However, you can start and stop new measurements at any time.

Capturing data in MSRA/MSRT mode

In MSRA/MSRT mode, I/Q data from the input signal is captured and stored by the MSRA/MSRT Master.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual. For details on the MSRT operating mode see the R&S FSW Real-Time Spectrum Application and MSRT Operating Mode User Manual.

Useful commands for configuring and performing sweeps described elsewhere:

- `[SENSe:]MTIMe` on page 221
- `[SENSe:]SWEep:COUNt` on page 304
- `[SENSe:]SWEep:COUNt:CURRent?` on page 304
- `[SENSe:]MEASure:POINts` on page 303

Remote commands exclusive to configuring and performing sweeps:

ABORt

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

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

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

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

Note on blocked remote control programs:

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

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

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

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

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

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

Usage: Event
SCPI confirmed

INITiate<n>:CONMeas

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

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

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

Suffix:

<n> irrelevant

Usage: Event

Manual operation: See "Continue Single Sweep" on page 118

INITiate<n>:CONTinuous <State>

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

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

If the measurement mode is changed for a measurement channel while the Sequencer is active (see `INITiate<n>:SEQuencer:IMMediate` on page 247) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

Example:

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

Manual operation: See "Continuous Sweep/RUN CONT" on page 117

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

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

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

Suffix:

<n>	irrelevant
Usage:	Event
Manual operation:	See "Single Sweep/ RUN SINGLE" on page 117

INITiate<n>:REFResh

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

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

Suffix:

<n>	irrelevant

Example:	`SYST:SEQ:OFF`
	Deactivates the scheduler
	`INIT:CONT OFF`
	Switches to single sweep mode.
	`INIT;*WAI`
	Starts a new data measurement and waits for the end of the sweep.
	`INST:SEL 'IQ ANALYZER'`
	Selects the IQ Analyzer channel.
	`INIT:REFR`
	Refreshes the display for the I/Q Analyzer channel.

Usage:	Event
Manual operation:	See "Refresh (MSRA/MSRT only)" on page 118

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

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

The data in the capture buffer is re-evaluated by all active MSRA/MSRT slave applications.

Suffix:

<n>	irrelevant

Example:

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

Usage: Event

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 247.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 249.

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

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

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

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 249).

Suffix:
<n> irrelevant

Example:

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

Usage: Event

INITiate<n>: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 249).

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

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

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

Suffix:

<n>	irrelevant

Parameters:

<Mode>

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

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

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

*RST: CONTinuous

Example:

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

INITiate:SYNC

This remote control command requests the R&S FSW Transient Analysis application option to wait until any auto-refresh operation is finished. However, it does not initiate a refresh itself.

An auto-refresh is performed automatically after a configuration parameter is changed that requires the results (and displays) to be re-calculated. Note that hardware changes require a new sweep to be performed, not just an auto-refresh.

This command can be issued at any time but makes sense only in single sweep mode.

Example: `INIT:IMM;*WAI`
R&S FSW Transient Analysis application performs a sweep and program is synchronized (waits) on completion of the sweep.
`CALC:AR:FREQ:BAND 10 MHZ`
R&S FSW Transient Analysis application starts re-calculating results with a new analysis region bandwidth, but program does not wait until completion of the new calculation, it continues immediately
`INIT:SYNC`
The program now waits until any pending auto-refresh calculations are finished before continuing.

Usage: Event

SYSTem:SEQuencer <State>

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

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

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

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

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

*RST: 0

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

11.6 Analyzing Transient Effects

The following commands are required to analyze transient effects in a measured signal.

11.6.1 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

11.6.1.1 General Window Commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 255).

Suffix:

<n>	Window

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:SIZE LARG`

DISPlay[:WINDow<n>]:SELect

This command sets the focus on the selected result display window.

This window is then the active window.

Suffix:

<n>	Window

Example: `DISP:WIND1:SEL`
Sets the window 1 active.

Usage: Setting only

11.6.1.2 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 186).

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

<WindowType> text value
Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation:
See "RF Spectrum" on page 60
See "Spectrogram" on page 61
See "RF Power Time Domain" on page 62
See "FM Time Domain" on page 63
See "Frequency Deviation Time Domain" on page 63
See "PM Time Domain" on page 64
See "PM Time Domain (Wrapped)" on page 64
See "Phase Deviation Time Domain" on page 65
See "Chirp Rate Time Domain" on page 65
See "Hop/Chirp Results Table" on page 66
See "Hop/Chirp Statistics Table" on page 66
See "Parameter Distribution" on page 67
See "Parameter Trend" on page 67
See "Marker Table" on page 68

For a detailed example see Chapter 11.11, "Programming Examples", on page 381.

Table 11-4: <WindowType> parameter values for Transient Analysis application

Parameter value	Window type
SGR	Spectrogram
RFPTime	RF Power Time Domain
FMTime	FM Time Domain
FDEViation	Frequency Deviation Time Domain *)
PDEViation	Phase Deviation Time Domain *)
PDIStribution	Parameter Distribution
PMTime	PM Time Domain
PMWRapped	PM Time Domain (Wrapped)
PTRend	Parameter Trend
RFSPectrum	RF Spectrum
CRTime	Chirp Rate Time Domain*)
MTABle	Marker table
RTABle	Results table*)
STABle	Statistics table*)
*) requires additional option R&S FSW-K60C/-K60H	

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName>	String containing the name of a window.

Return values:

<WindowIndex>	Index number of the window.

Example:	`LAY:WIND:IDEN? '2'`
	Queries the index of the result display named '2'.
	Response:
	`2`

Usage:	Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName>	String containing the name of the window. In the default state, the name of the window is its index.
Example:	`LAY:REM '2'` Removes the result display in the window named '2'.
Usage:	Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel 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 in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.
<WindowType>	Type of result display you want to use in the existing window. See `LAYout:ADD[:WINDow]?` on page 252 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.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 251 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

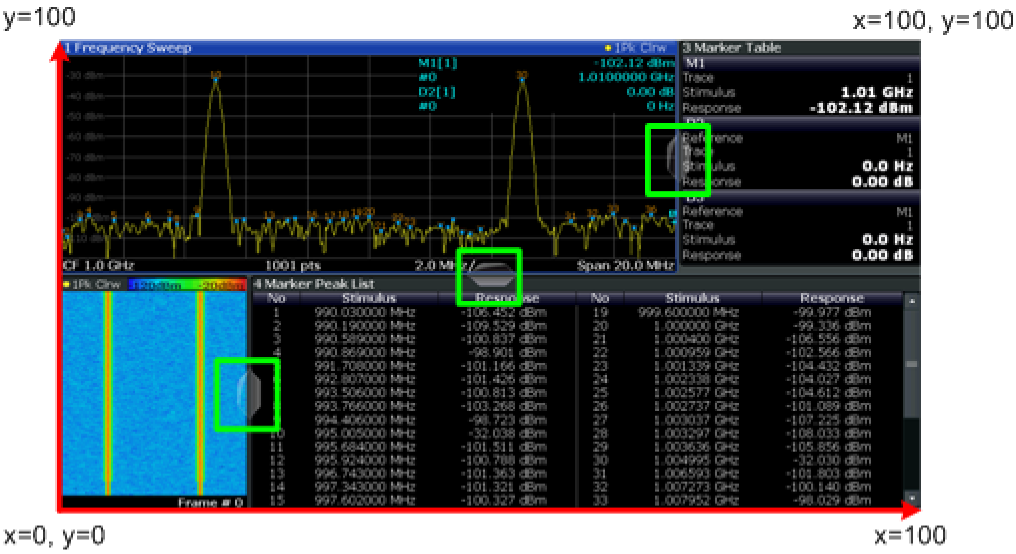


Figure 11-1: SmartGrid coordinates for remote control of the splitters

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 11-1.)
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.

Suffix:
<n> Window

Parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 252 for a list of available window types.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

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.

Suffix:
<n> Window

Parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 252 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

11.6.2 Defining the Evaluation Basis

Depending on the measurement task, not all of the measured data in the capture buffer may be of interest. In some cases it may be useful to restrict analysis to a specific user-definable region, or to a selected individual chirp rate or hop.

Which measurement basis is available for which result display is indicated in Table 5-1.

These commands are only available if the additional options R&S FSW-K60C/-K60H are installed.

DISPlay:[WINDow<n>:]EVAL <Eval>

Determines the evaluation basis for the specified result display.

Which evaluation basis is available for which result display is indicated in Table 5-1.

Suffix:
<n> Window

Parameters:
<Eval> FULL | REGion | SIGNal

FULL
the full capture buffer

REGion
the selected analysis region (see Chapter 11.4.11, "Selecting the Analysis Region", on page 240)

SIGNal
an individual selected hop / chirp (see CALCulate<n>:HOPDetection:SELected on page 261 / CALCulate<n>:CHRDetection:SELected on page 261)

*RST: depends on result display

Example: `DISP:WIND1:EVAL SIGN`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Full Capture / Region Analysis / Hop / Chirp" on page 130

11.6.3 Configuring the Result Range

The result range determines which data is displayed on the screen (see also "Measurement range vs result range" on page 45).

These settings are only available if the additional options R&S FSW-K60C/-K60H are installed.

CALCulate<n>:RESult:ALIGnment <Reference>

Defines the alignment of the result range in relation to the selected reference point (see `CALCulate<n>:RESult:REFerence` on page 260).

Suffix:
<n> irrelevant

Setting parameters:
<Reference> LEFT | CENTer | RIGHt

LEFT
The result range starts at the hop/chirp center or selected edge.

CENTer
The result range is centered around the hop/chirp center or selected edge.

RIGHt
The result range ends at the hop/chirp center or selected edge.

*RST: CENTer

Example: `CALC:RES:ALIG LEFT`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Alignment" on page 122

CALCulate<n>:RESult:LENGth <Time>

This command defines the length or duration of the result range.

Note this command is only available for manual range scaling (see `CALCulate<n>:RESult:RANGe:AUTO` on page 260).

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: `CALC:RES:LENG 1us`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Length" on page 122

CALCulate<n>:RESult:OFFSet <Time>

The offset in seconds from the hop/chirp edge or center at which the result range reference point occurs.

Suffix:
<n> irrelevant

Parameters:
<Time> Default unit: S

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Offset" on page 122

CALCulate<n>:RESult:RANGe:AUTO <ON|OFF>

Defines whether the result range length is determined automatically according to the width of the selected hop/chirp.

Suffix:
<n> irrelevant

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

Example: `CALC:RES:RANG:AUTO ON`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Automatic Range Scaling" on page 122

CALCulate<n>:RESult:REFerence <Reference>

Defines the reference point for positioning the result range.

Suffix:
<n> irrelevant

Setting parameters:
<Reference> RISE | CENTer | FALL

RISE
The result range is defined in reference to the rising edge.

CENTer
The result range is defined in reference to the center of the hop/chirp top.

FALL
The result range is defined in reference to the falling edge.

*RST: CENTer

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Result Range Reference Point" on page 122

11.6.4 Selecting the Hop/Chirp

The selected hop/chirp determines which results are calculated and displayed.

These commands are only available if the additional options R&S FSW-K60C/-K60H are installed.

CALCulate<n>:CHRDetection:SELected <ChirpNo>

Defines the individual chirp for which results are calculated and displayed.

Suffix:
<n> irrelevant

Parameters for setting and query:
<ChirpNo>

Example: `CALC:CHRD:SEL 3`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Manual operation: See "Select Hop / Select Chirp" on page 130

CALCulate<n>:HOPDetection:SELected <HopNo>

Defines the individual hop for which results are calculated and displayed.

Suffix:
<n> irrelevant

Parameters for setting and query:
<HopNo>

Example: `CALC:HOPD:SEL 3`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Select Hop / Select Chirp" on page 130

11.6.5 Table Configuration

The following commands define which statistical and characteristic values are determined for measured hops/chirps.

These commands are only available if the additional options R&S FSW-K60C/-K60H are installed.

11.6.5.1 Chirp Results

CALCulate<n>:CHRDetection:TABLe:COLumn <State>, <Headers>...

This command enables or disables columns in all chirp results and statistics tables.

Note that only the enabled columns are returned for the `CALCulate<n>:CHRDetection:TABLe:RESults?` query.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

Enables or disables all subsequently listed headers

ON
Provides results for the defined `<Headers>` only

OFF
Provides results for all table parameters except the specified `<Headers>`.

*RST: ON

<Headers> ALL | STATe | BEGin | LENGth | RATE | CHERror | FREQuency | MAXFm | RMSFm | AVGFm | MINPower | MAXPower | AVGPower | PWRRipple | AVPHm | MXPHm | RMSPm

All listed parameters are displayed or hidden in the table results (depending on the `<State>` parameter).

ALL
See Chapter 5.2, "Chirp Parameters", on page 52.

STATe
Chirp state

BEGin
Chirp Begin

LENGth
Chirp length

RATe
Chirp rate

CHERror
Chirp state deviation

FREQuency
Average frequency

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

AVGPower
Average power

MINPower
Minimum power

MAXPower
Maximum power

PWRRipple
Power ripple

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Example: `CALC:CHRD:TABL:COL ON, CHRNo, STATe`
Provides results for the chirp number and chirp state only.

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

CALCulate<n>:CHRDetection:TABLe:FREQuency:ALL[:STATe] <State>[, <Scaling>]

If enabled, all frequency parameters are included in the result tables (see "Frequency parameters" on page 55).

Note that only the enabled columns are returned for the `CALCulate<n>:CHRDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> GHZ | MHZ | KHZ | HZ
Defines the scaling for the frequency parameters

Usage: Setting only

Manual operation: See "Frequency parameters" on page 55

CALCulate<n>:CHRDetection:TABLe:FREQuency:AVGFm <State>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:FREQuency:CHERror <State>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:FREQuency:FREQuency <State>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:FREQuency:MAXFm <State>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:FREQuency:RMSFm <State>[, <Scaling>]

If enabled, the specified frequency parameter is included in the result tables (see "Frequency parameters" on page 55).

Note that only the enabled columns are returned for the `CALCulate<n>:CHRDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> GHZ | MHZ | KHZ | HZ
Defines the scaling for the frequency parameters

Manual operation: See "Frequency Deviation (RMS)" on page 56

CALCulate<n>:CHRDetection:TABLe:PHASe:ALL[:STATe] <State>[, <Scaling>]

If enabled, all phase deviation parameters are included in the result tables (see "Phase parameters" on page 56).

Note that only the enabled columns are returned for the CALCulate<n>:CHRDetection:TABLe:RESults? query.

Suffix:

<n> irrelevant

Parameters:

<State> *RST: ON

Setting parameters:

<Scaling> DEG | RAD

Defines the scaling for the phase parameters

Usage: Setting only

Manual operation: See "Phase parameters" on page 56

CALCulate<n>:CHRDetection:TABLe:PHASe:AVGPm <Visability>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:PHASe:MAXPm <Visability>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:PHASe:RMSPm <State>[, <Scaling>]

If enabled, the specified phase deviation parameter is included in the result tables (see "Phase parameters" on page 56).

Note that only the enabled columns are returned for the CALCulate<n>:CHRDetection:TABLe:RESults? query.

Suffix:

<n> irrelevant

Parameters:

<State> *RST: ON

Setting parameters:

<Scaling> DEG | RAD

Defines the scaling for the phase parameters

Manual operation: See "Phase Deviation (RMS)" on page 57

CALCulate<n>:CHRDetection:TABLe:POWer:ALL[:STATe] <State>

If enabled, all power parameters are included in the result tables (see "Power parameters" on page 58).

Note that only the enabled columns are returned for the CALCulate<n>:CHRDetection:TABLe:RESults? query.

Scaling is always in dB and need not be specified.

Suffix:

<n> irrelevant

Parameters:

<State> *RST: ON

Usage: Setting only

Manual operation: See "Power parameters" on page 58

CALCulate<n>:CHRDetection:TABLe:POWer:AVEPower <State>
CALCulate<n>:CHRDetection:TABLe:POWer:MAXPower <State>
CALCulate<n>:CHRDetection:TABLe:POWer:MINPower <State>
CALCulate<n>:CHRDetection:TABLe:POWer:PWRRipple <State>

If enabled, the Ripple Power column is displayed in the result tables.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Manual operation: See "Power Ripple" on page 58

CALCulate<n>:CHRDetection:TABLe:STATe:INDex <State>

If enabled, the State Index column is displayed in the result tables.

Note that only the enabled columns are returned for the `CALCulate<n>:CHRDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Manual operation: See "State Index" on page 54

CALCulate<n>:CHRDetection:TABLe:TIMing:ALL[:STATe] <State>[, <Scaling>]

If enabled, all timing parameters are included in the result tables (see"Timing parameters" on page 54).

Note that only the enabled columns are returned for the `CALCulate<n>:CHRDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> S | MS | US | NS
Defines the scaling for the timing parameters

Usage: Setting only

Manual operation: See "Timing parameters" on page 54

CALCulate<n>:CHRDetection:TABLe:TIMing:BEGin <State>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:TIMing:LENGth <State>[, <Scaling>]
CALCulate<n>:CHRDetection:TABLe:TIMing:RATE <State>[, <Scaling>]

If enabled, the specified timing parameter is included in the result tables (see"Timing parameters" on page 54).

Note that only the enabled columns are returned for the `CALCulate<n>:CHRDetection:TABLe:RESults?` query.

Suffix:

<n>	irrelevant

Parameters:

<State>	*RST: ON

Setting parameters:

<Scaling>	GHZ_US | MHZ_US | KHZ_US | HZ_US Defines the scaling for the timing parameters

Manual operation: See "Chirp Rate" on page 54

11.6.5.2 Hop Results

CALCulate<n>:HOPDetection:TABLe:COLumn <State>, <Headers>...

This command enables or disables columns in all hop results and statistics tables.

Note that only the enabled columns are returned for the CALCulate<n>:CHRDetection:TABLe:RESults? query.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

Enables or disables all subsequently listed headers

ON
Provides results for the defined <Headers> only

OFF
Provides results for all table parameters except the specified <Headers>.

*RST: ON

<Headers> ALL | STATe | BEGin | DWELl | SWITching | STAFrequency | FREQuency | RELFrequency | FMERror | MAXFm | RMSFm | AVGFm | MINPower | MAXPower | AVGPower | PWRRipple | AVPHm | MXPHm | RMSPm

All listed parameters are displayed or hidden in the table results (depending on the `<State>` parameter).

ALL
See Chapter 5.1, "Hop Parameters", on page 46.

STATe
Hop state

BEGin
Hop Begin

DWELl
Hop dwell time

SWITching
Switching time

STAFrequency
State frequency (nominal)

FREQuency
Average frequency

RELFrequency
Relative frequency (hop-to-hop)

FMERror
Hop state deviation

MAXFm
Maximum frequency deviation

RMSFm
RMS frequency deviation

AVGFm
Average frequency deviation

MINPower
Minimum power

MAXPower
Maximum power

AVGPower
Average power

PWRRipple
Power ripple

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Example: `CALC:HOPD:TABL:COL ON, HOPNo, STATe`
Provides results for the HOP number and HOP state only.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

CALCulate<n>:HOPDetection:TABLe:FREQuency:ALL[:STATe] <State>[, <Scaling>]

If enabled, all frequency parameters are included in the result tables (see "Frequency parameters" on page 48).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> GHZ | MHZ | KHZ | HZ
Defines the scaling for the frequency parameters

Usage: Setting only

CALCulate<n>:HOPDetection:TABLe:FREQuency:AVGFm <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:FREQuency:FMERror <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:FREQuency:FREQuency <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:FREQuency:MAXFm <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:FREQuency:RELFrequency <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:FREQuency:RMSFm <State>[, <Scaling>]

If enabled, the specified frequency parameter is included in the result tables (see "Frequency parameters" on page 48).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> GHZ | MHZ | KHZ | HZ
Defines the scaling for the frequency parameters

Manual operation: See "Frequency Deviation (RMS)" on page 49

CALCulate<n>:HOPDetection:TABLe:PHASe:ALL[:STATe] <State>[, <Scaling>]

If enabled, all phase deviation parameters are included in the result tables (see "Phase parameters" on page 50).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:

<n> irrelevant

Parameters:

<State> *RST: ON

Setting parameters:

<Scaling> DEG | RAD

Defines the scaling for the phase parameters

Usage: Setting only

Manual operation: See "Phase parameters" on page 50

CALCulate<n>:HOPDetection:TABLe:PHASe:AVGPm <Visability>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:PHASe:MAXPm <Visability>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:PHASe:RMSPm <State>[, <Scaling>]

If enabled, the specified phase deviation parameter is included in the result tables (see "Phase parameters" on page 50).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:

<n> irrelevant

Parameters:

<State> *RST: ON

Setting parameters:

<Scaling> DEG | RAD

Defines the scaling for the phase parameters

Manual operation: See "Phase Deviation (RMS)" on page 51

CALCulate<n>:HOPDetection:TABLe:POWer:ALL[:STATe] <State>

If enabled, all power parameters are included in the result tables (see "Power parameters" on page 51).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

(The suffix <n> is irrelevant.)

Parameters:

<State>	*RST:	ON

Usage: Setting only

Manual operation: See "Power parameters" on page 51

CALCulate<n>:HOPDetection:TABLe:POWer:AVEPower <State>
CALCulate<n>:HOPDetection:TABLe:POWer:MAXPower <State>
CALCulate<n>:HOPDetection:TABLe:POWer:MINPower <State>
CALCulate<n>:HOPDetection:TABLe:POWer:PWRRipple <State>

If enabled, the specified power parameter is displayed in the result tables.

Suffix:

<n> irrelevant

Parameters:

<State>	*RST:	ON

Manual operation: See "Power Ripple" on page 52

CALCulate<n>:HOPDetection:TABLe:STATe:ALL[:STATe] <State>

If enabled, all state parameters are included in the result tables (see "State parameters" on page 47).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:

<n> irrelevant

Parameters:

<State>	*RST:	ON

Usage: Setting only

Manual operation: See "State parameters" on page 47
See "Frequency parameters" on page 48

CALCulate<n>:HOPDetection:TABLe:STATe:INDex <State>

If enabled, the State Index column is displayed in the result tables.

Suffix:

<n> irrelevant

Parameters:

<State>	*RST:	ON

Manual operation: See "State Index" on page 47

CALCulate<n>:HOPDetection:TABLe:STATe:STAFrequency <State>[, <Scaling>]

If enabled, the hop state frequency parameter is included in the result tables (see "State parameters" on page 47).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> GHZ | MHZ | KHZ | HZ
Defines the scaling for the frequency parameters

Manual operation: See "State Frequency (Nominal)" on page 48

CALCulate<n>:HOPDetection:TABLe:TIMing:ALL[:STATe] <State>[, <Scaling>]

If enabled, all timing parameters are included in the result tables (see "Timing parameters" on page 47).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> S | MS | US | NS
Defines the scaling for the timing parameters

Usage: Setting only

Manual operation: See "Timing parameters" on page 47

CALCulate<n>:HOPDetection:TABLe:TIMing:BEGin <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:TIMing:DWELl <State>[, <Scaling>]
CALCulate<n>:HOPDetection:TABLe:TIMing:SWITching <State>[, <Scaling>]

If enabled, the specified tTime parameter is included in the result tables (see "Timing parameters" on page 47).

Note that only the enabled columns are returned for the `CALCulate<n>:HOPDetection:TABLe:RESults?` query.

Suffix:
<n> irrelevant

Parameters:
<State> *RST: ON

Setting parameters:
<Scaling> S | MS | US | NS
Defines the scaling for the timing parameters

Manual operation: See "Switching Time" on page 48

11.6.6 Configuring Parameter Distribution Displays

For details on the parameter distribution result displays see "Parameter Distribution" on page 67.

CALCulate<n>:DISTribution:CHIRp:FREQuency <XAxis>, <YAxis>

Configures the Parameter Distribution result display for chirp frequency parameters.

Suffix:
<n> irrelevant

Parameters:
<XAxis> AVGFm | CHERror | FREQuency | MAXFm | RMSFm

CHERror
Chirp state deviation

FREQuency
Average frequency

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

Setting parameters:
<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of chirps in which the parameter value occurred.

OCCurance
Percentage of all measured chirps in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:CHIRp:PHASe <XAxis>, <YAxis>

Configures the x-axis and y-axis of the Parameter Distribution result display for chirp phase parameters over time.

Suffix:
<n> irrelevant

Parameters:
<XAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Setting parameters:
<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of hops in which the parameter value occurred.

OCCurance
Percentage of all measured hops in which the parameter value occurred.

*RST: COUNt

Usage: Setting only

CALCulate<n>:DISTribution:CHIRp:POWer <XAxis>, <YAxis>

Configures the Parameter Distribution result display for chirp power parameters.

Suffix:
<n> irrelevant

Parameters:

<XAxis> AVGPower | MAXPower | MINPower | PWRRipple

AVGPower
Average power

MINPower
Minimum power

MAXPower
Maximum power

PWRRipple
Power ripple

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of chirps in which the parameter value occurred.

OCCurance
Percentage of all measured chirps in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:CHIRp:STATe <XAxis>, <YAxis>

Configures the Parameter Distribution result display for chirp state parameters.

Suffix:

<n> irrelevant

Parameters:

<XAxis> INDex

Chirp state index

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of chirps in which the parameter value occurred.

OCCurance
Percentage of all measured chirps in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:CHIRp:TIMing <XAxis>, <YAxis>

Configures the Parameter Distribution result display for chirp timing parameters.

Suffix:

<n> irrelevant

Parameters:

<XAxis> BEGin | LENGth | RATE

Chirp parameter to be displayed on the x-axis. For a description of the available parameters see Chapter 5.2, "Chirp Parameters", on page 52.

BEGin
Chirp begin

LENGth
Chirp length

RATE
Chirp rate

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of chirps in which the parameter value occurred.

OCCurance
Percentage of all measured chirps in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:HOP:FREQuency <XAxis>, <YAxis>

Configures the Parameter Distribution result display for hop frequency parameters.

Suffix:

<n> irrelevant

Parameters:

<XAxis> AVGFm | FMERror | FREQuency | MAXFm | RMSFm | RELFrequency

FREQuency
Average frequency

RELFrequency
Relative frequency (hop-to-hop)

FMERror
Hop state deviation

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of hops in which the parameter value occurred.

OCCurance
Percentage of all measured hops in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:HOP:PHASe <XAxis>, <YAxis>

Configures the x-axis and y-axis of the Parameter Distribution result display for hop phase parameters over time.

Suffix:

<n> irrelevant

Parameters:

<XAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of hops in which the parameter value occurred.

OCCurance
Percentage of all measured hops in which the parameter value occurred.

*RST: COUNt

Usage: Setting only

CALCulate<n>:DISTribution:HOP:POWer <XAxis>, <YAxis>

Configures the Parameter Distribution result display for hop power parameters.

Suffix:

<n> irrelevant

Parameters:

<XAxis> AVGPower | MAXPower | MINPower | PWRRipple

MINPower
Minimum power

MAXPower
Maximum power

AVGPower
Average power

PWRRipple
Power ripple

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of hops in which the parameter value occurred.

OCCurance
Percentage of all measured hops in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:HOP:STATe <XAxis>, <YAxis>

Configures the Parameter Distribution result display for hop state parameters.

Suffix:

<n> irrelevant

Parameters:

<XAxis> INDex | STAFrequency

INDex
Hop state index

STAFrequency
State frequency (nominal)

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of hops in which the parameter value occurred.

OCCurance
Percentage of all measured hops in which the parameter value occurred.

*RST: COUNt

CALCulate<n>:DISTribution:HOP:TIMing <XAxis>, <YAxis>

Configures the Parameter Distribution result display for hop timing parameters.

Suffix:

<n> irrelevant

Parameters:

<XAxis> BEGin | DWELl | SWITching

Hop parameter to be displayed on the x-axis. For a description of the available parameters see Chapter 5.1, "Hop Parameters", on page 46Chapter 5.2, "Chirp Parameters", on page 52.

BEGin
Hop begin time

DWELl
Hop dwell time

SWITching
Hop switching time

Setting parameters:

<YAxis> COUNt | OCCurrence

Parameter to be displayed on the y-axis.

COUNt
Number of hops in which the parameter value occurred.

OCCurance
Percentage of all measured hops in which the parameter value occurred.

*RST: COUNt

Example: `CALC:DIST:HOP:TIM SWIT,COUN`

CALCulate<n>:DISTribution:NBINs <#bins>

This command sets the number of bins used to calculate the histrogram.

Suffix:

<n> irrelevant

Parameters:

<#bins> Range: 1 to 1000

Manual operation: See "Histogram Bins" on page 126

CALCulate<n>:DISTribution:X?

Queries the x-axis values of the specified Parameter Distribution display.

Suffix:

<n> irrelevant

Return values:

<XAxis> The number of values is defined by `CALCulate<n>:DISTribution:NBINs`. The used unit depends on the selected parameter.

Example: `CALC:DIST:X?`

Usage: Query only

Manual operation: See "Parameter Distribution" on page 67
See "X-Axis" on page 125

CALCulate<n>:DISTribution:Y?

Queries the y-axis values of the specified Parameter Distribution display.

Suffix:

<n> irrelevant

Return values:

<YAxis> The number of values is defined by `CALCulate<n>:DISTribution:NBINs`. The used unit depends on the selected parameter.

Usage: Query only

Manual operation: See "Parameter Distribution" on page 67
See "Y-Axis" on page 126

11.6.7 Configuring Parameter Trends

For details on the parameter trend result displays see "Parameter Trend" on page 67.

11.6.7.1 General Commands

CALCulate<n>:TRENd:SWAP:XY

Swaps the x and y axis parameters of the Parameter Trend result display.

Suffix:

<n> irrelevant

Usage: Event

Manual operation: See "Swap X and Y Axis" on page 127

CALCulate<n>:TRENd:X?

Queries the x-axis of the Parameter Trend result display.

Suffix:
<n> irrelevant

Return values:
<XAxis>

Usage: Query only

Manual operation: See "Parameter Trend" on page 67
See "X-Axis" on page 126

CALCulate<n>:TRENd:Y?

Queries the y-axis of the Parameter Trend result display.

Suffix:
<n> irrelevant

Return values:
<YAxis>

Usage: Query only

Manual operation: See "Parameter Trend" on page 67
See "Y-Axis" on page 127

11.6.7.2 Chirp Parameter Trends

CALCulate<n>:TRENd:CHIRp:FREQuency <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for chirp trends over time.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVGFm | CHERror | FREQuency | MAXFm | RMSFm

CHERror
Chirp state deviation

FREQuency
Average frequency

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

<XAxis> BEGin

BEGin
Chirp Begin

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:FREQuency:X <XAxis>

Configures the x-axis of the Parameter Trend result display for chirp frequency parameters.

Suffix:
<n> irrelevant

Setting parameters:
<XAxis> AVGFm | CHERror | FREQuency | MAXFm | RMSFm

CHERror
Chirp state deviation

FREQuency
Average frequency

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:FREQuency:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for chirp frequency parameters.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVGFm | CHERror | FREQuency | MAXFm | RMSFm

CHERror
Chirp state deviation

FREQuency
Average frequency

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:PHASe <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for chirp phase parameters over time.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

<XAxis> BEGin

BEGin
Chirp begin

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:PHASe:X <XAxis>

Configures the x-axis of the Parameter Trend result display for chirp phase parameters.

Suffix:
<n> irrelevant

Setting parameters:
<XAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:PHASe:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for chirp phase parameters.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:POWer <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for chirp trends over time.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVGPower | MAXPower | MINPower | PWRRipple

AVGPower
Average power

MINPower
Minimum power

MAXPower
Maximum power

PWRRipple
Power ripple

<XAxis> BEGin

BEGin
Chirp Begin

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:POWer:X <XAxis>

Configures the x-axis of the Parameter Trend result display for chirp power parameters.

Suffix:
<n> irrelevant

Setting parameters:
<XAxis> AVGPower | MAXPower | MINPower | PWRRipple

AVGPower
Average power

MINPower
Minimum power

MAXPower
Maximum power

PWRRipple
Power ripple

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:POWer:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for chirp power parameters.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVGPower | MAXPower | MINPower | PWRRipple

AVGPower
Average power

MINPower
Minimum power

MAXPower
Maximum power

PWRRipple
Power ripple

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:STATe <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for chirp trends over time.

Suffix:

<n>	irrelevant

Setting parameters:

<YAxis>	INDex Chirp state index

<XAxis>	BEGin
	BEGin
	Chirp Begin

Usage:	Setting only

CALCulate<n>:TRENd:CHIRp:STATe:X <XAxis>

Configures the y-axis of the Parameter Trend result display for chirp state parameters.

Suffix:

<n>	irrelevant

Setting parameters:

<XAxis>	INDex Chirp state index
Usage:	Setting only

CALCulate<n>:TRENd:CHIRp:STATe:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for chirp state parameters.

Suffix:

<n>	irrelevant

Setting parameters:

<YAxis>	INDex Chirp state index
Usage:	Setting only

CALCulate<n>:TRENd:CHIRp:TIMing <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for chirp trends over time.

Suffix:

<n>	irrelevant

Setting parameters:

<YAxis> BEGin | LENGth | RATE

BEGin
Chirp Begin

LENGth
Chirp length

RATe
Chirp rate

<XAxis> BEGin

BEGin
Chirp Begin

Example: `CALC2:TREN:CHIR:TIM NUMB,LENG`

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:TIMing:X <XAxis>

Configures the x-axis of the Parameter Trend result display for chirp timing parameters.

Suffix:

<n> irrelevant

Setting parameters:

<XAxis> BEGin | LENGth | RATE

BEGin
Chirp Begin

LENGth
Chirp length

RATe
Chirp rate

Usage: Setting only

CALCulate<n>:TRENd:CHIRp:TIMing:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for chirp timing parameters.

Suffix:

<n> irrelevant

Setting parameters:

<YAxis> BEGin | LENGth | RATE

BEGin
Chirp Begin

LENGth
Chirp length

RATe
Chirp rate

Example: `CALC2:TREN:CHIR:TIM:Y BEGin`

Usage: Setting only

11.6.7.3 Hop Parameter Trends

CALCulate<n>:TRENd:HOP:FREQuency <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for hop trends over time.

Suffix:

<n> irrelevant

Setting parameters:

<YAxis> AVGFm | FMERror | FREQuency | MAXFm | RMSFm | RELFrequency

FREQuency
Average frequency

RELFrequency
Relative frequency (hop-to-hop)

FMERror
Hop state deviation

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

<XAxis> BEGin

BEGin
Hop Begin

Usage: Setting only

CALCulate<n>:TRENd:HOP:FREQuency:X <XAxis>

Configures the x-axis of the Parameter Trend result display for hop frequency parameters.

Suffix:

<n> irrelevant

Setting parameters:

<XAxis> AVGFm | FMERror | FREQuency | MAXFm | RMSFm | RELFrequency

FREQuency
Average frequency

RELFrequency
Relative frequency (hop-to-hop)

FMERror
Hop state deviation

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

Usage: Setting only

CALCulate<n>:TRENd:HOP:FREQuency:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for hop frequency parameters.

Suffix:

<n> irrelevant

Setting parameters:

<YAxis> AVGFm | FMERror | FREQuency | MAXFm | RMSFm | RELFrequency

FREQuency
Average frequency

RELFrequency
Relative frequency (hop-to-hop)

FMERror
Hop state deviation

MAXFm
Maximum Frequency Deviation

RMSFm
RMS Frequency Deviation

AVGFm
Average Frequency Deviation

Usage: Setting only

CALCulate<n>:TRENd:HOP:PHASe <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for hop phase parameters over time.

Suffix:

<n> irrelevant

Setting parameters:

<YAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

<XAxis> BEGin

BEGin
Chirp begin

Usage: Setting only

CALCulate<n>:TRENd:HOP:PHASe:X <XAxis>

Configures the x-axis of the Parameter Trend result display for hop phase parameters.

Suffix:
<n> irrelevant

Setting parameters:
<XAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Usage: Setting only

CALCulate<n>:TRENd:HOP:PHASe:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for hop phase parameters.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> AVPHm | MXPHm | RMSPm

AVPHm
Average phase deviation

MXPHm
Maximum phase deviation

RMSPm
RMS phase deviation

Usage: Setting only

CALCulate<n>:TRENd:HOP:POWer <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for hop trends over time.

Suffix:
<n> irrelevant

Setting parameters:

<YAxis> AVGPower | MAXPower | MINPower | PWRRipple

MINPower
Minimum power

MAXPower
Maximum power

AVGPower
Average power

PWRRipple
Power ripple

<XAxis> BEGin

BEGin
Hop Begin

Usage: Setting only

CALCulate<n>:TRENd:HOP:POWer:X <XAxis>

Configures the x-axis of the Parameter Trend result display for hop power parameters.

Suffix:

<n> irrelevant

Setting parameters:

<XAxis> AVGPower | MAXPower | MINPower | PWRRipple

MINPower
Minimum power

MAXPower
Maximum power

AVGPower
Average power

PWRRipple
Power ripple

Usage: Setting only

CALCulate<n>:TRENd:HOP:POWer:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for hop power parameters.

Suffix:

<n> irrelevant

Setting parameters:

<YAxis> AVGPower | MAXPower | MINPower | PWRRipple

MINPower
Minimum power

MAXPower
Maximum power

AVGPower
Average power

PWRRipple
Power ripple

Usage: Setting only

CALCulate<n>:TRENd:HOP:STATe <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for hop trends over time.

Suffix:

<n> irrelevant

Setting parameters:

<YAxis> INDex | STAFrequency

INDex
Hop index

STAFrequency
State frequency (nominal)

<XAxis> BEGin

BEGin
Hop Begin

Usage: Setting only

CALCulate<n>:TRENd:HOP:STATe:X <XAxis>

Configures the x-axis of the Parameter Trend result display for hop state parameters.

Suffix:

<n> irrelevant

Setting parameters:

<XAxis> INDex | STAFrequency

INDex
Hop index

STAFrequency
State frequency (nominal)

Usage: Setting only

CALCulate<n>:TRENd:HOP:STATe:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for hop state parameters.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> INDex | STAFrequency

INDex
Hop index

STAFrequency
State frequency (nominal)

Usage: Setting only

CALCulate<n>:TRENd:HOP:TIMing <YAxis>, <XAxis>

Configures the x-axis and y-axis of the Parameter Trend result display for hop trends over time.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> BEGin | DWELl | SWITching

BEGin
Hop Begin

DWELl
Hop dwell time

SWITching
Switching time

<XAxis> BEGin

BEGin
Hop Begin

Usage: Setting only

CALCulate<n>:TRENd:HOP:TIMing:X <XAxis>

Configures the x-axis of the Parameter Trend result display for hop timing parameters.

Suffix:
<n> irrelevant

Setting parameters:
<XAxis> BEGin | DWELl | SWITching

BEGin
Hop Begin

DWELl
Hop dwell time

SWITching
Switching time

Usage: Setting only

CALCulate<n>:TRENd:HOP:TIMing:Y <YAxis>

Configures the y-axis of the Parameter Trend result display for hop timing parameters.

Suffix:
<n> irrelevant

Setting parameters:
<YAxis> BEGin | DWELl | SWITching

BEGin
Hop Begin

DWELl
Hop dwell time

SWITching
Switching time

Usage: Setting only

11.6.8 Configuring the Y-Axis Scaling and Units

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These commands are described here.

Useful commands for configuring scaling described elsewhere:

- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 210

Remote commands exclusive to scaling the y-axis

CALCulate<n>:UNIT:ANGLe <Unit>

This command selects the global unit for phase results.

Suffix:
<n> irrelevant

Setting parameters:
<Unit> DEG | RAD
*RST: RAD

Manual operation: See "Phase Unit" on page 129

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

This command defines the display range of the y-axis (for all traces).

Suffix:
<n> Window
<t> irrelevant

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

Manual operation: See "Range" on page 129

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

If enabled, the Y-axis is scaled automatically according to the current measurement.

Suffix:
<n> Window
<t> irrelevant

Parameters for setting and query:
<State> **OFF**
Switch the function off
ON
Switch the function on
*RST: ON

Manual operation: See "Automatic Grid Scaling" on page 128
See "Auto Scale Once" on page 128

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

This command defines the maximum value of the y-axis for all traces in the selected result display.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Value> <numeric value>

*RST: depends on the result display
The unit and range depend on the result display.

Example:
`DISP:TRAC:Y:MIN -60`
`DISP:TRAC:Y:MAX 0`
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 128

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

This command defines the minimum value of the y-axis for all traces in the selected result display.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Value> <numeric value>

*RST: depends on the result display
The unit and range depend on the result display.

Example:
`DISP:TRAC:Y:MIN -60`
`DISP:TRAC:Y:MAX 0`
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 128

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

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

Suffix:
<n> Window

<t> irrelevant

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

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

*RST: depends on the result display

Example:
`DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Per Division" on page 128

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

This command defines the vertical position of the reference level on the display grid (for all traces).

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

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Position> 0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.

*RST: 100 PCT = frequency display; 50 PCT = time display

Example: `DISP:TRAC:Y:RPOS 50PCT`

Usage: SCPI confirmed

Manual operation: See "Ref Position" on page 128
See "Ref Level Position" on page 129

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

This command defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Value> numeric value WITHOUT UNIT

Default unit: dBm

Manual operation: See "Ref Value" on page 129

11.6.9 Configuring Traces

The trace settings determine how the measured data is analyzed and displayed in the window. Depending on the result display, between 1 and 6 traces may be displayed.

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

This command selects the trace mode.

Suffix:

<n> Window

<t> Trace

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.

VIEW
The current contents of the trace memory are frozen and displayed.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example:

`INIT:CONT OFF`
Switching to single sweep mode.
`SWE:COUN 16`
Sets the number of measurements to 16.
`DISP:TRAC3:MODE WRIT`
Selects clear/write mode for trace 3.
`INIT;*WAI`
Starts the measurement and waits for the end of the measurement.

Manual operation: See "Mode" on page 131

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

Suffix:

<n> Window

<t> Trace

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 operation: See "Hold" on page 132

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> Window

<t> Trace

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6" on page 131
See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 133

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] <Detector>

Defines the trace detector to be used for trace analysis.

Suffix:

<n> Window

<t> Trace

Parameters:
<Detector>

APEak
Autopeak

NEGative
Negative peak

POSitive
Positive peak

SAMPle
First value detected per trace point

AVERage
Average

*RST: APEak

Example: `DET POS`
Sets the detector to "positive peak".

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO <State>

This command couples and decouples the detector to the trace mode.

Suffix:
<n> Window

<t> Trace

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

Example: `DET:AUTO OFF`
The selection of the detector is not coupled to the trace mode.

Manual operation: See "Detector" on page 132

[SENSe:]MEASure:POINts <MeasurementPoints>

Defines the maximum number of trace points within a trace.

Parameters:
<MeasurementPoints>

Manual operation: See "Maximum number of trace points" on page 133

[SENSe:]STATistic:TYPE <Statistic Type>

Defines which hops/chirps are included in the statistical evaluation.

Parameters:

<Statistic Type> SELected | ALL

SELected
Only the selected hop/chirp from each sweep (capture) is included in the statistical evaluation.

ALL
All measured hops/chirps from each sweep (capture) are included in the statistical evaluation.

Manual operation: See "Selected Hop / Selected Chirp vs All Hops / All Chirps" on page 133

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of measurements that the application uses to average traces.

In case of continuous measurement mode, the application calculates the moving average over the average count.

In case of single measurement mode, the application stops the measurement and calculates the average after the average count has been reached.

Suffix:

<n> Window

Example:
`SWE:COUN 64`
Sets the number of measurements to 64.
`INIT:CONT OFF`
Switches to single measurement mode.
`INIT;*WAI`
Starts a measurement and waits for its end.

Usage: SCPI confirmed

Manual operation: See "Sweep / Average Count" on page 118

[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.

Usage: Query only

11.6.10 Configuring Spectrograms

The remote commands required for the individual settings available for spectrogram displays are described here. For color mapping commands, see Chapter 11.6.11, "Configuring Color Maps", on page 309.

CALCulate<n>:SGRam:CLEar

This command resets the spectrogram and clears the history buffer.

Suffix:

<n>	irrelevant

Usage: Event

Manual operation: See "Clear Spectrogram" on page 140

CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect <Frame> | <Time>

This command selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:

<n>	irrelevant

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 operation: See "Selecting a frame to display" on page 118

CALCulate<n>:SGRam|SPECtrogram:HDEPth <History>

This command defines the number of frames to be stored in the R&S FSW memory.

Suffix:

<n>	irrelevant

Parameters:
<Depth>

Example: `CALC:SGR:SPEC 1500`
Sets the history depth to 1500.

Manual operation: See "History Depth" on page 137

CALCulate<n>:SGRam|SPECtrogram:TRESolution <TimeRes>

This command sets the spectrogram time resolution for `CALCulate<n>:SGRam|SPECtrogram:TRESolution:AUTO OFF`.

The time resolution determines the size of the bins used for each FFT calculation. The shorter the time span used for each FFT, the shorter the resulting span, and thus the higher the resolution in the spectrum becomes.

Suffix:
<n> irrelevant

Parameters:
<TimeRes> The values depend on the evaluation basis of the spectrogram (see `DISPlay:[WINDow<n>:]EVAL` on page 258)

Range: full capture area: 1 / sample rate; analysis region or hop/chirp: (1 / sample rate) * (meas bw / analysis region bw); to full capture area: measurement time; analysis region: time gate length; hop/chirp: result range length

*RST: 0

Manual operation: See "Time Resolution" on page 113

CALCulate<n>:SGRam|SPECtrogram:TRESolution:AUTO <Reference>

This command switches the spectrogram time resolution from auto to manual.

Suffix:
<n> irrelevant

Setting parameters:
<Reference> AUTO | MANual

AUTO
The optimal resolution is determined automatically according to the data acquisition settings.

MANual
You must define the time resolution using `CALCulate<n>:SGRam|SPECtrogram:TRESolution`.

Manual operation: See "Time Resolution" on page 113

CALCulate<n>:SGRam|SPECtrogram:TSTamp:DATA? <Frames>

This command queries the time stamp (starting time) of the frames.

The return values consist of four values for each frame. If the spectrogram is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with `TRAC:DATA? SGR`

See `TRACe<n>[:DATA]?` on page 375.

Suffix:

<n> irrelevant

Parameters:

<Frames>

CURRent
Returns the starting time of the current frame.

ALL
Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

Return values:

<Seconds> Number of seconds that have passed since 01.01.1970 till the frame start

<Nanoseconds> Number of nanoseconds that have passed *in addition to the <Seconds>* since 01.01.1970 till the frame start.

<Reserved> The third and fourth value are reserved for future uses.

Example:
`CALC:SGR:TST ON`
Activates the time stamp.
`CALC:SGR:TST:DATA? ALL`
Returns the starting times of all frames sorted in a descending order.

Usage: Query only

Manual operation: See "Timestamp" on page 137

CALCulate<n>:SGRam|SPECtrogram:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- `CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe` on page 329
- `CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 324
- `CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect` on page 305

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:SGR:TST ON`
`CALC:SPEC:TST ON`
Activates the time stamp.

Manual operation: See "Timestamp" on page 137

[SENSe:][WINDow<n>:]SGRam|SPECtrogram:DETector:FUNCtion <Detector>

This command queries or sets the spectrogram detector type for the specified window.

Suffix:

<n> Window

Parameters:

<Detector> SUM | AVERage | RMS | MAXimum | MINimum | SAMPle

SUM
Calculates the sum of all values in one sample point

AVERage
Calculates the linear average of all values in one sample point

RMS
Calculates the RMS of all values in one sample point

MAXimum
Determines the largest of all values in one sample point

MINimum
Determines the minimum of all values in one sample point

SAMPle
Selects the last measured value for each sample point

*RST: MAXimum

Example: `SENS:SGR:DET:FUNC SUM`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "Detector" on page 139

[SENSe:]SWEep:FFT:WINDow:LENGth?

This commands queries the FFT window length

Return values:

<WindowLength> 1024 | 2048 | 4096

*RST: 1024

Example: `SWE:FFT:WIND:LENG?`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Usage: Query only

[SENSe:]SWEep:FFT:WINDow:TYPE <ColorScheme>

This command queries or sets the FFT windowing function.

Parameters:

<ColorScheme> BLACkharris | CHEByshev | FLATtop | GAUSsian | HAMMing | HANNing | RECTangular

*RST: BLACkharris

Example: `SWE:FFT:WIND:TYPE BLAC`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Manual operation: See "FFT Window" on page 112

11.6.11 Configuring Color Maps

The color display used in spectrograms is highly configurable to adapt the display to your needs.

For details see Chapter 4, "Measurement Basics", on page 16.

DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

This command restores the original color map.

Suffix:

<n> Window

Usage: Event

Manual operation: See "Set to Default" on page 142

DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Suffix:

<n> Window

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:LOW 10`
Sets the start of the color map to 10%.

Manual operation: See "Start / Stop" on page 141

DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Suffix:

<n> Window

Parameters:

<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Manual operation: See "Shape" on page 141

DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Suffix:

<n> Window

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Manual operation: See "Start / Stop" on page 141

DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Parameters:

<ColorScheme>

HOT
Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD
Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
Shows the results in shades of gray.

*RST: HOT

Example: `DISP:WIND:SPEC:COL GRAY`
Changes the color scheme of the spectrogram to black and white.

Manual operation: See "Hot/Cold/Radar/Grayscale" on page 141

11.6.12 Working with Markers Remotely

In the Transient Analysis application, up to 16 markers or delta markers can be activated for each window simultaneously.

11.6.12.1 Setting Up Individual Markers

The following commands define the position of markers in the diagram.

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Suffix:

<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual operation: See "All Markers Off" on page 147

CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m> <State>

This command links normal marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, marker <m1> changes its horizontal position to the same value.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See "Linking to Another Marker" on page 146

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.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 145
See "Marker Type" on page 146
See "Select Marker" on page 147

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window

<m> Marker

Parameters:
<Trace>

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual operation: See "Assigning the Marker to a Trace" on page 147

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.

Suffix:
<m> Marker (query: 1 to 16)

<n> Window

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
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 operation: See "Marker Table" on page 68
See "Marker Position (X-value)" on page 146

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 measurement mode.

See also `INITiate<n>:CONTinuous` on page 245.

Suffix:

<n>	Window
<m>	Marker

Return values:

<Result>	Result at the marker position.

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

Manual operation: See "Marker Table" on page 68

CALCulate<n>:DELTamarker<m>:AOFF

This command turns *all* delta markers off.

Suffix:

<n>	Window
<m>	irrelevant

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 (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2:LINK ON`

Manual operation: See "Linking to Another Marker" on page 146

CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m> <State>

This command links delta marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, delta marker <m1> changes its horizontal position to the same value.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See "Linking to Another Marker" on page 146

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

Suffix:

<n> Window

<m> Marker

Parameters:

<Reference>

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 146

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 145
See "Marker Type" on page 146
See "Select Marker" on page 147

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> Window

<m> Marker

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:

<m> Marker

<n> Window

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker Position (X-value)" on page 146

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:

<n> Window

<m> Marker

Return values:

<Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

CALCulate<n>:DELTamarker<m>:Y?

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 measurement mode.

See also `INITiate<n>:CONTinuous` on page 245.

The unit depends on the application of the command.

Suffix:

<m> Marker

<n> Window

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

11.6.12.2 General Marker Settings

The following commands control 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 operation: See "Marker Table Display" on page 148

CALCulate<n>:MARKer<m>:LINK <State>

This command defines whether all markers within the selected result display are linked. If enabled, and you move one marker along the x-axis, all other markers in the display are moved to the same x-axis position.

Suffix:

<m> irrelevant

<n> Window

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC2:MARK:LINK ON`

Manual operation: See "Linked Markers" on page 148

11.6.12.3 Configuring and Performing a Marker Search

The following commands control the marker search.

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Suffix:

<n>, <m> irrelevant

Manual operation: See "Peak Excursion" on page 151

11.6.12.4 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: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.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Peak" on page 151

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Peak" on page 151

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Peak Search" on page 151

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.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Next Peak" on page 151

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.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Next Minimum" on page 152

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Next Minimum" on page 152

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Minimum" on page 152

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.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Next Minimum" on page 152

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.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event

Manual operation: See "Search Next Peak" on page 151

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Peak" on page 151

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Peak Search" on page 151

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.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Peak" on page 151

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.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Minimum" on page 152

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Minimum" on page 152

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Minimum" on page 152

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.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Minimum" on page 152

11.6.12.5 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 319
- CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 319
- CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 319
- CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 320
- CALCulate<n>:MARKer<m>:MINimum:LEFT on page 320
- CALCulate<n>:MARKer<m>:MINimum:NEXT on page 320
- CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 321
- CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 321

Remote commands exclusive to spectrogram markers

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame> | <Time>
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example:
`CALC:MARK:SGR:FRAM -20`
Sets the marker on the 20th frame before the present.
`CALC:MARK2:SGR:FRAM -2s`
Sets second marker on the frame 2 seconds ago.

Manual operation: See "Frame (for Spectrograms only)" on page 146

CALCulate<n>:MARKer<m>:SGRam:SARea <SearchArea>
CALCulate<n>:MARKer<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for all spectrogram markers in the measurement channel.

Suffix:

<n>, <m> irrelevant

Parameters:

<SearchArea>

VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "Marker Search Area" on page 151

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:
<n> Window

<m> Marker

Usage: Event

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:

<n> Window

<m> Marker

Usage: Event

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 321
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 322
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 322
- `CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 322

- CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 322
- CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 323
- CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 323
- CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 323

Remote commands exclusive to spectrogram markers

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe <Frame> | <Time>
CALCulate<n>:DELTamarker<m>:SPECtrogram: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.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<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<n>:DELTamarker<m>:SGRam:SARea <SearchArea>
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for *all* spectrogram markers in the measurement channel.

Suffix:
<n>, <m> irrelevant

Parameters:
<SearchArea>
VISible
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).
MEMory
Performs a search within all frames in the memory.
*RST: VISible

Manual operation: See "Marker Search Area" on page 151

CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:
<n> Window
<m> Marker

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:
<n> Window
<m> Marker

Usage: Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 150

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event

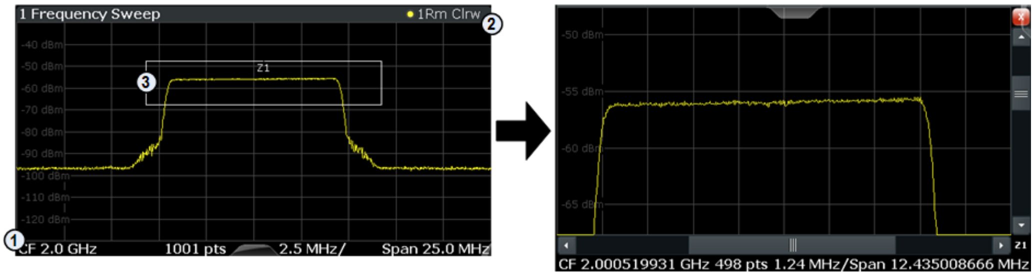
11.6.13 Zooming into the Display

11.6.13.1 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)

Suffix:
<n> 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 operation: See "Single Zoom" on page 152

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Suffix:
<n> Window

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

Example: `DISP:ZOOM ON`
Activates the zoom mode.

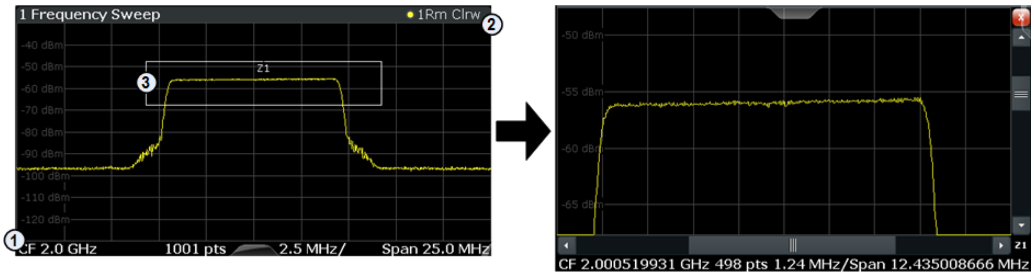
Manual operation: See "Single Zoom" on page 152
See "Restore Original Display" on page 153
See " Deactivating Zoom (Selection mode)" on page 154

11.6.13.2 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:

<n>	Window
<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 operation: See "Multiple Zoom" on page 153

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe <State>

This command turns the multiple zoom on and off.

Suffix:

<n>	Window
<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 operation: See "Multiple Zoom" on page 153
See "Restore Original Display" on page 153
See " Deactivating Zoom (Selection mode)" on page 154

11.7 Configuring an Analysis Interval and Line (MSRA mode only)

In MSRA operating mode, only the MSRA Master actually captures data; the MSRA slave applications define an extract of the captured data for analysis, referred to as the **analysis interval**. The **analysis line** is a common time marker for all MSRA slave applications.

For the Transient Analysis slave application, the commands to define tha analysis interval are the same as those used to define the actual data acquisition (see Chapter 11.4.5, "Data Acquisition", on page 220. Be sure to select the correct measurement channel before executing these commands.

Useful commands related to MSRA mode described elsewhere:

- `INITiate<n>:REFResh` on page 246
- `INITiate<n>:SEQuencer:REFResh[:ALL]` on page 246

Remote commands exclusive to MSRA slave applications

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

CALCulate<n>:MSRA:ALINe:SHOW

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

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

Suffix:
<n> irrelevant

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

Manual operation: See "Show Line" on page 155

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

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

Suffix:
<n> irrelevant

Parameters:

<Position> Position of the analysis line in seconds. The position must lie within the measurement time of the MSRA measurement.

Default unit: s

Manual operation: See "Position" on page 154

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

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

Suffix:

<n> Window

Return values:

<IntStart> Start value of the analysis interval in seconds

Default unit: s

<IntStop> Stop value of the analysis interval in seconds

Usage: Query only

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

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

Parameters:

<Offset> This parameter defines the time offset between the capture buffer start and the start of the extracted slave application data. The offset must be a positive value, as the slave application can only analyze data that is contained in the capture buffer.

Range: 0 to <Record length>
*RST: 0

11.8 Configuring an Analysis Interval and Line (MSRT mode only)

In MSRT operating mode, only the MSRT Master actually captures data; the MSRT slave applications define an extract of the captured data for analysis, referred to as the **analysis interval**. The **analysis line** is a common time marker for all MSRT slave applications.

For the Transient Analysis slave application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see Chapter 11.4.5, "Data Acquisition", on page 220. Be sure to select the correct measurement channel before executing these commands.

In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval for the Transient Analysis measurement.

Useful commands related to MSRT mode described elsewhere:

- `INITiate<n>:REFResh` on page 246
- `INITiate<n>:SEQuencer:REFResh[:ALL]` on page 246

Remote commands exclusive to MSRT slave applications

The following commands are only available for MSRT slave application channels:

CALCulate<n>:RTMS:ALINe:SHOW

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

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

Suffix:
<n> irrelevant

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

Manual operation: See "Show Line" on page 155

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

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

Suffix:
<n> irrelevant

Parameters:
<Position> Position of the analysis line in seconds. The position must lie within the measurement time (pretrigger + posttrigger) of the MSRT measurement.
Default unit: s

Manual operation: See "Position" on page 154

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

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

Suffix:

<n>	Window

Return values:

<IntStart>	Start value of the analysis interval in seconds Default unit: s
<IntStop>	Stop value of the analysis interval in seconds
Usage:	Query only

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

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

Parameters:

<Offset>	This parameter defines the time offset between the capture buffer start and the start of the extracted slave application data. The offset must be a positive value, as the slave application can only analyze data that is contained in the capture buffer. Range: - [pretrigger time] to min (posttrigger time; sweep time) *RST: 0
Manual operation:	See "Capture Offset" on page 108

11.9 Retrieving Results

The following commands are required to query the results of the transient analysis.

Note that for each hop/chirp result query you can specify for which hop/chirp(s) you require results:

- **ALL**: for all hops/chirps detected in the entire measurement
- **CURRent**: for all hops/chirps in the current capture buffer
- **SELected**: only for the currently selected hop/chirp

For each hop/chirp result, you can query either the current value (default) or the following statistical values for the hops/chirps detected in the capture buffer or the entire measurement:

- **AVER:** average of the results
- **MIN:** minimum of the results
- **MAX:** maximum of the results

- **SDEV:** standard deviation of the results

11.9.1 Retrieving Information on Detected Hops

The following commands return information on the currently selected or all detected hops.

CALCulate<n>:HOPDetection:TABLe:RESults? [<Start>, <End>]

This command queries the hop results table. The result is a comma-separated list of value sets, one set for each hop.

If no query parameters are specified, the results for all detected hops are returned.

Which values are returned depends on the enabled parameters for the results tables (see `CALCulate<n>:HOPDetection:TABLe:COLumn` on page 268).

Suffix:

<n>	irrelevant

Query parameters:

<Start>	integer The hop number of the first hop to be returned. Hop numbers start at 1.
<End>	integer The hop number of the last hop to be returned.

Return values:

<ID>	timestamp which corresponds to the absolute time the beginning of the hop was detected
<HopNo>	consecutive number of detected hop, starts at 1 for each new measurement
<StateIndex>	consecutive number of corresponding nominal hop state as defined in the "hop States" table (see `CALCulate<n>:HOPDetection:STATes[:DATA]` on page 229)
<Begin>	relative time (in ms) from the capture start at which the signal first enters the tolerance area of a nominal hop (within the analysis region) Default unit: ms
<DwellTime>	The duration of a hop from begin to end, that is, the time the signal remains in the tolerance area of a nominal hop frequency. Default unit: ms
<SwitchTime>	The time the signal requires to "hop" from one level to the next. It is defined as the time between a hop end and the following hop begin. Default unit: ms

<FreqNom>	Nominal frequency of the hop state Default unit: kHz
<FreqAvg>	Average frequency measured within the frequency measurement range of the hop Default unit: kHz
<FreqDev>	Deviation of the hop frequency from the nominal hop state frequency For details see "Hop State Deviation" on page 48. Default unit: kHz
<FreqRel>	Relative difference in frequency between two hops. For details see "Relative Frequency (Hop-to-Hop)" on page 49. Default unit: kHz
<FMDevMax>	Maximum deviation of the hop frequency from the nominal hop frequency as defined in the "Hop States" table. The deviation is calculated within the frequency measurement range of the hop. For details see "Frequency Deviation (Peak)" on page 49. Default unit: kHz
<FMDevRMS>	RMS deviation of the hop frequency from the nominal (linear) hop frequency as defined in the "Hop States" table. The deviation is calculated within the frequency measurement range of the hop. For details see "Frequency Deviation (RMS)" on page 49. Default unit: kHz
<FMDevAvg>	Average deviation of the hop frequency from the nominal (linear) hop frequency as defined in the "Hop States" table. The deviation is calculated within the frequency measurement range of the hop. For details see "Frequency Deviation (Average)" on page 50. Default unit: kHz
<PMDevMax>	Maximum deviation of the hop phase from the nominal hop phase as defined in the "Hop States" table. The deviation is calculated within the frequency measurement range of the hop. For details see "Phase Deviation (Peak)" on page 50. Default unit: kHz
<PMDevRMS>	RMS deviation of the hop phase from the nominal (linear) hop phase as defined in the "Hop States" table. The deviation is calculated within the frequency measurement range of the hop. For details see "Phase Deviation (RMS)" on page 51. Default unit: kHz

<PMDevAvg>	Average deviation of the hop phase from the nominal (linear) hop phase as defined in the "Hop States" table. The deviation is calculated within the frequency measurement range of the hop. For details see "Phase Deviation (Average)" on page 51. Default unit: kHz
<PowMin>	Minimum power level measured during a hop. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration. Default unit: dBm
<PowMax>	Maximum power level measured during a hop. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration. Default unit: dBm
<PowAvg>	Average power level measured during a hop. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration. Default unit: dBm
<PowRip>	Power level measured during the hop ripple time. Which part of the hop precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration. Default unit: dBm
Example:	`CALC3:HOPD:TABLe? 1, 10` Result:
Example:	See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.
Usage:	Query only

Manual operation: See "State Index" on page 47
See "Hop Begin" on page 47
See "Dwell Time" on page 48
See "Switching Time" on page 48
See "State Frequency (Nominal)" on page 48
See "Average Frequency" on page 48
See "Hop State Deviation" on page 48
See "Relative Frequency (Hop-to-Hop)" on page 49
See "Frequency Deviation (Peak)" on page 49
See "Frequency Deviation (RMS)" on page 49
See "Frequency Deviation (Average)" on page 50
See "Phase Deviation (Peak)" on page 50
See "Phase Deviation (RMS)" on page 51
See "Phase Deviation (Average)" on page 51
See "Minimum Power" on page 51
See "Maximum Power" on page 52
See "Average Power" on page 52
See "Power Ripple" on page 52
See "Minimum Power" on page 58
See "Maximum Power" on page 58
See "Power Ripple" on page 58

CALCulate<n>:HOPDetection:TOTal?

This command returns the total number of hops found.

Suffix:
<n> irrelevant

Return values:
<TotalHops>

Usage: Query only

[SENSe:]HOP:FREQuency:AVGFm? <QueryRange>

Returns the average Frequency Deviation from the Results table for the specified hop(s).

Query parameters:
<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Frequency Deviation (Average)" on page 50

[SENSe:]HOP:FREQuency:AVGFm:AVERage? <QueryRange>
[SENSe:]HOP:FREQuency:AVGFm:MAXimum? <QueryRange>
[SENSe:]HOP:FREQuency:AVGFm:MINimum? <QueryRange>
[SENSe:]HOP:FREQuency:AVGFm:SDEViation? <QueryRange>

Returns the statistical value for the average Frequency Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:FREQuency:FMERror? <QueryRange>

Returns the frequency deviation from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Hop State Deviation" on page 48

[SENSe:]HOP:FREQuency:FMERror:AVERage? <QueryRange>
[SENSe:]HOP:FREQuency:FMERror:MAXimum? <QueryRange>
[SENSe:]HOP:FREQuency:FMERror:MINimum? <QueryRange>
[SENSe:]HOP:FREQuency:FMERror:SDEViation? <QueryRange>

Returns the statistical value for the frequency deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:FREQuency:FREQuency? <QueryRange>

Returns the average frequency from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Average Frequency" on page 48

[SENSe:]HOP:FREQuency:FREQuency:AVERage? <QueryRange>
[SENSe:]HOP:FREQuency:FREQuency:MAXimum? <QueryRange>
[SENSe:]HOP:FREQuency:FREQuency:MINimum? <QueryRange>
[SENSe:]HOP:FREQuency:FREQuency:SDEViation? <QueryRange>

Returns the statistical value for the average frequency from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:FREQuency:MAXFm? <QueryRange>

Returns the maximum Frequency Deviation from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Frequency Deviation (Peak)" on page 49

[SENSe:]HOP:FREQuency:MAXFm:AVERage? <QueryRange>
[SENSe:]HOP:FREQuency:MAXFm:MAXimum? <QueryRange>
[SENSe:]HOP:FREQuency:MAXFm:MINimum? <QueryRange>
[SENSe:]HOP:FREQuency:MAXFm:SDEViation? <QueryRange>

Returns the statistical value for the maximum Frequency Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:FREQuency:RELFrequency? <QueryRange>

Returns the relative hop-to-hop frequency from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Relative Frequency (Hop-to-Hop)" on page 49

[SENSe:]HOP:FREQuency:RELFrequency:AVERage? <QueryRange>
[SENSe:]HOP:FREQuency:RELFrequency:MAXimum? <QueryRange>
[SENSe:]HOP:FREQuency:RELFrequency:MINimum? <QueryRange>
[SENSe:]HOP:FREQuency:RELFrequency:SDEViation? <QueryRange>

Returns the statistical value for the relative hop-to-hop frequency from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:FREQuency:RMSFm? <QueryRange>

Returns the RMS Frequency Deviation from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Frequency Deviation (RMS)" on page 49

[SENSe:]HOP:FREQuency:RMSFm:AVERage? <QueryRange>
[SENSe:]HOP:FREQuency:RMSFm:MAXimum? <QueryRange>
[SENSe:]HOP:FREQuency:RMSFm:MINimum? <QueryRange>
[SENSe:]HOP:FREQuency:RMSFm:SDEViation? <QueryRange>

Returns the statistical value for the RMS Frequency Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:ID? <QueryRange>

Returns the hop IDs from the Results table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:PHASe:AVGPm? <QueryRange>

This command queries the Average Phase Deviation from the Result Table

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Phase Deviation (Average)" on page 51

[SENSe:]HOP:PHASe:AVGPm:AVERage? <QueryRange>
[SENSe:]HOP:PHASe:AVGPm:MAXimum? <QueryRange>
[SENSe:]HOP:PHASe:AVGPm:MINimum? <QueryRange>
[SENSe:]HOP:PHASe:AVGPm:SDEViation? <QueryRange>

Returns the statistical value for the Average Phase Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:PHASe:MAXPm? <QueryRange>

This command queries Maximum Phase Deviation from the Result Table

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Phase Deviation (Peak)" on page 50

[SENSe:]HOP:PHASe:MAXPm:AVERage? <QueryRange>
[SENSe:]HOP:PHASe:MAXPm:MAXimum? <QueryRange>

[SENSe:]HOP:PHASe:MAXPm:MINimum? <QueryRange>
[SENSe:]HOP:PHASe:MAXPm:SDEViation? <QueryRange>

Returns the statistical value for the Maximum Phase Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:PHASe:RMSPm? <QueryRange>

This command queries the RMS Phase Deviation from the Result Table

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Phase Deviation (RMS)" on page 51

[SENSe:]HOP:PHASe:RMSPm:AVERage? <QueryRange>
[SENSe:]HOP:PHASe:RMSPm:MAXimum? <QueryRange>
[SENSe:]HOP:PHASe:RMSPm:MINimum? <QueryRange>
[SENSe:]HOP:PHASe:RMSPm:SDEViation? <QueryRange>

Returns the statistical value for the RMS Phase Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:NUMBer? <QueryRange>

Returns the hop numbers from the Results table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:POWer:AVEPower? <QueryRange>

Returns the average power from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Average Power" on page 52

[SENSe:]HOP:POWer:AVEPower:AVERage? <QueryRange>
[SENSe:]HOP:POWer:AVEPower:MAXimum? <QueryRange>
[SENSe:]HOP:POWer:AVEPower:MINimum? <QueryRange>
[SENSe:]HOP:POWer:AVEPower:SDEViation? <QueryRange>

Returns the statistical value for the average power from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:POWer:MAXPower? <QueryRange>

Returns the maximum hop power from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Maximum Power" on page 52

[SENSe:]HOP:POWer:MAXPower:AVERage? <QueryRange>
[SENSe:]HOP:POWer:MAXPower:MAXimum? <QueryRange>
[SENSe:]HOP:POWer:MAXPower:MINimum? <QueryRange>
[SENSe:]HOP:POWer:MAXPower:SDEViation? <QueryRange>

Returns the statistical value for the maximum power from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:POWer:MINPower? <QueryRange>

Returns the minimum hop power from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Minimum Power" on page 51
See "Power Ripple" on page 52

[SENSe:]HOP:POWer:MINPower:AVERage? <QueryRange>
[SENSe:]HOP:POWer:MINPower:MAXimum? <QueryRange>

[SENSe:]HOP:POWer:MINPower:MINimum? <QueryRange>
[SENSe:]HOP:POWer:MINPower:SDEViation? <QueryRange>

Returns the statistical value for the minimum power from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:POWer:PWRRipple? <QueryRange>

Returns the ripple power from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:POWer:PWRRipple:AVERage? <QueryRange>
[SENSe:]HOP:POWer:PWRRipple:MAXimum? <QueryRange>
[SENSe:]HOP:POWer:PWRRipple:MINimum? <QueryRange>
[SENSe:]HOP:POWer:PWRRipple:SDEViation? <QueryRange>

Returns the statistical value for the ripple power from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:STATe[:INDex]? <QueryRange>

Returns the hop states from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "State Index" on page 47

[SENSe:]HOP:STATe[:INDex]:AVERage? <QueryRange>
[SENSe:]HOP:STATe[:INDex]:MAXimum? <QueryRange>
[SENSe:]HOP:STATe[:INDex]:MINimum? <QueryRange>
[SENSe:]HOP:STATe[:INDex]:SDEViation? <QueryRange>

Returns the statistical value for the hop states from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:STATe:STAFrequency? <QueryRange>

Returns the nominal hop state frequency from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "State Frequency (Nominal)" on page 48

[SENSe:]HOP:STATe:STAFrequency:AVERage? <QueryRange>
[SENSe:]HOP:STATe:STAFrequency:MAXimum? <QueryRange>

[SENSe:]HOP:STATe:STAFrequency:MINimum? <QueryRange>
[SENSe:]HOP:STATe:STAFrequency:SDEViation? <QueryRange>

Returns the statistical value for the nominal hop state frequency from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:TIMing:BEGin? <QueryRange>

Returns the begin times from the Results table for the specified hop(s).

The begin time is the relative time (in ms) from the capture start at which the signal first enters the tolerance area of a nominal hop (within the analysis region).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Hop Begin" on page 47

[SENSe:]HOP:TIMing:BEGin:AVERage? <QueryRange>
[SENSe:]HOP:TIMing:BEGin:MAXimum? <QueryRange>
[SENSe:]HOP:TIMing:BEGin:MINimum? <QueryRange>
[SENSe:]HOP:TIMing:BEGin:SDEViation? <QueryRange>

Returns the statistical value for the begin time from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:TIMing:DWELl? <QueryRange>

Returns the dwell time from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Dwell Time" on page 48

[SENSe:]HOP:TIMing:DWELl:AVERage? <QueryRange>
[SENSe:]HOP:TIMing:DWELl:MAXimum? <QueryRange>
[SENSe:]HOP:TIMing:DWELl:MINimum? <QueryRange>
[SENSe:]HOP:TIMing:DWELl:SDEViation? <QueryRange>

Returns the statistical value for the hop dwell time from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]HOP:TIMing:SWITching? <QueryRange>

Returns the switching time from the Results table for the specified hop(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected hop

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

Manual operation: See "Switching Time" on page 48

[SENSe:]HOP:TIMing:SWITching:AVERage? <QueryRange>
[SENSe:]HOP:TIMing:SWITching:MAXimum? <QueryRange>
[SENSe:]HOP:TIMing:SWITching:MINimum? <QueryRange>
[SENSe:]HOP:TIMing:SWITching:SDEViation? <QueryRange>

Returns the statistical value for the hop switching time from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

11.9.2 Retrieving Information on Detected Chirps

The following commands return information on the currently selected or all detected chirps.

CALCulate<n>:CHRDetection:TABLe:RESults? [<Start>, <End>]

This command queries the chirp results table. The result is a comma-separated list of value sets, one set for each chirp.

If no query parameters are specified, the results for all detected chirps are returned.

Which values are returned depends on the enabled parameters for the results tables (see `CALCulate<n>:CHRDetection:TABLe:COLumn` on page 262).

Suffix:

<n>	irrelevant

Query parameters:

<Start>	integer The chirp number of the first chirp to be returned. Chirp numbers start at 1.
<End>	integer The chirp number of the last chirp to be returned.

Return values:

<ID>	Timestamp which corresponds to the absolute time the beginning of the chirp was detected
<ChirpNo>	Consecutive number of detected chirp, starts at 1 for each new measurement
<StateIndex>	Consecutive number of corresponding nominal chirp state as defined in the "Chirp States" table (see `CALCulate<n>:CHRDetection:STATes[:DATA]` on page 226)
<Begin>	Time offset from the analyis region start at which the signal first enters the tolerance area of a nominal chirp Default unit: ms
<Length>	The duration of a chirp from begin to end, that is, the time the signal remains in the tolerance area of a nominal chirp. Default unit: ms
<CRate>	Derivative of the FM vs time trace within the frequency measurement range Default unit: kHz/µs

<CRateDev>	Deviation of the detected chirp rate from the nominal chirp state (in kHz/us). For details see "Chirp State Deviation" on page 55. Default unit: kHz/μs
<FreqAvg>	Average frequency measured within the frequency measurement range of the chirp Default unit: kHz
<FMDevMax>	Maximum deviation of the chirp frequency from the nominal chirp frequency as defined in the "Chirp States" table. The deviation is calculated within the frequency measurement range of the chirp. For details see "Frequency Deviation (Peak)" on page 55. Default unit: kHz
<FMDevRMS>	RMS deviation of the chirp frequency from the nominal (linear) chirp frequency as defined in the "Chirp States" table. The deviation is calculated within the frequency measurement range of the chirp. For details see "Frequency Deviation (RMS)" on page 56. Default unit: kHz
<FMDevAvg>	Average deviation of the chirp frequency from the nominal (linear) chirp frequency as defined in the "Chirp States" table. The deviation is calculated within the frequency measurement range of the chirp. For details see "Frequency Deviation (Average)" on page 56. Default unit: kHz
<PMDevMax>	Maximum deviation of the chirp phase from the nominal chirp phase as defined in the "Chirp States" table. The deviation is calculated within the frequency measurement range of the chirp. For details see "Phase Deviation (Peak)" on page 57. Default unit: kHz
<PMDevRMS>	RMS deviation of the chirp phase from the nominal (linear) chirp phase as defined in the "Chirp States" table. The deviation is calculated within the frequency measurement range of the chirp. For details see "Phase Deviation (RMS)" on page 57. Default unit: kHz
<PMDevAvg>	Average deviation of the chirp phase from the nominal (linear) chirp phase as defined in the "Chirp States" table. The deviation is calculated within the frequency measurement range of the chirp. For details see "Phase Deviation (Average)" on page 57. Default unit: kHz

<PowMin> Minimum power level measured during a chirp. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration.

Default unit: dBm

<PowMax> Maximum power level measured during a chirp. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration.

Default unit: dBm

<PowAvg> Average power level measured during a chirp. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration.

Default unit: dBm

<PowRip> Power level measured during the chirp ripple time. Which part of the chirp precisely is used for calculation depends on the power parameters in the "Power" measurement range configuration.

Default unit: dBm

Example: `CALC3:CHRD:TABLe? 1, 10`
Result:

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Usage: Query only

Manual operation:
See "State Index" on page 54
See "Chirp Begin" on page 54
See "Chirp Length" on page 54
See "Chirp Rate" on page 54
See "Chirp State Deviation" on page 55
See "Average Frequency" on page 55
See "Frequency Deviation (Peak)" on page 55
See "Frequency Deviation (RMS)" on page 56
See "Frequency Deviation (Average)" on page 56
See "Phase Deviation (Peak)" on page 57
See "Phase Deviation (RMS)" on page 57
See "Phase Deviation (Average)" on page 57
See "Average Power" on page 58

CALCulate<n>:CHRDetection:TOTal?

This command returns the total number of chirps found.

Suffix:
<n> irrelevant

Return values:
<TotalChirps>

Usage: Query only

[SENSe:]CHIRp:FREQuency:AVGFm? <QueryRange>

Returns the average Frequency Deviation from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Frequency Deviation (Average)" on page 56

[SENSe:]CHIRp:FREQuency:AVGFm:AVERage? <QueryRange>
[SENSe:]CHIRp:FREQuency:AVGFm:MAXimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:AVGFm:MINimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:AVGFm:SDEViation? <QueryRange>

Returns the statistical value for the average Frequency Deviation from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:FREQuency:CHERror? <QueryRange>

Returns the chirp rate deviation from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Chirp State Deviation" on page 55

[SENSe:]CHIRp:FREQuency:CHERror:AVERage? <QueryRange>
[SENSe:]CHIRp:FREQuency:CHERror:MAXimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:CHERror:MINimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:CHERror:SDEViation? <QueryRange>

Returns the statistical value for the chirp rate deviation from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:FREQuency:FREQuency? <QueryRange>

Returns theaverage frequency from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Average Frequency" on page 55

[SENSe:]CHIRp:FREQuency:FREQuency:AVERage? <QueryRange>
[SENSe:]CHIRp:FREQuency:FREQuency:MAXimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:FREQuency:MINimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:FREQuency:SDEViation? <QueryRange>

Returns the statistical value for the average frequency from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:FREQuency:MAXFm? <QueryRange>

Returns the maximum Frequency Deviation from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Frequency Deviation (Peak)" on page 55

[SENSe:]CHIRp:FREQuency:MAXFm:AVERage? <QueryRange>
[SENSe:]CHIRp:FREQuency:MAXFm:MAXimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:MAXFm:MINimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:MAXFm:SDEViation? <QueryRange>

Returns the statistical value for the maximum Frequency Deviation from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:FREQuency:RMSFm? <QueryRange>

Returns the RMS Frequency Deviation from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Frequency Deviation (RMS)" on page 56

[SENSe:]CHIRp:FREQuency:RMSFm:AVERage? <QueryRange>
[SENSe:]CHIRp:FREQuency:RMSFm:MAXimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:RMSFm:MINimum? <QueryRange>
[SENSe:]CHIRp:FREQuency:RMSFm:SDEViation? <QueryRange>

Returns the statistical value for the RMS Frequency Deviation from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:ID? <QueryRange>

Returns the chirp IDs from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:NUMBer? <QueryRange>

Returns the chirp numbers from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:PHASe:AVGPm? <QueryRange>

This command queries the Average Phase Deviation from the Result Table

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Phase Deviation (Average)" on page 57

[SENSe:]CHIRp:PHASe:AVGPm:AVERage? <QueryRange>
[SENSe:]CHIRp:PHASe:AVGPm:MAXimum? <QueryRange>
[SENSe:]CHIRp:PHASe:AVGPm:MINimum? <QueryRange>
[SENSe:]CHIRp:PHASe:AVGPm:SDEViation? <QueryRange>

Returns the statistical value for the Average Phase Deviation from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:PHASe:MAXPm? <QueryRange>

This command queries Maximum Phase Deviation from the Result Table

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Phase Deviation (Peak)" on page 57

[SENSe:]CHIRp:PHASe:MAXPm:AVERage? <QueryRange>
[SENSe:]CHIRp:PHASe:MAXPm:MAXimum? <QueryRange>

[SENSe:]CHIRp:PHASe:MAXPm:MINimum? <QueryRange>
[SENSe:]CHIRp:PHASe:MAXPm:SDEViation? <QueryRange>

Returns the statistical value for the Maximum Phase Deviation from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:PHASe:RMSPm? <QueryRange>

This command queries the RMS Phase Deviation from the Result Table

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Phase Deviation (RMS)" on page 57

[SENSe:]CHIRp:PHASe:RMSPm:AVERage? <QueryRange>
[SENSe:]CHIRp:PHASe:RMSPm:MAXimum? <QueryRange>
[SENSe:]CHIRp:PHASe:RMSPm:MINimum? <QueryRange>
[SENSe:]CHIRp:PHASe:RMSPm:SDEViation? <QueryRange>

Returns the statistical value for the RMS Phase Deviation from the statistics table for the specified hop(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected hops in the current capture buffer

ALL
All hops detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:POWer:AVEPower? <QueryRange>

Returns the average power from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Average Power" on page 58

[SENSe:]CHIRp:POWer:AVEPower:AVERage? <QueryRange>
[SENSe:]CHIRp:POWer:AVEPower:MAXimum? <QueryRange>
[SENSe:]CHIRp:POWer:AVEPower:MINimum? <QueryRange>
[SENSe:]CHIRp:POWer:AVEPower:SDEViation? <QueryRange>

Returns the statistical value for the average power from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:POWer:MAXPower? <QueryRange>

Returns the Chirp Maximum Power from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Maximum Power" on page 58

[SENSe:]CHIRp:POWer:MAXPower:AVERage? <QueryRange>
[SENSe:]CHIRp:POWer:MAXPower:MAXimum? <QueryRange>
[SENSe:]CHIRp:POWer:MAXPower:MINimum? <QueryRange>
[SENSe:]CHIRp:POWer:MAXPower:SDEViation? <QueryRange>

Returns the statistical value for the Chrip Maximum Power from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:POWer:MINPower? <QueryRange>

Returns the Chirp Minimum Power from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Minimum Power" on page 58

[SENSe:]CHIRp:POWer:MINPower:AVERage? <QueryRange>
[SENSe:]CHIRp:POWer:MINPower:MAXimum? <QueryRange>
[SENSe:]CHIRp:POWer:MINPower:MINimum? <QueryRange>
[SENSe:]CHIRp:POWer:MINPower:SDEViation? <QueryRange>

Returns the statistical value for the Chirp Minimum Power from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:POWer:PWRRipple? <QueryRange>

Returns the Chirp Power Ripple from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Power Ripple" on page 58

[SENSe:]CHIRp:POWer:PWRRipple:AVERage? <QueryRange>
[SENSe:]CHIRp:POWer:PWRRipple:MAXimum? <QueryRange>
[SENSe:]CHIRp:POWer:PWRRipple:MINimum? <QueryRange>
[SENSe:]CHIRp:POWer:PWRRipple:SDEViation? <QueryRange>

Returns the statistical value for the Chirp Power Ripple from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:STATe? <QueryRange>

Returns the chirp states from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "State Index" on page 54

[SENSe:]CHIRp:STATe:AVERage? <QueryRange>
[SENSe:]CHIRp:STATe:MAXimum? <QueryRange>
[SENSe:]CHIRp:STATe:MINimum? <QueryRange>
[SENSe:]CHIRp:STATe:SDEViation? <QueryRange>

Returns the statistical value for the chirp states from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:TIMing:BEGin? <QueryRange>

Returns the chirp begin time from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Chirp Begin" on page 54

[SENSe:]CHIRp:TIMing:BEGin:AVERage? <QueryRange>
[SENSe:]CHIRp:TIMing:BEGin:MAXimum? <QueryRange>
[SENSe:]CHIRp:TIMing:BEGin:MINimum? <QueryRange>
[SENSe:]CHIRp:TIMing:BEGin:SDEViation? <QueryRange>

Returns the statistical value for the chirp begin from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:TIMing:LENGth? <QueryRange>

Returns the chirp length from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Chirp Length" on page 54

[SENSe:]CHIRp:TIMing:LENGth:AVERage? <QueryRange>
[SENSe:]CHIRp:TIMing:LENGth:MAXimum? <QueryRange>
[SENSe:]CHIRp:TIMing:LENGth:MINimum? <QueryRange>
[SENSe:]CHIRp:TIMing:LENGth:SDEViation? <QueryRange>

Returns the statistical value for the chirp begin from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

[SENSe:]CHIRp:TIMing:RATE? <QueryRange>

Returns the chirp rate from the Results table for the specified chirp(s).

Query parameters:

<QueryRange> SELected | CURRent | ALL

SELected
Selected chirp

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

Manual operation: See "Chirp Rate" on page 54

[SENSe:]CHIRp:TIMing:RATE:AVERage? <QueryRange>
[SENSe:]CHIRp:TIMing:RATE:MAXimum? <QueryRange>
[SENSe:]CHIRp:TIMing:RATE:MINimum? <QueryRange>
[SENSe:]CHIRp:TIMing:RATE:SDEViation? <QueryRange>

Returns the statistical value for the chirp rate from the statistics table for the specified chirp(s).

Query parameters:

<QueryRange> CURRent | ALL

CURRent
Detected chirps in the current capture buffer

ALL
All chirps detected in the entire measurement

Usage: Query only

11.9.3 Retrieving Trace Data

In order to retrieve the trace results in a remote environment, use the following command:

Useful commands for retrieving trace results described elsewhere:

- `CALCulate<n>:DISTribution:X?` on page 281
- `CALCulate<n>:DISTribution:Y?` on page 282

Remote commands exclusive to

CALCulate<n>:SGRam|SPECtrogram:FRAMe:COUNt?

This command queries the number of frames that are contained in the selected result display (depends on the evaluation basis).

Suffix:

<n> Window

Return values:

<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth
Increment: 1

Example: `INIT:CONT OFF`
Selects single sweep mode.
`LAY:REPL 2,SGR`
Replaces the result display in window 2 by a spectrogram.
`DISP:WIND2:EVAL REG`
Defines the analysis region as the evaluation basis for the spectrogram in window 2.
`CALC:SGR:FRAM:COUN?`
Queries the number of frames in the spectrogram based on the analysis region.

Usage: Query only

DISPlay:[WINDow<n>:]TRACe<t>:LENGth?

Queries the trace length for the specified trace in the specified window.

Suffix:
<n> Window

<t> Trace

Return values:
<TraceLength> Number of measurement points for the trace.

Example: `DISP:WIND:TRAC:LENG?`

Usage: Query only

TRACe<n>[:DATA]? <Trace>

This command queries current trace data and measurement results.

Suffix:
<n> Window

Query parameters:
<Trace> TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6 | SGRam | SPECtrogram

Determines which trace results are returned.
If no trace parameter is provided with the query, trace 1 is assumed.

*RST: TRACe1

Example: `TRAC:DATA? TRACe2`

Example: See Chapter 11.11.2, "Programming Example: Performing a Chirp Detection Measurement", on page 383.

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Usage: Query only

TRACe<n>[:DATA]:X? <Trace>

This remote control command returns the X values only for the trace in the selected result display. Depending on the type of result display and the scaling of the x-axis, this can be either the pulse number or a timestamp for each detected pulse in the capture buffer.

This command is only available for graphical displays, except for the Magnitude Capture display.

Suffix:
<n> Window

Query parameters:
<Trace> TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6
The trace number whose values are to be returned.

Usage: Query only

11.9.4 Exporting Table Results to an ASCII File

Table results can be exported to an ASCII file for further evaluation in other (external) applications.

Useful commands for exporting table results described elsewhere:

- `FORMat:DEXPort:DSEParator` on page 377

Remote commands exclusive to exporting table results:

MMEMory:STORe<n>:TABLe <Columns>, <FileName>

This command exports result table data from the specified window to an ASCii file (`.DAT`).

For details on the file format see Chapter A.1, "Reference: ASCII File Export Format", on page 389.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Suffix:
<n> Window

Parameters:

<Columns> Columns to be stored in file

SELected
Export only the selected (visible) table columns

ALL
Export all table columns (all possible measured parameters)

*RST: SEL

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TABL SEL,'TEST.DAT'`
Stores the selected columns from the result table in window 1 in the file `TEST.DAT`.

Usage: SCPI confirmed

Manual operation: See "Columns to Export" on page 124
See "Export Table to ASCII File" on page 124

11.9.5 Exporting Trace Results

Trace results can be exported to a file.

For more commands concerning data and results storage see the R&S FSW User Manual.

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 operation: See "Decimal Separator" on page 124

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

Manual operation: See "Include Instrument Measurement Settings" on page 134

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see MMEMory:STORe<n>:TRACe on page 379).

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 operation: See "Export all Traces and all Table Results" on page 134

MMEMory:STORe<n>:SPECtrogram <FileName>

This command exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Suffix:
<n> Window

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SGR 'Spectrogram'`
Copies the spectrogram data to a file.

MMEMory:STORe<n>:TA:MEAS <File>

This command stores the current measurement results (all enabled traces of all windows) into the specified .csv file.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Suffix:
<n> irrelevant

Setting parameters:
<File> path and file name

Example: `MMEM:STOR:TA:MEAS 'C:\R_S\userdata\MyMeas.csv'`

Example: See Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

Usage: Setting only

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Suffix:

<n>	Window

Parameters:

<Trace>	Number of the trace to be stored
<FileName>	String containing the path and name of the target file.
Example:	`MMEM:STOR1:TRAC 3,'C:\TEST.ASC'` Stores trace 3 from window 1 in the file `TEST.ASC`.
Usage:	SCPI confirmed
Manual operation:	See "Export Trace to ASCII File" on page 135

11.9.6 Exporting I/Q Results to an iq-tar File

The I/Q data results can be exported to an iq-tar file. For details see Chapter 7.7, "Export Functions", on page 142.

MMEMory:STORe<n>:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

Suffix:

<n>	irrelevant

Parameters:

<Comment>	String containing the comment.

Example:	`MMEM:STOR:IQ:COMM 'Device test 1b'`
	Creates a description for the export file.
	`MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
	Stores I/Q data and the comment to the specified file.

MMEMory:STORe<n>:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSW User Manual.

Suffix:
<n> irrelevant

Parameters:
1

<FileName> String containing the path and name of the target file.

Example:
```
MMEM:STOR:IQ:STAT 1, 'C:
\R_S\Instr\user\data.iq.tar'
```
Stores the captured I/Q data to the specified file.

11.10 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, e.g. information on errors or limit violations which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

The R&S FSW Transient Analysis application uses only the registers provided by the base system.

For details on the common R&S FSW status registers refer to the description of remote control basics in the R&S FSW User Manual.

11.11 Programming Examples

The following examples demonstrate how to perform transient analysis in a remote environment.

Note that some of the used commands may not be necessary as they define default values, but are included to demonstrate their use.

11.11.1 Programming Example: Performing a Basic Transient Analysis Measurement

This example demonstrates how to perform a basic transient analysis measurement for an unknown signal in a remote environment.

```
//----------- Preparing the measurement ------------
//Reset the instrument
*RST
//Activate the transient analysis application
INST:SEL 'TA'

//-----------Configuring the measurement -----------
//Set the center frequency
FREQ:CENT 1GHz

// Configure a power trigger to detect transient power effects
TRIG:SEQ:SOUR IFP
TRIG:SEQ:LEV:IFP -50dBm

//Configure data acquisition for 5 ms in a 80 MHz bandwidth
BAND:DEM 80MHz
MTIM 5ms

//----------- Configuring the results -------------------------------
//Result displays (default):
//upper row: (1)RF Spectrum (2)FM Time Domain
//bottom row: (3)Spectrogram (4)RF Power Time Domain

//Configure RF Power Time Domain: automatic scaling
DISP:WIND4:TRAC:Y:SCAL:AUTO ON

//Configure Spectrogram: MAX detector, GAUSS window function; Query number of bins
SENS:WIND3:SGR:DET:FUNC MAX
SWE:FFT:WIND:TYPE GAUS
SWE:FFT:WIND:LENG?

//-----------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//-----------Retrieving Results-------------
//Retrieve trace data for RF Power Time Domain
TRAC1:DATA? TRACe1
TRAC1:DATA:X? TRACe1
```

11.11.2 Programming Example: Performing a Chirp Detection Measurement

This example demonstrates how to perform transient analysis on a chirped signal in a remote environment.

```
//----------- Preparing the measurement ------------
//Reset the instrument
*RST
//Activate the transient analysis application
INST:SEL 'TA'

//-----------Configuring the measurement -----------
//Set the center frequency
FREQ:CENT 1GHz

// Configure a power trigger to detect transient power effects
TRIG:SEQ:SOUR IFP
TRIG:SEQ:LEV:IFP -50dBm

//Configure data acquisition for 5 ms in a 80 MHz bandwidth
BAND:DEM 80MHz
MTIM 1ms
SRAT 100 MHz
RLEN 100000

//Configure the expected chirp signal manually
SIGN:MOD CHIR
CALC:CHRD:STAT:AUTO OFF
CALC:CHRD:STAT 400kHz, 4kHz
CALC:CHRD:LENG:AUTO OFF
CALC:CHRD:LENG:MIN 0.000003022
CALC:CHRD:LENG:MAX 0.001

//Configure the measurement range
//Frequency calc: cut off 5us at beginning and end of chirp
CALC:CHRD:FREQ:REF EDGE
CALC:CHRD:FREQ:OFFS:BEG 0.000005
CALC:CHRD:FREQ:OFFS:END 0.000005
//Power calc. : cut off 5% at each end of chirp
CALC:CHRD:POW:REF CENT
CALC:CHRD:POW:LENG 90

//Configure the analysis region: analyze 0.5 ms in 20MHz bandwidth in center
CALC:AR:FREQ:BAND 40MHz
CALC:AR:FREQ:DELT -20MHz
CALC:AR:TIME:LENG 500 us
CALC:AR:TIME:STAR 250 us

//Configure the result range manually: display 50us at beginning of each chirp,
```

```
//but cut off first 5us
CALC:RES:RANG:AUTO OFF
CALC:RES:REF RISE
CALC:RES:OFFS 0.000005
CALC:RES:ALIG LEFT
CALC:RES:LENG 0.00005

//----------- Configuring the results -------------------------------
//Result displays:
//upper row: (1)RF Spectrum (A.Region) (2)RF Spectrum (chirp1)
//middle row: (3) Spectrogram (full capture), default (4) RF Power Time Domain (full capture)
//bottom row: (5) Chirp Results table (default) (4) Chirp Statistics table
DISP:WIND1:EVAL REG
LAY:ADD:WIND? '1',RIGH,RFSP
DISP:WIND2:EVAL ##SIGN##
INIT:CONT OFF
INIT:IMM;*WAI
CALC:CHRD:SEL 1
LAY:REPL:WIND '4',RFPT
DISP:WIND4:EVAL FULL
LAY:ADD:WIND? '5',RIGH,STAB

//Configure RF Power Time Domain: automatic scaling
DISP:WIND4:TRAC:Y:SCAL:AUTO ON

//Configure range for (1)RF Spectrum (A. Region)
DISP:WIND1:TRAC:Y:SCAL:AUTO OFF
DISP:WIND1:TRAC:Y:SCAL:MAX -80 dBM
DISP:WIND1:TRAC:Y:SCAL:MIN -130 dBM

//Configure table results: show state,begin, length, frequency, max fm, average power
CALC:CHRD:TABL:COL ON, STAT, BEG, LENG, FREQ, MAXF, AVGP

//Configure Spectrogram. MAX detector, GAUSS window function; Query number of bins
SENS:WIND3:SGR:DET:FUNC MAX
SWE:FFT:WIND:TYPE GAUS
SWE:FFT:WIND:LENG?

//-----------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//-----------Retrieving Results-------------
//Retrieve trace data for RF Power Time Domain
TRAC1:DATA? TRACe1
TRAC1:DATA:X? TRACe1

//Retrieve trace length for single transient
```

```
DISP:WIND2:TRAC1:LENG?

//Retrieve table results for first 10 chirps
CALC5:CHRD:TABL:RES? 1,10
CALC5:CHRD:STAT:DATA?

//Export entire statistics result table (all params) to an ASCII file
MMEM:STOR6:TABL ALL,'C:\R_S\Instr\AllStatResults.dat'
```

11.11.3 Programming Example: Performing a Hop Detection Measurement

This example demonstrates how to perform transient analysis on a hopped signal in a remote environment.

```
//----------- Preparing the measurement ------------
//Reset the instrument
*RST
//Activate the transient analysis application
INST:SEL 'TA'

//-----------Configuring the measurement -----------
//Set the center frequency
FREQ:CENT 1GHz

// Configure a power trigger to detect transient power effects
TRIG:SEQ:SOUR IFP
TRIG:SEQ:LEV:IFP -50dBm

//Configure data acquisition for 1 ms in a 80 MHz bandwidth
BAND:DEM 80MHz
SRAT 100 MHz
MTIM 5ms
RLEN 500000


//Configure the expected hop signal manually
SIGN:MOD HOP
CALC:HOPD:STAT:AUTO OFF
CALC:HOPD:STAT -5e6, 5MHZ, 1e6, 5MHZ
CALC:HOPD:STAT:DATA? !-5e+006, 5e+006, 1e+006, 5e+006
CALC:HOPD:DWEL:AUTO OFF
CALC:HOPD:DWEL:MIN 0.0001
CALC:HOPD:DWEL:MAX 0.000350

//Configure the measurement range
//Frequency calc: cut off 5us at beginning and end of chirp
CALC:HOPD:FREQ:REF EDGE
CALC:HOPD:FREQ:OFFS:BEG 0.000005
CALC:HOPD:FREQ:OFFS:END 0.000005
```

```
//Power calc. : cut off 5% at each end of hop
CALC:HOPD:POW:REF CENT
CALC:HOPD:POW:LENG 90

//Configure the analysis region: analyze 1 ms in 20MHz bandwidth in center
CALC:AR:FREQ:BAND 40MHz
CALC:AR:FREQ:DELT -20MHz
CALC:AR:TIME:LENG 1ms
CALC:AR:TIME:STAR 2 ms

//Configure the result range manually: display 50us at beginning of each hop,
//but cut off first 5us
CALC:RES:RANG:AUTO OFF
CALC:RES:REF RISE
CALC:RES:OFFS 0.000005
CALC:RES:ALIG LEFT
CALC:RES:LENG 0.00005

//----------- Configuring the results -------------------------------
//Result displays:
//upper row: (1)RF Spectrum (full capture),default (2)RF Spectrum (hop1)
//middle row: (3) Spectrogram (full capture), default (4) RF Power Time Domain (A. Region)
//bottom row: (5) Hop Results table (default) (4) Hop Statistics table
DISP:WIND1:EVAL REG
LAY:ADD:WIND? '1',RIGH,RFSP
DISP:WIND2:EVAL ##SIGN##
INIT:CONT OFF
INIT:IMM;*WAI
CALC:HOPD:SEL 1
LAY:REPL:WIND '4',RFSP
DISP:WIND3:EVAL REG
LAY:ADD:WIND? '6',RIGH,STAB

//Configure RF Power Time Domain: automatic scaling
DISP:WIND4:TRAC:Y:SCAL:AUTO ON

//Configure range for (4)RF Spectrum (A. Region)
DISP:WIND4:TRAC:Y:SCAL:AUTO OFF
DISP:WIND4:TRAC:Y:SCAL:MAX -80 dBM
DISP:WIND4:TRAC:Y:SCAL:MIN -130 dBM

//Configure table results: show state,begin, length, frequency, max fm, average power
CALC:HOPD:TABL:COL ON, STAT, BEG, DWEL, FREQ, MAXF, AVGP

//Configure Spectrogram. MAX detector, largeR no. of bins, GAUSS window function; Query numbe
SENS:WIND3:SGR:DET:FUNC MAX
SWE:FFT:WIND:TYPE GAUS
SWE:FFT:WIND:LENG?

//-----------Performing the Measurement-----
```

```
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//-----------Retrieving Results-------------
//Retrieve trace data for RF Power Time Domain
TRAC1:DATA? TRACe1
TRAC1:DATA:X? TRACe1

//Retrieve trace length for single transient
DISP:WIND2:TRAC1:LENG?

//Retrieve table results for first 10 hops
CALC5:HOPD:TABL:RES? 1,10
CALC5:HOPD:STAT:DATA?

//Store all enabled traces in all windows to a CSV file
MMEM:STOR:TA:MEAS 'C:\R_S\Instr\MyMeas.csv'
```

11.11.4 Programming Example: Analyzing Parameter Distribution

This example demonstrates how to analyze parameter distribution for a hopped signal in a remote environment. It can be performed subsequently to the measurement described in Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

```
//------------- Adding a parameter distribution result -------------------------------
//Result displays:
//upper row: (1)RF Power Time Domain (full capture), (2) Average Frequency dist. (vs. count)
//middle row: (3)Spectrogram (full capture), default (4)RF Spectrum (A.Region)
//bottom row: (5)Hop Results table, default (6)Hop Statistics table
LAY:REPL:WIND '2',PDIS

//Configure parameter distribution: 20 bins
CALC2:DIST:NBIN 20
CALC2:DIST:HOP:FREQ FREQ,COUN

//-----------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------
//Retrieve results for parameter distribution
//CALC2:DIST:X?
//CALC2:DIST:Y?
```

11.11.5 Programming Example: Analyzing Parameter Trends

This example demonstrates how to analyze parameter trend for a hopped signal in a remote environment. It can be performed subsequently to the measurement described in Chapter 11.11.3, "Programming Example: Performing a Hop Detection Measurement", on page 385.

```
//------------- Adding parameter trend results ------------------------------
//Result displays:
//upper row: (1)RF Power Time Domain (full capture), (2) Avg. Power vs. Dwell Time Trend
//middle row: (3)Average Frequency vs Begin Trend (4)RF Spectrum (A.Region)
//bottom row: (5)Hop Results table, default (6)Hop Statistics table
LAY:REPL:WIND '2',PTR
CALC2:TREN:HOP:TIM:X DWEL
CALC2:TREN:HOP:POW:Y AVGP
LAY:REPL:WIND '3',PTR
CALC3:TREN:HOP:FREQ FREQ,BEG

//-----------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------
//Retrieve results for parameter trends
//CALC2:TREN:X?
//CALC2:TREN:Y?
//CALC3:TREN:X?
//CALC3:TREN:Y?
```

Annex

A Reference

A.1 Reference: ASCII File Export Format

Trace data can be exported to a file in ASCII format for further evaluation in other applications

The file consists of the header containing important scaling parameters and a data section containing the trace data.

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 124).

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 two lines containing the measured parameter names and units, followed by the measured data in multiple columns (depending on measurement) which are also separated by a semicolon.

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 A-1: ASCII file format for table export

File contents	Description
Header data	
Type;R&S FSW;	Instrument model
Version;5.00;	Firmware version
Date;01.Oct 2013;	Date of data set storage
Mode;Ta;	Application
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
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Meas BW;10000000,Hz	Measurement Bandwidth

File contents	Description
Meas Time;0.000350000;s	Measurment time
Sweep Count;20;	Number of sweeps set
Preamplifier;OFF	Preamplifier status
Number of Windows;6;	Number of result displays
Window section	
Window;1;Full RF Time Domain;	Window number and type
Trace section	
Trace 1;;	Trace number
Trace Mode;Clear Write;	Trace mode
x-Axis;Linear;	x-axis scaling mode
Start Freq;0;s	x-axis start value
Stop Freq;0.00035;s	x-axis stop value
x-Unit;s;	x-axis unit
y-Axis;Linear;	y-axis scaling mode
Level Range;0.0010;dBm	y-axis range per division
Ref Position;100.0000;%	y-axis reference position
Ref Value;-113.97900;dBm	y-axis reference value
y-Unit;dBm;	y-axis unit
Data section	
Values; 1001;	Number of rows of measured values in the table
0;-113.97937774658203125 0;-113.97937774658203125 ...;...	Measured values: <x-value>;<y-value>

A.2 I/Q Data File Format (iq-tar)

I/Q data is packed in a file with the extension `.iq.tar`. An iq-tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the iq-tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include user-specific data.

The iq-tar container packs several files into a single `.tar` archive file. Files in `.tar` format can be unpacked using standard archive tools (see http://en.wikipedia.org/wiki/Comparison_of_file_archivers) available for most operating systems. The advantage of `.tar` files is that the archived files inside the `.tar` file are not changed (not compressed) and thus it is possible to read the I/Q data directly within the archive without the need to unpack (untar) the `.tar` file first.

Contained files

An iq-tar file must contain the following files:

- **I/Q parameter XML file**, e.g. `xyz.xml`
  Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an iq-tar file.
- **I/Q data binary file**, e.g. `xyz.complex.float32`
  Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an iq-tar file.

Optionally, an iq-tar file can contain the following file:

- **I/Q preview XSLT file**, e.g. `open_IqTar_xml_file_in_web_browser.xslt`
  Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.
  A sample stylesheet is available at http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt.

A.2.1 I/Q Parameter XML File Specification

The content of the I/Q parameter XML file must comply with the XML schema `RsIqTar.xsd` available at: http://www.rohde-schwarz.com/file/RsIqTar.xsd.

In particular, the order of the XML elements must be respected, i.e. iq-tar uses an "ordered XML schema". For your own implementation of the iq-tar file format make sure to validate your XML file against the given schema.

The following example shows an I/Q parameter XML file. The XML elements and attributes are explained in the following sections.

Sample I/Q parameter XML file: xyz.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl"
href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1"
xsi:noNamespaceSchemaLocation="RsIqTar.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Name>R&S FSW</Name>
  <Comment>Here is a comment</Comment>
  <DateTime>2011-01-24T14:02:49</DateTime>
  <Samples>68751</Samples>
  <Clock unit="Hz">6.5e+006</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
  <ScalingFactor unit="V">1</ScalingFactor>
```

```
  <NumberOfChannels>1</NumberOfChannels>
<DataFilename>xyz.complex.float32</DataFilename>
<UserData>
  <UserDefinedElement>Example</UserDefinedElement>
</UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>
```

Element	Description
RS_IQ_TAR_File-Format	The root element of the XML file. It must contain the attribute `fileFormatVersion` that contains the number of the file format definition. Currently, `fileFormatVersion` "2" is used.
Name	Optional: describes the device or application that created the file.
Comment	Optional: contains text that further describes the contents of the file.
DateTime	Contains the date and time of the creation of the file. Its type is `xs:dateTime` (see `RsIqTar.xsd`).
Samples	Contains the number of samples of the I/Q data. For multi-channel signals all channels have the same number of samples. One sample can be: ● A complex number represented as a pair of I and Q values ● A complex number represented as a pair of magnitude and phase values ● A real number represented as a single real value See also `Format` element.
Clock	Contains the clock frequency in Hz, i.e. the sample rate of the I/Q data. A signal generator typically outputs the I/Q data at a rate that equals the clock frequency. If the I/Q data was captured with a signal analyzer, the signal analyzer used the clock frequency as the sample rate. The attribute `unit` must be set to "Hz".
Format	Specifies how the binary data is saved in the I/Q data binary file (see `DataFilename` element). Every sample must be in the same format. The format can be one of the following: ● `complex`: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless ● `real`: Real number (unitless) ● `polar`: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires `DataType` = `float32` or `float64`
DataType	Specifies the binary format used for samples in the I/Q data binary file (see `DataFilename` element and Chapter A.2.2, "I/Q Data Binary File", on page 394). The following data types are allowed: ● `int8`: 8 bit signed integer data ● `int16`: 16 bit signed integer data ● `int32`: 32 bit signed integer data ● `float32`: 32 bit floating point data (IEEE 754) ● `float64`: 64 bit floating point data (IEEE 754)
ScalingFactor	Optional: describes how the binary data can be transformed into values in the unit Volt. The binary I/Q data itself has no unit. To get an I/Q sample in the unit Volt the saved samples have to be multiplied by the value of the `ScalingFactor`. For polar data only the magnitude value has to be multiplied. For multi-channel signals the `ScalingFactor` must be applied to all channels. The attribute `unit` must be set to "`V`". The `ScalingFactor` must be > 0. If the `ScalingFactor` element is not defined, a value of 1 V is assumed.

Element	Description
NumberOfChan-nels	Optional: specifies the number of channels, e.g. of a MIMO signal, contained in the I/Q data binary file. For multi-channels, the I/Q samples of the channels are expected to be interleaved within the I/Q data file (see Chapter A.2.2, "I/Q Data Binary File", on page 394). If the `NumberOfChannels` element is not defined, one channel is assumed.
DataFilename	Contains the filename of the I/Q data binary file that is part of the iq-tar file. It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> ● <xyz> = a valid Windows file name ● <Format> = complex, polar or real (see `Format` element) ● <Channels> = Number of channels (see `NumberOfChannels` element) ● <Type> = float32, float64, int8, int16, int32 or int64 (see `DataType` element) Examples: ● xyz.complex.1ch.float32 ● xyz.polar.1ch.float64 ● xyz.real.1ch.int16 ● xyz.complex.16ch.int8
UserData	Optional: contains user, application or device-specific XML data which is not part of the iq-tar specification. This element can be used to store additional information, e.g. the hardware configuration. User data must be valid XML content.
PreviewData	Optional: contains further XML elements that provide a preview of the I/Q data. The preview data is determined by the routine that saves an iq-tar file (e.g. R&S FSW). For the definition of this element refer to the `RsIqTar.xsd` schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet `open_IqTar_xml_file_in_web_browser.xslt` is available.

Example: ScalingFactor

Data stored as `int16` and a desired full scale voltage of 1 V

`ScalingFactor` = 1 V / maximum int16 value = 1 V / 2^{15} = 3.0517578125e-5 V

Scaling Factor	Numerical value	Numerical value x ScalingFac-tor
Minimum (negative) int16 value	- 2^{15} = - 32768	-1 V
Maximum (positive) int16 value	2^{15}-1= 32767	0.999969482421875 V

Example: PreviewData in XML

```
<PreviewData>
    <ArrayOfChannel length="1">
      <Channel>
        <PowerVsTime>
          <Min>
            <ArrayOfFloat length="256">
              <float>-134</float>
              <float>-142</float>
              ...
              <float>-140</float>
            </ArrayOfFloat>
          </Min>
```

```
          <Max>
            <ArrayOfFloat length="256">
              <float>-70</float>
              <float>-71</float>
              ...
              <float>-69</float>
            </ArrayOfFloat>
          </Max>
        </PowerVsTime>
        <Spectrum>
          <Min>
            <ArrayOfFloat length="256">
              <float>-133</float>
              <float>-111</float>
              ...
              <float>-111</float>
            </ArrayOfFloat>
          </Min>
          <Max>
            <ArrayOfFloat length="256">
              <float>-67</float>
              <float>-69</float>
              ...
              <float>-70</float>
              <float>-69</float>
            </ArrayOfFloat>
          </Max>
        </Spectrum>
        <IQ>
          <Histogram width="64" height="64">0123456789...0</Histogram>
        </IQ>
      </Channel>
    </ArrayOfChannel>
  </PreviewData>
```

A.2.2 I/Q Data Binary File

The I/Q data is saved in binary format according to the format and data type specified in the XML file (see `Format` element and `DataType` element). To allow reading and writing of streamed I/Q data, all data is interleaved, i.e. complex values are interleaved pairs of I and Q values and multi-channel signals contain interleaved (complex) samples for channel 0, channel 1, channel 2 etc. If the `NumberOfChannels` element is not defined, one channel is presumed.

Example: Element order for real data (1 channel)

```
I[0],                         // Real sample 0
I[1],                         // Real sample 1
```

```
I[2],                        // Real sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

```
I[0], Q[0],                  // Real and imaginary part of complex sample 0
I[1], Q[1],                  // Real and imaginary part of complex sample 1
I[2], Q[2],                  // Real and imaginary part of complex sample 2
...
```

Example: Element order for complex polar data (1 channel)

```
Mag[0], Phi[0],              // Magnitude and phase part of complex sample 0
Mag[1], Phi[1],              // Magnitude and phase part of complex sample 1
Mag[2], Phi[2],              // Magnitude and phase part of complex sample 2
...
```

Example: Element order for complex cartesian data (3 channels)

Complex data: I[channel no][time index], Q[channel no][time index]

```
I[0][0], Q[0][0],           // Channel 0, Complex sample 0
I[1][0], Q[1][0],           // Channel 1, Complex sample 0
I[2][0], Q[2][0],           // Channel 2, Complex sample 0

I[0][1], Q[0][1],           // Channel 0, Complex sample 1
I[1][1], Q[1][1],           // Channel 1, Complex sample 1
I[2][1], Q[2][1],           // Channel 2, Complex sample 1

I[0][2], Q[0][2],           // Channel 0, Complex sample 2
I[1][2], Q[1][2],           // Channel 1, Complex sample 2
I[2][2], Q[2][2],           // Channel 2, Complex sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

This example demonstrates how to store complex cartesian data in float32 format using MATLAB®.

```
% Save vector of complex cartesian I/Q data, i.e. iqiqiq...
N = 100
iq = randn(1,N)+1j*randn(1,N)
fid = fopen('xyz.complex.float32','w');
for k=1:length(iq)
  fwrite(fid,single(real(iq(k))),'float32');
  fwrite(fid,single(imag(iq(k))),'float32');
end
fclose(fid)
```

List of Remote Commands (Transient Analysis)

Index

Symbols