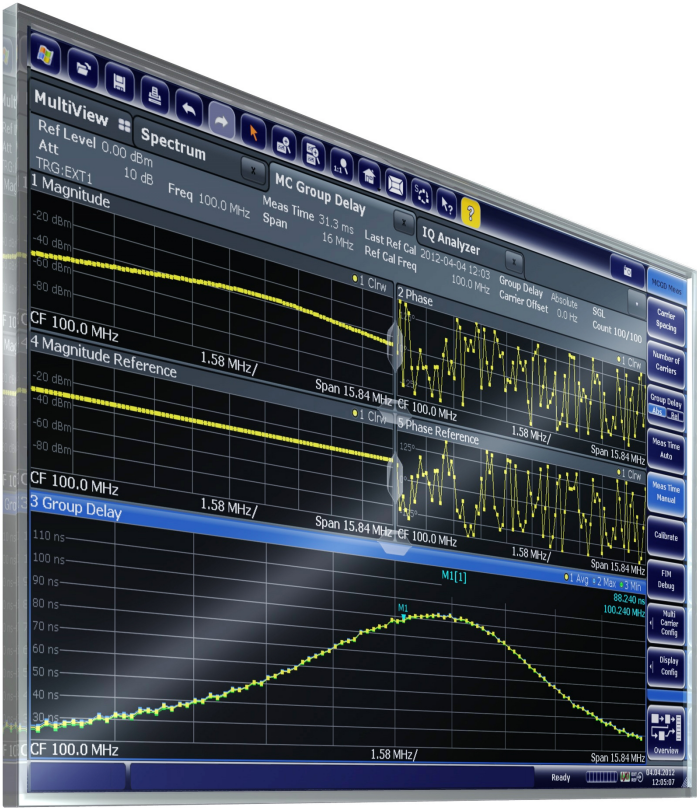


R&S®FSW-K17

Multi-Carrier Group Delay Measurement

User Manual



1173.9405.02 – 15

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-K17 (1313.4150.02)

The software contained in this product makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).

Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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Trade names are trademarks of the owners.

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

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1 Preface

1.1 About this Manual

This Multi-Carrier Group Delay 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 Multi-Carrier Group Delay Application**
Introduction to and getting familiar with the application
- **About the measurement**
General concept of the MCGD measurement and typical applications
- **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 Multi-Carrier Group Delay Application**
Step-by-step instructions to perform a basic MCGD measurement
- **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 Multi-Carrier Group Delay Measurements**
Remote commands required to configure and perform Multi-Carrier Group Delay measurements 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
- **Annex**
Reference material
- **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.
<i>Input</i>	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 Multi-Carrier Group Delay Application

The R&S FSW-K17 option is a firmware application that adds functionality to perform Multi-Carrier Group Delay measurements to the R&S FSW.

The Multi-Carrier Group Delay application features:

- Highly accurate group delay measurement for large spans
- Orthogonal measurement method
- Frequency converted group delay measurement
- Storage and loading functions for reference data
- Storage functions for measurement settings and results
- Graphical display of:
 - Group delay
 - Gain
 - Magnitude and phase at carrier frequency points in measurement or reference signal
 - Phase difference between measurement and reference signal
- Interactive or remote measurement control

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 Multi-Carrier Group Delay Application

The Multi-Carrier Group Delay application adds a new measurement to the R&S FSW.

To activate the Multi-Carrier Group Delay 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 "MC Group Delay" item.



The R&S FSW opens a new measurement channel for the Multi-Carrier Group Delay application.


The measurement is started immediately with the default settings. It can be configured in the Multi-Carrier Group Delay "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see [Chapter 6.1, "Configuration Overview"](#), on page 25).

Multiple Measurement Channels and Sequencer Function

When you activate an application, a new measurement channel is created which determines the measurement settings for that application. The same application can be activated with different measurement settings by creating several channels for the same application.

The number of channels that can be configured at the same time depends on the available memory on the instrument.

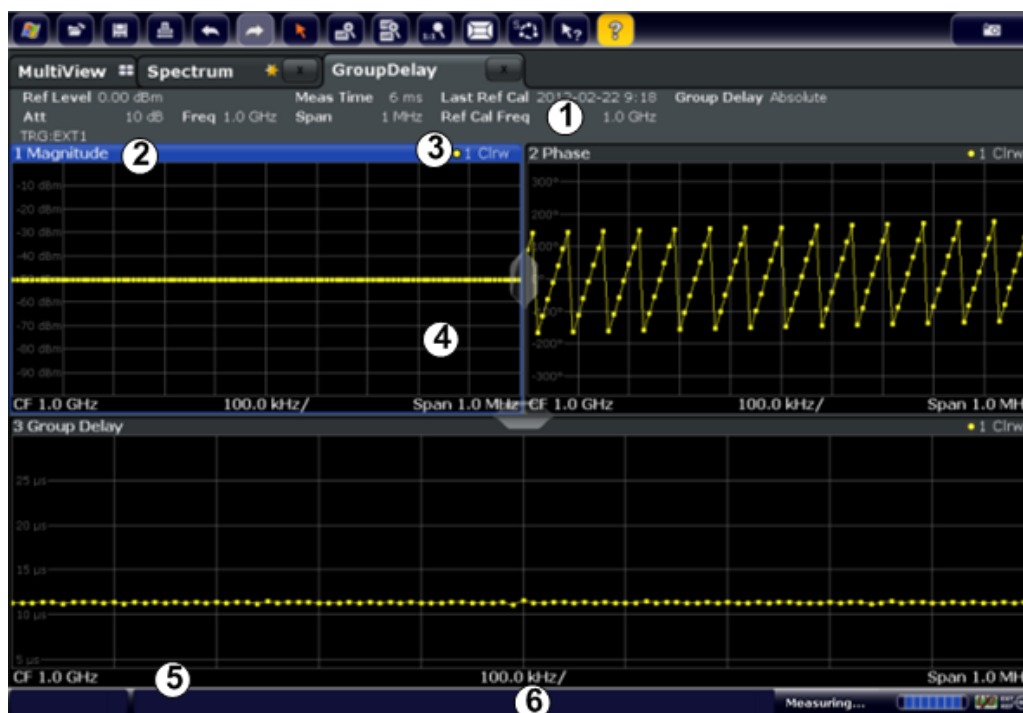
Only one measurement can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

If activated, the measurements configured in the currently active channels are performed one after the other in the order of the tabs. The currently active measurement is indicated by a  symbol in the tab label. The result displays of the individual channels are updated in the tabs (including the "MultiView") as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

For details on the Sequencer function see the R&S FSW User Manual.

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, depending on evaluation
- 6 = Instrument status bar with error messages, progress bar and date/time display

Channel bar information

In the Multi-Carrier Group Delay application, the R&S FSW shows the following settings:

Table 2-1: Information displayed in the channel bar in the Multi-Carrier Group Delay application

"Ref Level"	Reference level
"Att"	Mechanical and electronic RF attenuation
"Offset"	Reference level offset
"Freq"	Center frequency for the RF signal
"Meas Time"	Measurement time
"Span"	Measurement bandwidth
"Last Ref Cal"	Timestamp of most recently performed reference calibration (if it has already been performed)
"Ref Cal Freq"	Frequency used for reference calibration
"Group Delay"	Mode of group delay result display (absolute or relative)
"Carrier Offset"	Offset of the multi-carrier signal from the center frequency

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 Multi-Carrier Group Delay application

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

Diagram footer information

The diagram footer (beneath the diagram) contains the center frequency and span and the range displayed per division.

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 the Measurement

Frequency delay in transmitted signals

All frequency components of a signal are delayed when passed through a device such as an amplifier, a loudspeaker, or propagated through space or a medium, such as air. This signal delay will be different for the various frequencies unless the device has the property of being linear phase. The delay variation means that signals consisting of multiple frequency components will suffer distortion because these components are not delayed by the same amount of time at the output of the device. This changes the shape of the signal in addition to any constant delay, which can result in a signal that no longer matches the receiver filter, which in turn results in degraded Signal to Noise Ratio (SNR) or Bit Error Rate (BER).

Group delay as a characterization of transmission components

The delay of all frequencies together is referred to as the group delay and can be used to characterize the quality of transmission for such components. Group delay is also a measure of how long it takes for a signal's information to propagate through a channel or device under test.

Since digital modulation schemes in which the frequency plays an important role are very common, the group delay is of special interest to all manufacturers or testers of transmission components, as well as frequency converters. Satellite transponders, for example, need to be characterized by the phase transmission in addition to the amplitude transmission. Both values can be determined precisely and easily with the R&S FSW Multi-Carrier Group Delay application.

The Multi-Carrier Group Delay measurement method

The R&S FSW Multi-Carrier Group Delay application evaluates an input signal provided by a signal generator. After a preliminary reference measurement of this signal without the device under test, the same signal is evaluated with the device subsequently. Instead of evaluating the timing of the signals, the phase shift and magnitude response of multiple carriers across frequency is measured. A baseband signal consisting of several unmodulated carriers with a fixed step size is used as an input signal, allowing for a very quick wideband measurement. By measuring the phase differences between the two signals at the input and at the output, the application calculates the relative phase between output and input.

However, the phase of the carriers at the input to the DUT does not actually have to be measured. Instead, the results are normalized. That way, no reference path or connection is needed between the input and the output of the DUT. A reference mixer in the signal generator provides a phase reference at the IF frequency. Thus, a constant delay factor is eliminated and the group delay is calculated relative to the reference signal.

If an external trigger is used, the absolute group delay can also be calculated. Absolute group delay is of interest for instance to equalize the delay of two channels, characterize cables and design quadrature FM demodulators.

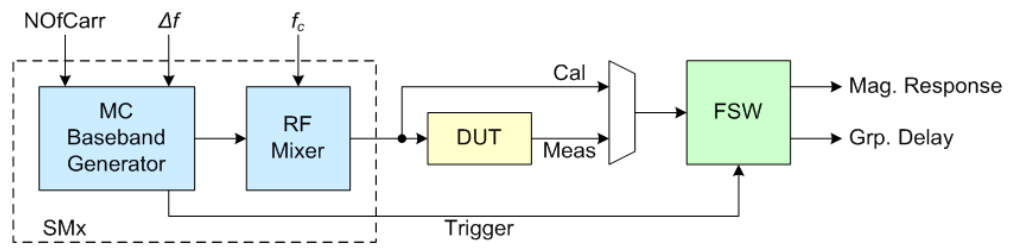


Figure 3-1: Multi-Carrier Group Delay Measurement Setup

4 Measurements and Result Display

The data that was measured by the R&S FSW can be evaluated using various different methods. In the Multi-Carrier Group Delay application, up to 6 evaluation methods can be displayed simultaneously in separate windows.

All results are determined from the I/Q data set captured for the measurement.

Storing Results

The results of the Multi-Carrier Group Delay measurement can be stored to a file, either in CSV or ASCII format. The results of the calibration (reference) measurement can also be stored in CSV format.

- [Evaluation Methods for Multi-Carrier Group Delay](#)..... 15

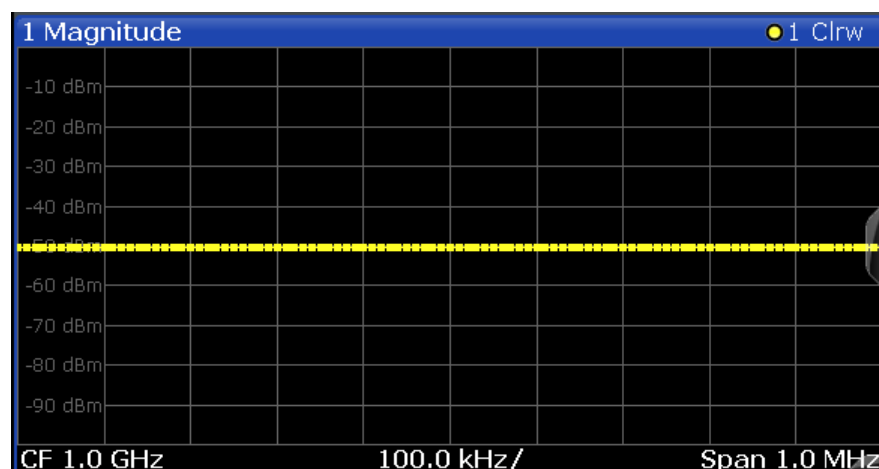
4.1 Evaluation Methods for Multi-Carrier Group Delay

The following evaluation methods can be selected for Multi-Carrier Group Delay measurements.

Magnitude	15
Magnitude Reference	16
Phase	16
Phase Difference	16
Phase Reference	17
Group Delay	17
Gain	18
Marker Table	18

Magnitude

Displays the spectrum of the input signal. In contrast to the Spectrum application, the frequency values are determined using an *Discrete frequency transformation* (DFT) from the recorded I/Q data set.



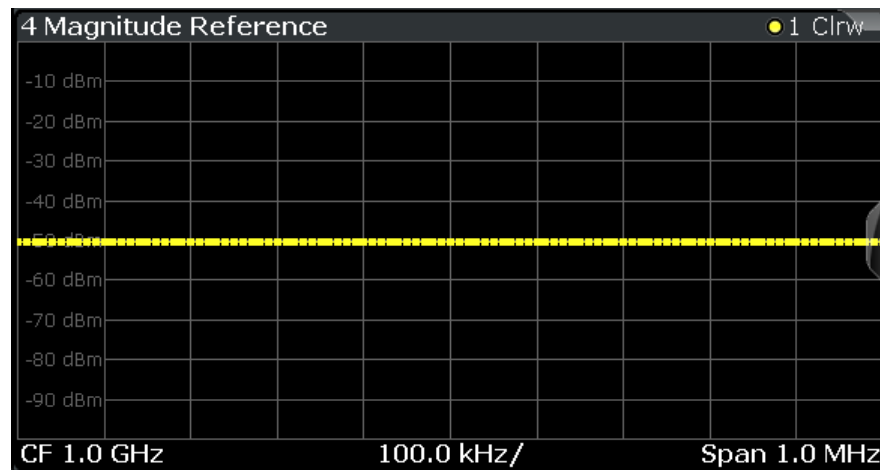
Remote command:

LAY:ADD? '1', RIGH, MAGN

(see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Magnitude Reference

Displays the spectrum of the reference signal. In contrast to the Spectrum application, the frequency values are determined using DFT from the recorded I/Q data set.



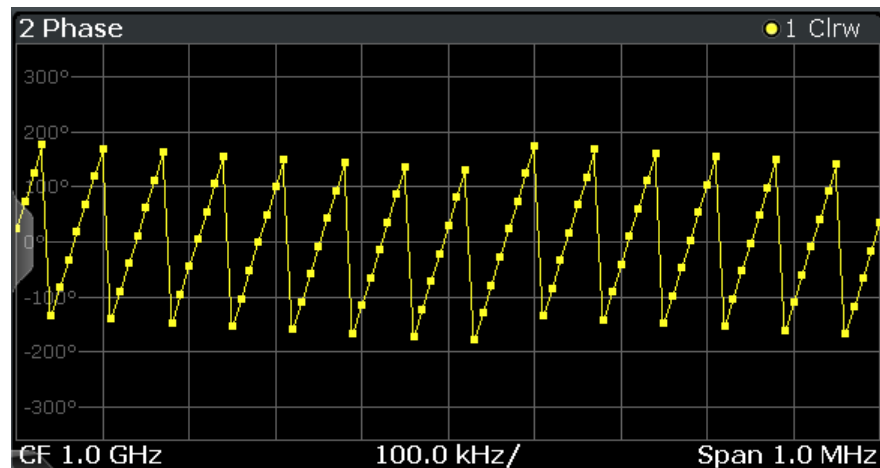
Remote command:

LAY:ADD? '1', RIGH, RMAG

(see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Phase

Displays the phase deviations of the measured signal (in rad or °) versus frequency.



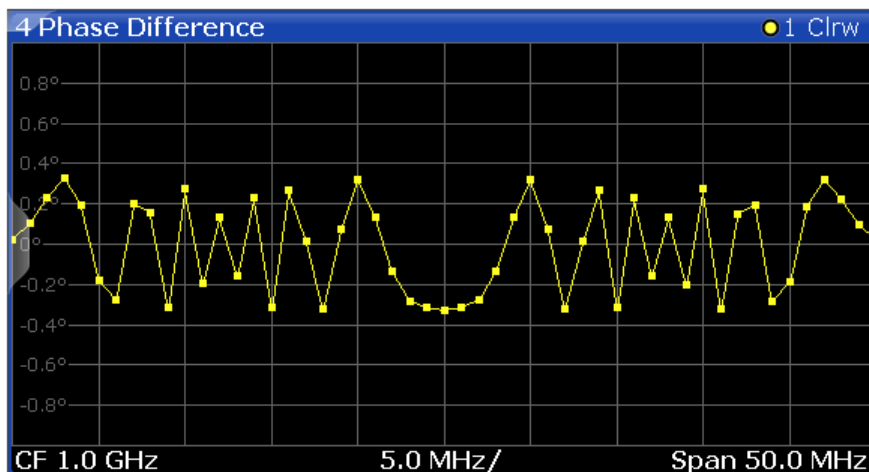
Remote command:

LAY:ADD? '1', RIGH, PHAS

(see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Phase Difference

Displays the phase difference (in rad or °) between the measured signal and the calibration (reference) signal vs frequency.



Note: This result display requires a calibration measurement (see ["Calibrate \(Execute Reference Calibration\)"](#) on page 50).

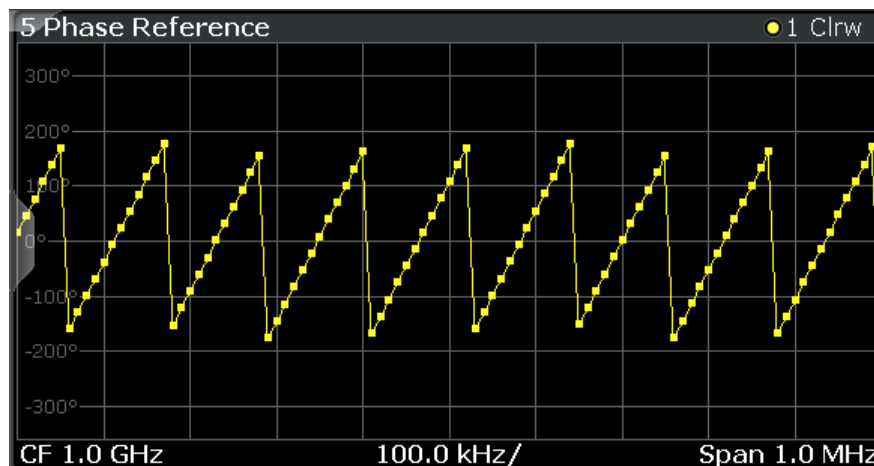
Remote command:

LAY:ADD? '1',RIGH,DPHase

(see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Phase Reference

Displays the phase deviations of the reference signal (in rad or °) versus frequency.



Remote command:

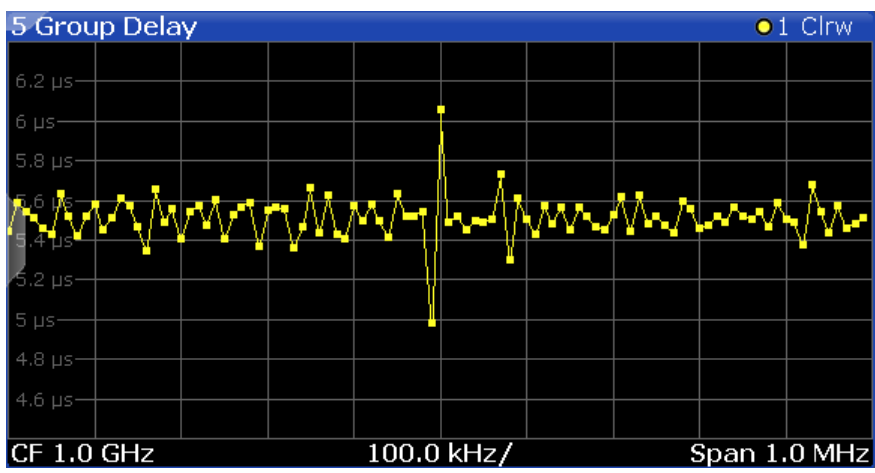
LAY:ADD? '1',RIGH,RPH

(see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Group Delay

Displays the time deviations of the signal versus frequency.

Note: This result display requires a calibration measurement (see ["Calibrate \(Execute Reference Calibration\)"](#) on page 50).

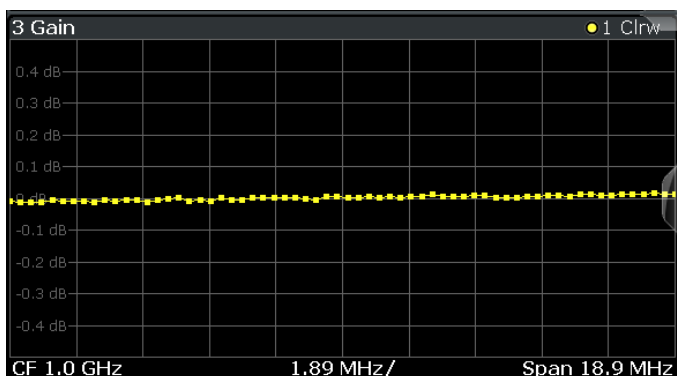


Remote command:
 LAY:ADD? '1', RIGH, GDEL
 (see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Gain

Displays the gain in magnitude from the reference trace to the measurement trace in dB or percent. This diagram characterizes the transmission behavior of the DUT.

Note: This result display requires a calibration measurement (see "[Calibrate \(Execute Reference Calibration\)](#)" on page 50).



Remote command:
 LAY:ADD? '1', RIGH, GAIN
 (see [LAYout:ADD\[:WINDow\]?](#) on page 116)

Marker Table

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

This table may be displayed automatically if configured accordingly (see "[Marker Table Display](#)" on page 65).

Wnd	Type	Ref	Trc	X-value	Y-value
1	M1		1	13.25 GHz	-200.0 dBm
1	D2	M1	1	-600.0 kHz	0.0 dB
1	D3	M1	1	600.0 kHz	0.0 dB
1	D4	M1	1	-2.0 MHz	0.0 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 116

Results:

[CALCulate<n>:MARKer<m>:X](#) on page 142

[CALCulate<n>:MARKer<m>:Y?](#) on page 128

5 Measurement Basics

Some background knowledge on basic terms and principles used in Multi-Carrier Group Delay measurements is provided here for a better understanding of the required configuration settings.

5.1 Definitions

Group delay

Group delay is a measure of phase distortion and defined as the derivation of phase over frequency:

$$\tau(f) = -\frac{1}{2\pi} \cdot \frac{d\varphi_{\text{delta}}(f)}{df} \quad \text{with} \quad \varphi_{\text{delta}}(f) = \text{unwrap}(\varphi_{\text{meas}}(f) - \varphi_{\text{cal}}(f))$$

Gain (Magnitude flatness)

The *gain* (also referred to as the magnitude flatness or amplitude flatness) is defined as the relation between the measured magnitude and the reference (calibration) magnitude:

$$\text{Gain}(f) = \frac{M_{\text{meas}}(f)}{M_{\text{cal}}(f)}$$

The gain describes the transmission behavior of the DUT.

5.2 The Multi-Carrier Measurement

The R&S FSW Multi-Carrier Group Delay application evaluates an input signal provided by a signal generator. A signal consisting of several unmodulated carriers with a fixed step size is used as an input signal.

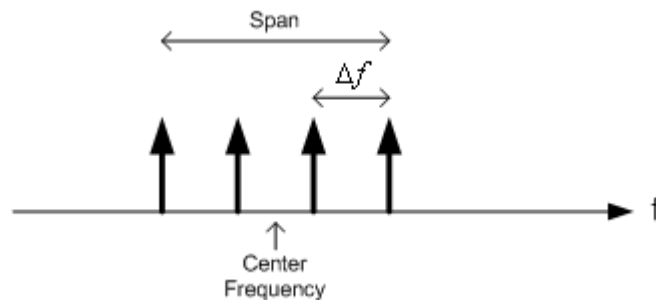
Dependency of the span on the number of carriers

The frequency **span** to be swept during the measurement is determined by the number of carriers in the input signal and the spacing between them. It is recommended that you set the span according to the following equation:

$$\text{Span} = (\text{Number of carriers} - 1) * \text{carrier spacing} (\Delta f)$$

Example:

A span $\geq 3 * \text{carrier spacing } (\Delta f)$ is required to measure a signal with four carriers.



As a rule, the span can only be defined as a multiple of the carrier spacing.

Center frequency and carrier offset

If the carriers are not aligned with the defined center frequency, the offset can be estimated automatically; the carrier frequencies with the fixed offset are then used to improve the calculation.

Carrier estimation

If the carrier frequencies are distorted due to the Doppler-effect, the frequencies for each carrier can be estimated, thus improving the results of the group delay.

Demodulation bandwidth

The bandwidth to be demodulated during the measurement is determined automatically by the application from the defined span and carrier spacing.

Measurement time

The required duration of the measurement can be determined automatically by the application according to the defined carrier spacing and span, or it can be configured manually.

Averaging results

The calculated values can be averaged over several sweeps in order to obtain more reliable results.

Orthogonal calculation method

The orthogonal calculation method aligns the trace points in the result display to the carrier frequencies of the input signal. To do so, a DFT window length equaling $1/\Delta f$ is used.

Absolute vs relative group delay

By default, the group delay is calculated relative to the reference signal, eliminating any constant delay factors. Optionally, the reference carrier frequency for relative measurements can be defined manually.

Alternatively, if an external trigger is used, the absolute group delay can also be calculated. In this case, the trigger uncertainty for the current measurement bandwidth is indicated and considered as an additional error in the group delay calculation.

5.3 The Calibration (Reference) Measurement

The Multi-Carrier Group Delay measurement method requires a preliminary reference measurement of the input signal *without the device under test* before the actual group delay measurement. This reference measurement is also referred to as the **calibration measurement**. The results of this measurement are stored internally in the R&S FSW to be used as a reference for the group delay calculation in the subsequent measurement *with* the DUT.

The results of the calibration measurement can be stored to a file and loaded as reference data for future measurements with the same setup.

The date and time of the most recently performed or loaded calibration measurement is indicated in the channel bar.

5.4 Measurement Setup

Before a Multi-Carrier Group Delay measurement can be performed, the R&S FSW must be set up in a test environment. This section describes the required settings of the R&S FSW. Before starting the measurements, the R&S FSW has to be configured correctly and supplied with power as described in the R&S FSW Getting Started manual, "Preparing For Use". Furthermore, the application firmware R&S FSW-K17 must be enabled. Installation and enabling of the application firmware are described in the R&S FSW Getting Started manual or in the Release Notes.

A Multi-Carrier Group Delay measurement requires the following devices:

- A baseband signal generator, e.g. a Vector Signal Generator R&S SMW
 - The R&S FSW with application firmware R&S FSW-K17: Multi-Carrier Group Delay
 - The device under test to be analyzed
- ▶ Connect the signal generator output to the RF INPUT connector of the R&S FSW - first without the DUT, then with the DUT inbetween.

For absolute group delay measurement, connect the trigger output of the signal generator to one of the trigger inputs (TRIGGER INPUT) of the R&S FSW (see "[Trigger 2/3](#)" on page 42).

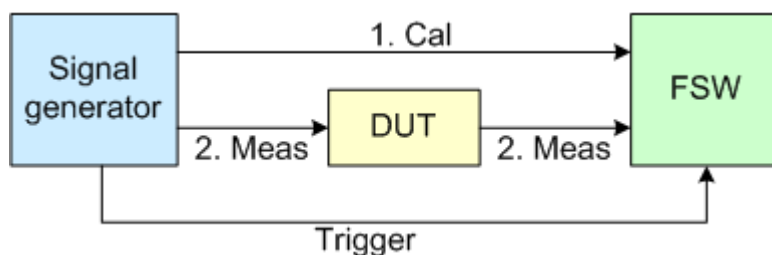


Figure 5-1: Multi-Carrier Group Delay test setup

It is recommended that you use an input signal with a low crest factor to get the phase response of the DUT. Furthermore, an external frequency reference is recommended for high accuracy measurements.

The following list summarizes the necessary measurement and calculation steps:

1. Calibration measurement without DUT:

$$\varphi_{cal}(f)$$

2. Measurement with DUT:

$$\varphi_{meas}(f)$$

3. Evaluate group delay:

$$\tau(f) = -\frac{1}{2\pi} \cdot \frac{d\varphi_{delta}(f)}{df} \quad \text{with} \quad \varphi_{delta}(f) = \text{unwrap}(\varphi_{meas}(f) - \varphi_{cal}(f))$$

5.5 Trace Smoothing

(Software-based) **smoothing** is a way to visually remove anomalies in the trace that may distort the results. The smoothing process is based on a moving average over the complete measurement range. The number of samples included in the averaging process (the *aperture size*) is variable and is a percentage of all samples that the trace consists of.

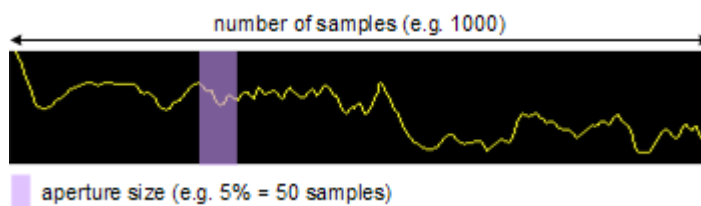


Figure 5-2: Sample size included in trace smoothing

The application smooths the trace only after the measurement has been finished and the data has been analyzed and written to a trace. Thus, smoothing is really just an enhancement of the trace display, not of the data itself. This also means that smoothing is always applied after any other trace averagings have been done, as these happen during the measurement itself.

You can turn trace smoothing on and off for all traces individually and compare, for example, the raw and the smooth trace.

Linear smoothing is based on the following algorithm:

$$y'(s) = \frac{1}{n} \left(\sum_{x=s-\frac{n-1}{2}}^{x=s+\frac{n-1}{2}} y(x) \right)$$

Equation 5-1: Linear trace smoothing

With:

s = sample number

y(s) = group delay, magnitude or gain

x = sample offset from s

n = aperture size

6 Configuration

Multi-Carrier Group Delay Application

Access: MODE"MC Group Delay"

Multi-Carrier Group Delay measurements require a special application on the R&S FSW.

When you switch the application of a measurement channel to Multi-Carrier Group Delay 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 Multi-Carrier Group Delay application, a Multi-Carrier Group Delay measurement for the input signal is started automatically with the default configuration. The "MCGD Meas" menu is displayed and provides access to the most important configuration functions.

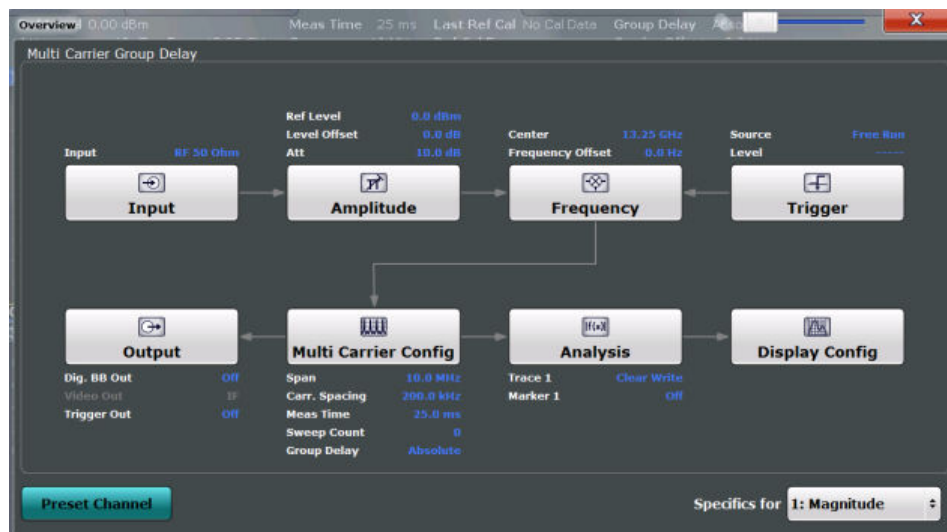
- [Configuration Overview](#).....25
- [Input Source Settings](#).....27
- [Amplitude and Y-Axis Scaling](#).....30
- [Frequency Settings](#).....36
- [Trigger Settings](#).....38
- [Multi-Carrier Configuration](#).....44
- [Sweep Settings](#).....50
- [Output Settings](#).....51
- [Automatic Settings](#).....54

6.1 Configuration Overview



Access: all menus

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



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. Input Settings
See [Chapter 6.2, "Input Source Settings"](#), on page 27
2. Amplitude Settings
See [Chapter 6.3, "Amplitude and Y-Axis Scaling"](#), on page 30
3. Frequency Settings
See [Chapter 6.4, "Frequency Settings"](#), on page 36
4. Trigger Settings
See [Chapter 6.5, "Trigger Settings"](#), on page 38
5. Multi-Carrier Configuration
See [Chapter 6.6, "Multi-Carrier Configuration"](#), on page 44
6. Output Settings
See [Chapter 6.8, "Output Settings"](#), on page 51
7. Analysis
See [Chapter 7, "Analysis"](#), on page 56
8. Display Configuration
See [Chapter 7.4, "Display Configuration"](#), on page 69



The main configuration settings and dialog boxes are also available via the "MCGD Meas" menu which is displayed when you press the MEAS CONFIG key.

In this documentation, only the most convenient method of accessing the dialog boxes is indicated - usually via the "Overview".

To configure settings

- ▶ Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the measurement channel tab) to change a specific setting.

For step-by-step instructions on configuring Multi-Carrier Group Delay measurements, see [Chapter 9, "How to Perform Measurements in the Multi-Carrier Group Delay Application"](#), on page 73.

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 87

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 Input Source Settings

Access: "Overview" > "Input" > "Input Source"

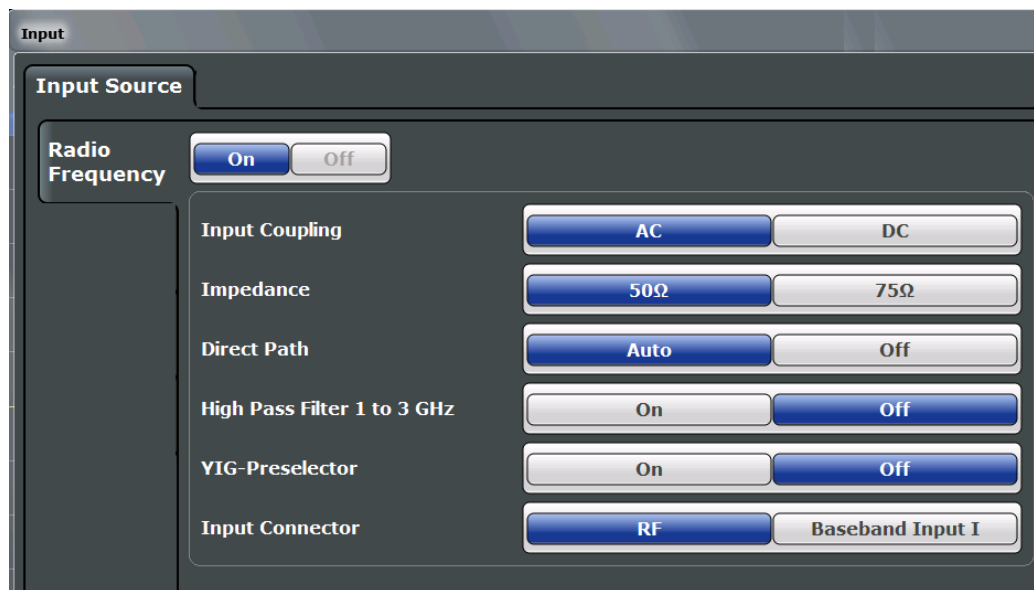
Or: INPUT/OUTPUT > "Input Source Config"

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

- [Radio Frequency Input](#).....27

6.2.1 Radio Frequency Input

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



Radio Frequency State..... 28
 Input Coupling..... 28
 Impedance..... 28
 Direct Path..... 29
 High-Pass Filter 1...3 GHz..... 29
 YIG-Preselector.....29

Radio Frequency State

Activates input from the RF INPUT connector.

Remote command:

[INPut:SElect](#) on page 90

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 88

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 25 Ω in series to the input impedance of the instrument.) The correction value in this case is 1.76 dB = 10 log (75 Ω /50 Ω).

Remote command:

`INPut:IMPedance` on page 90

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 88

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 89

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.

Note:

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

- I/Q Analyzer (and thus in all slave applications in MSRA operating mode)
- Multi-Carrier Group Delay
- GSM
- VSA

Remote command:

`INPut:FILTer:YIG[:STATe]` on page 89

6.3 Amplitude and Y-Axis Scaling

Access: "Overview" > "Amplitude"

Amplitude settings are identical to the base unit.

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

- [Amplitude Settings](#)..... 30
- [Scaling the Y-Axis](#)..... 33
- [Unit](#)..... 36

6.3.1 Amplitude Settings

Access: "Overview" > "Amplitude"

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



- [Reference Level](#)..... 31
 - [L Shifting the Display \(Offset\)](#)..... 31
- [RF Attenuation](#)..... 31

L Attenuation Mode / Value.....	31
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L Preamplifier.....	32

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 90

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 91

RF Attenuation

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

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 91

[INPut:ATTenuation:AUTO](#) on page 92

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 93

[INPut:EATT:AUTO](#) on page 92

[INPut:EATT](#) on page 92

Input Settings

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

The parameters "Input Coupling" and "Impedance" are identical to those in the "Input" settings.

Preamplicifier ← Input Settings

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

You can use a preamplicifier 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 preamplicifier is activated.

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

"Off"	Deactivates the preamplicifier.
"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 93

`INPut:GAIN[:VALue]` on page 93

6.3.2 Scaling the Y-Axis

Access: "Overview" > "Amplitude" > "Scaling" tab

The individual scaling settings that affect the vertical axis are described here.



Note that scaling settings are window-specific, as opposed to the amplitude settings. Depending on the result display, different methods of defining the scaling are available.

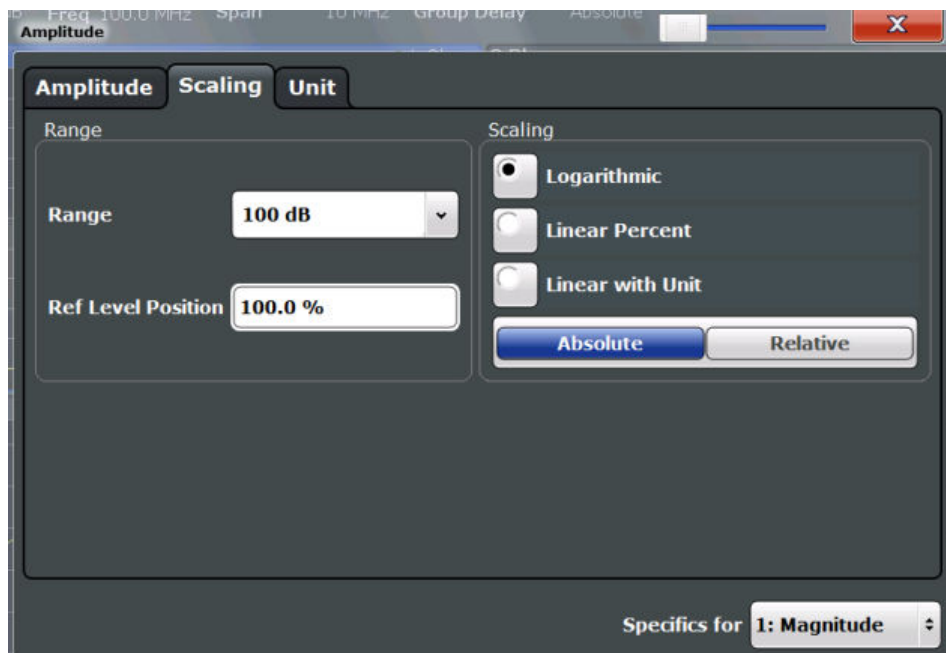


Figure 6-1: Scaling settings for Magnitude display

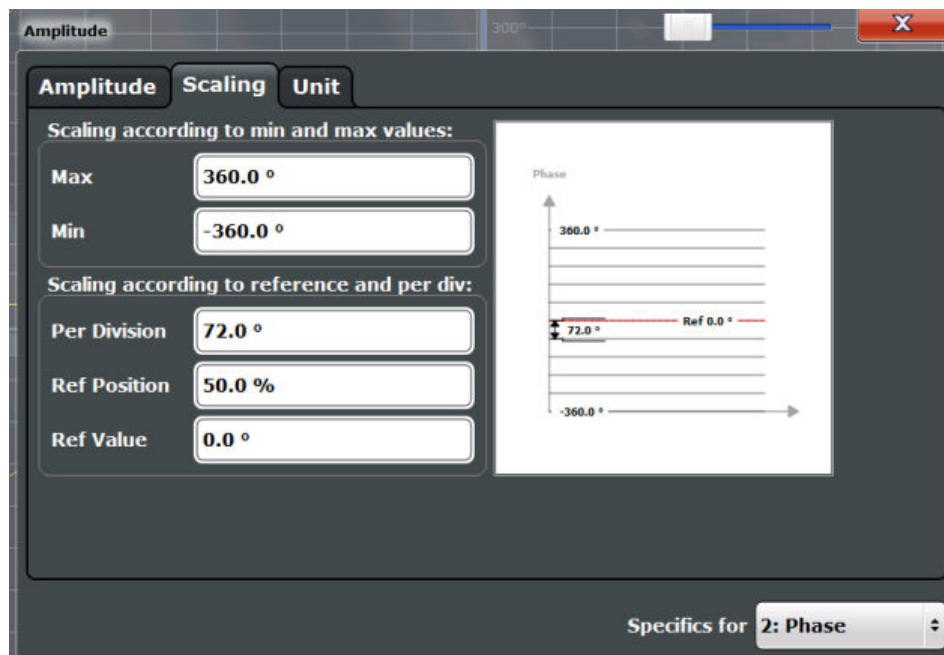


Figure 6-2: Scaling settings for Phase and Group Delay display

- Defining a Range and the Reference Level Position..... 34
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 - └ Y-Axis Reference Position..... 35
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- Defining Min and Max Values..... 35
- Scale Mode..... 36

Defining a Range and the Reference Level Position

For Magnitude displays, you can define the position of the reference level (for linear scaling), or define the range in dB and the position of the reference level.

Range ← Defining a Range and the Reference Level Position

Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 94

Ref Level Position ← Defining a Range and the Reference Level Position

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

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 96

Scaling ← Defining a Range and the Reference Level Position

Defines the scaling method for the y-axis.

"Logarithmic"	Logarithmic scaling (only available for logarithmic units - dB..., and A, V, Watt)
"Linear Unit"	Linear scaling in the unit of the measured signal
"Linear Percent"	Linear scaling in percentages from 0 to 100
"Absolute"	The labeling of the level lines refers to the absolute value of the reference level (not available for "Linear Percent")
"Relative"	The scaling is in dB, relative to the reference level (only available for logarithmic units - dB...). The upper line of the grid (reference level) is always at 0 dB.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 97

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE` on page 95

Configuring a Reference Point and Divisions

Defines the displayed range using a reference point and the size of the divisions.

Y-Axis Reference Value ← Configuring a Reference Point and Divisions

Defines a reference value for the y-axis in the current unit. The y-axis is adapted so that the reference value is displayed at the [Y-Axis Reference Position](#).

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 96

Y-Axis Reference Position ← Configuring a Reference Point and Divisions

Defines the position of the [Y-Axis Reference Value](#) on the y-axis. The position is defined as a percentage value, where 0 % refers to the bottom edge, 100 % refers to the top edge of the screen. The y-axis is adapted so that the reference value is displayed at the reference position.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 96

Range per Division ← Configuring a Reference Point and Divisions

Defines the value range to be displayed per division. Since the display consists of 10 divisions by default, the displayed range is:

$$\text{Range} = 10 * \langle \text{Range per Division} \rangle$$

Note: 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 range per division does not correspond to the actual display.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision` on page 96

Defining Min and Max Values

Defines the displayed range using minimum and maximum values.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum` on page 95

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 94

Scale Mode

For Gain display only: Defines the scaling method for the y-axis.

"Logarithmic" Logarithmic scaling (only available for logarithmic units - dB...)

"Linear" Linear scaling in percentages from 0 to 100

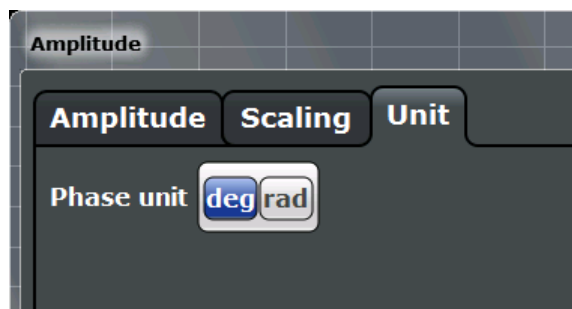
Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE` on page 95

6.3.3 Unit

Access: "Overview" > "Amplitude" > "Unit" tab

The unit defines how the measured data is displayed.



[Phase Unit \(Rad/Deg\)](#)..... 36

Phase Unit (Rad/Deg)

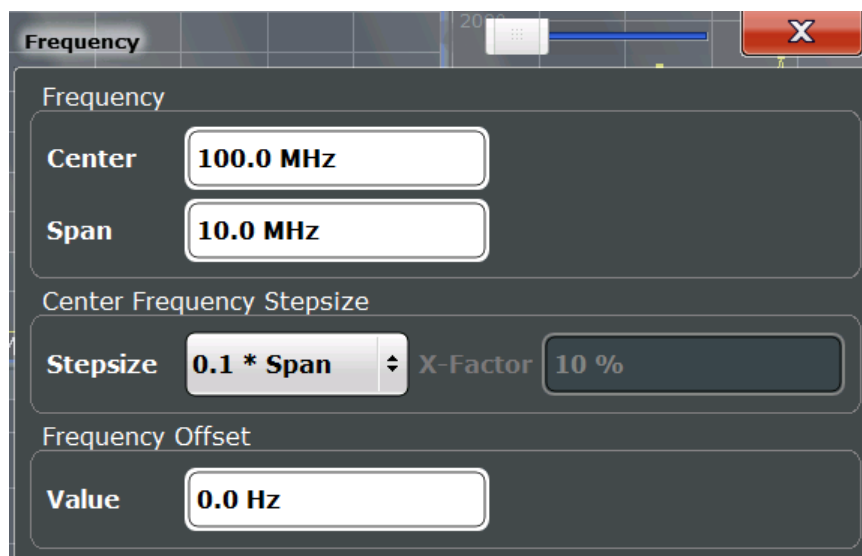
Sets the phase unit to rad or deg for displaying phase signals.

Remote command:

`UNIT:ANGLE` on page 97

6.4 Frequency Settings

Access: "Overview" > "Frequency"



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Center frequency

Defines the center frequency of the signal in Hertz.

Remote command:

[SENSe:] FREQuency: CENTer on page 98

Span

Defines the frequency span to be measured. Only a multiple of the carrier spacing can be defined. The [Number of Carriers](#) is adapted accordingly (see "[Dependency of the span on the number of carriers](#)" on page 20).

Remote command:

[SENSe:] FREQuency: SPAN on page 109

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.

"X * Span"	Sets the step size for the center frequency to a defined factor of the span. The "X-Factor" defines the percentage of the span. Values between 1 % and 100 % in steps of 1 % are allowed. The default setting is 10 %.
"= Center"	Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.

"= Marker" This setting is only available if a marker is active. Sets the step size to the value of the current marker and removes the coupling of the step size to span. 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 98

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.

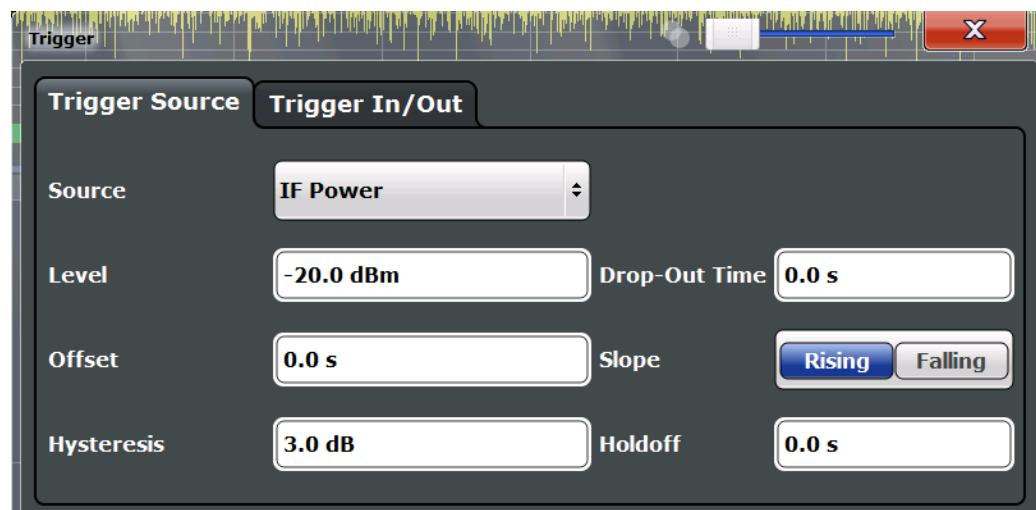
Remote command:

[SENSe:] FREQuency:OFFSet on page 99

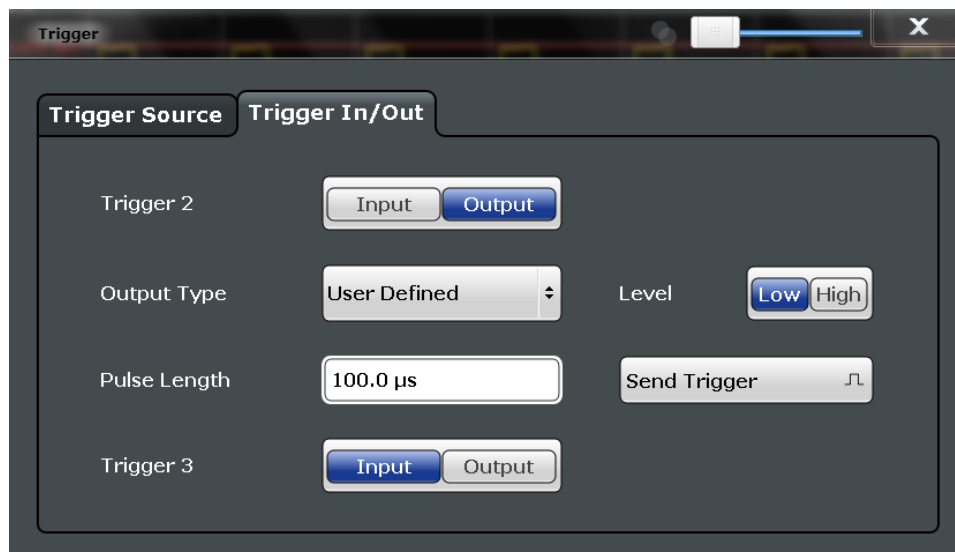
6.5 Trigger Settings

Access: "Overview" > "Trigger"

Trigger settings determine when the input signal is measured.



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 main R&S FSW User Manual.

- Trigger Source..... 39
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 - External Trigger 1/2/3..... 40
 - IF Power..... 40
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- Trigger 2/3..... 42
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Trigger Source

The trigger settings define the beginning of a measurement.

Trigger Source ← Trigger Source

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

Remote command:

TRIGger [:SEquence] :SOURce on page 103

Free Run ← Trigger Source ← Trigger Source

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

Remote command:

TRIG:SOUR IMM, see TRIGger[:SEquence]:SOURce on page 103

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

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

(See "Trigger Level" on page 41).

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

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

"External Trigger 1"

Trigger signal from the TRIGGER 1 INPUT connector.

"External Trigger 2"

Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector.

Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 42).

"External Trigger 3"

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

Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 42).

Remote command:

TRIG:SOUR EXT, TRIG:SOUR EXT2

TRIG:SOUR EXT3

See TRIGger[:SEquence]:SOURce on page 103

IF Power ← Trigger Source ← Trigger Source

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.

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

Note: Be aware that in auto sweep type mode, due to a possible change in sweep types, the trigger bandwidth can vary considerably for the same RBW setting.

Remote command:

TRIG:SOUR IFP, see TRIGger[:SEquence]:SOURce on page 103

RF Power ← Trigger Source ← Trigger Source

Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose, the instrument uses a level detector at the first intermediate frequency.

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

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

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the sweep 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 103

I/Q Power ← Trigger Source ← Trigger Source

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 103

Trigger Level ← Trigger Source

Defines the trigger level for the specified trigger source.

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

Remote command:

TRIGger[:SEquence]:LEVel:IFPower on page 102

TRIGger[:SEquence]:LEVel:IQPower on page 102

TRIGger[:SEquence]:LEVel[:EXTernal<port>] on page 101

Drop-Out Time ← Trigger Source

Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:

TRIGger[:SEquence]:DTIME on page 100

Trigger Offset ← Trigger Source

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

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger)

Remote command:

[TRIGger\[:SEquence\]:HOLDoff\[:TIME\]](#) on page 100

Hysteresis ← Trigger Source

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

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

Remote command:

[TRIGger\[:SEquence\]:IFPower:HYSTeresis](#) on page 101

Trigger Holdoff ← Trigger Source

Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:

[TRIGger\[:SEquence\]:IFPower:HOLDoff](#) on page 101

Slope ← Trigger Source

For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:

[TRIGger\[:SEquence\]:SLOPe](#) on page 103

Trigger 2/3

The screenshot shows a configuration panel for Trigger 2 and Trigger 3. For Trigger 2, there are 'Input' and 'Output' buttons. Below these, 'Output Type' is set to 'User Defined' with a dropdown arrow, and 'Level' is set to 'Low' with a 'High' button. 'Pulse Length' is set to '100.0 us' and there is a 'Send Trigger' button with a square wave icon. For Trigger 3, there are 'Input' and 'Output' buttons.

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 104

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.

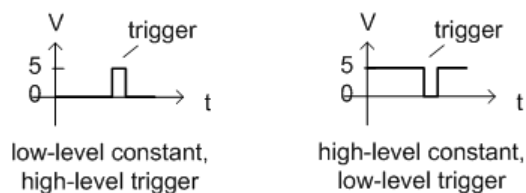
Remote command:

[OUTPut:TRIGger<port>:OTYPe](#) on page 105

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.



Remote command:

[OUTPut:TRIGger<port>:LEVel](#) on page 105

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 106

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 106

6.6 Multi-Carrier Configuration

Access: "Overview" > "Multi-Carrier Config"

Or: MEAS CONFIG > "Multi-Carrier Config"

The multiple carriers are configured in the "Multi-Carrier Config" dialog box.

- [Measurement Configuration](#).....44
- [Calibration](#).....49

6.6.1 Measurement Configuration

Access: "Overview" > "Multi-Carrier Config" > "Meas Config" tab

Or: MEAS CONFIG > "Multi-Carrier Config" > "Meas Config" tab

Depending on the group delay mode, the measurement parameters for group delay calculation vary slightly.

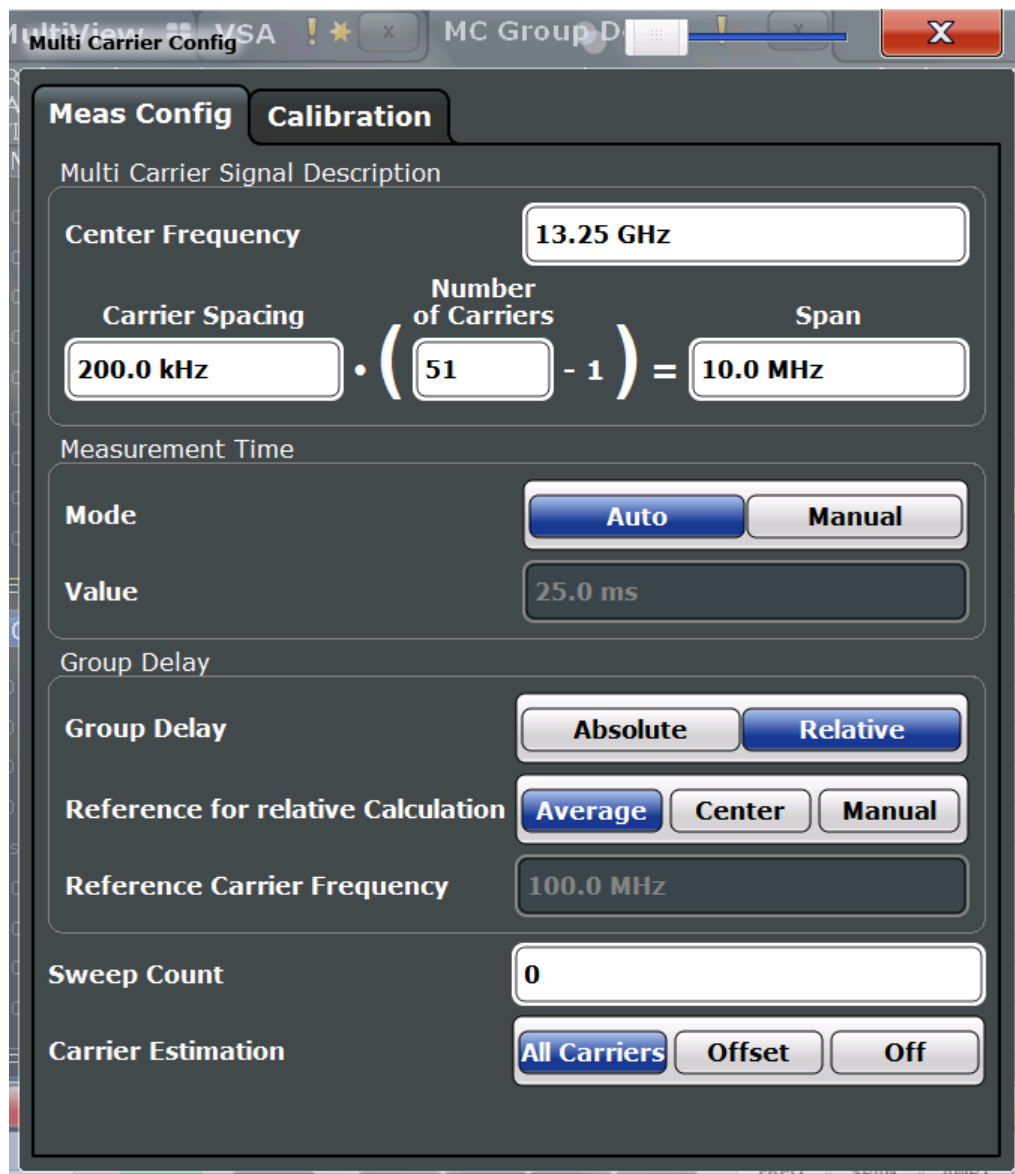


Figure 6-3: Multi Carrier Config dialog box for relative group delay

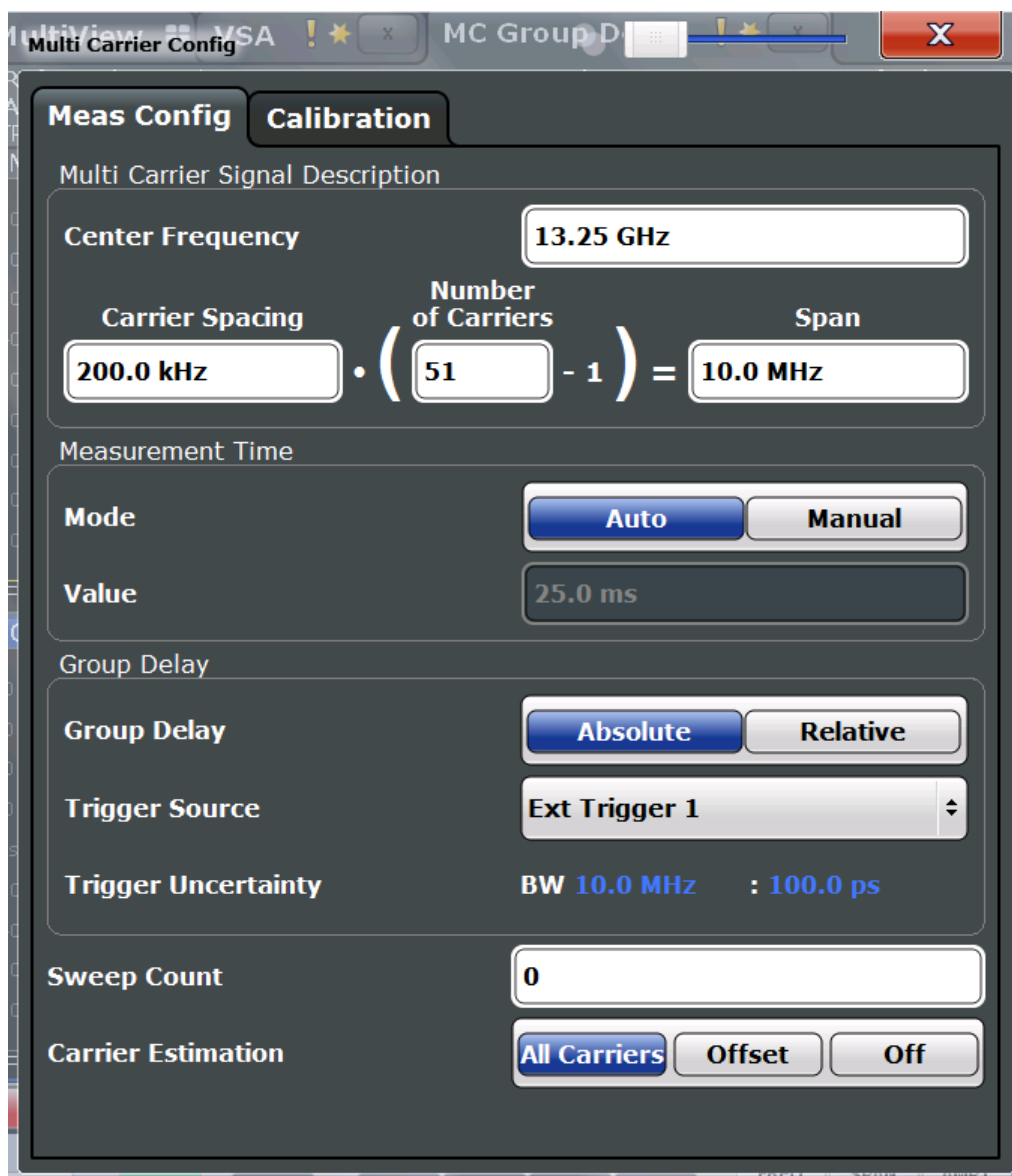


Figure 6-4: Multi Carrier Config dialog box for absolute group delay

Center frequency.....47

Carrier Spacing..... 47

Number of Carriers.....47

Span.....47

Measurement Time..... 47

Group Delay Mode..... 47

Reference for relative Calculation / Reference Carrier Frequency..... 48

Trigger Source..... 48

Trigger Uncertainty.....48

Sweep Count.....48

Carrier Estimation..... 48

Center frequency

Defines the center frequency of the signal in Hertz.

Remote command:

[SENSe:] FREQuency: CENTer on page 98

Carrier Spacing

Defines the spacing between two carriers. The "Span" on page 37 and the [Number of Carriers](#) are adapted accordingly (see "[Dependency of the span on the number of carriers](#)" on page 20).

Remote command:

[SENSe:] CARRier: SPACing on page 109

Number of Carriers

Defines the number of carriers in the signal. The "Span" on page 37 and [Carrier Spacing](#) are adapted according to the following formula:

$$\text{Number of carriers} - 1 = \text{Span} / \text{Carrier spacing}$$

For details see "[Dependency of the span on the number of carriers](#)" on page 20.

Remote command:

[SENSe:] CARRier: COUNT on page 108

Span

Defines the frequency span to be measured. Only a multiple of the carrier spacing can be defined. The [Number of Carriers](#) is adapted accordingly (see "[Dependency of the span on the number of carriers](#)" on page 20).

Remote command:

[SENSe:] FREQuency: SPAN on page 109

Measurement Time

Defines the duration of data acquisition

"Auto" (Default:) In automatic mode the required time is determined according to carrier spacing and span; the currently used measurement time is indicated for reference only

"Manual" The measurement time is defined manually; enter the measurement time in seconds

Remote command:

[SENSe:] MTIME? on page 110

[SENSe:] MTIME: AUTO on page 109

Group Delay Mode

Defines how the group delay is calculated.

"Absolute" Calculates the absolute group delay; requires an external trigger

"Relative" Calculates the relative group delay; the reference is configurable (see [Reference for relative Calculation / Reference Carrier Frequency](#))

Remote command:

CALCulate: GRPDelay: MODE on page 107

Reference for relative Calculation / Reference Carrier Frequency

Determines the reference used for relative group delay measurement.

"Average"	(Default:) The average group delay is used as a reference
"Center"	The group delay measured for the center frequency is used as a reference
"Manual"	The group delay measured at the user-defined "Reference Carrier Frequency" is used as a reference

Remote command:

[CALCulate:GRPDelay:REference](#) on page 107

[CALCulate:GRPDelay:REference:FREquency](#) on page 108

Trigger Source

The trigger source used for the group delay measurement; this is the same setting as in the [Chapter 6.5, "Trigger Settings"](#), on page 38); it is provided here for convenience as absolute group delay measurement requires an external trigger.

Remote command:

[TRIGger\[:SEquence\]:SOURce](#) on page 103

Trigger Uncertainty

For absolute group delay measurement using an external trigger, the trigger uncertainty for the current bandwidth (=Span) is indicated. This value is considered as an additional error in the group delay calculation.

Sweep Count

Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 32767 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in all diagrams.

During calibration measurements, the phase and amplitude values are averaged over the defined number of sweeps.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, this value also determines the number of averaging or maximum search procedures.

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 sweeps. For sweep count =1, no averaging, Max Hold or Min Hold operations are performed.

Remote command:

[\[SENSe:\]SWEep:COUNT](#) on page 126

Carrier Estimation

Defines whether the carrier frequencies are estimated and then compensated for.

"All Carriers"	Estimates the frequency for each carrier and uses the determined frequencies when calculating the group delay. This estimation is useful for in-orbit measurements of satellites for which the group delay may be distorted due to the Doppler effect.
"Offset"	The offset is assumed to be identical for all carriers. It is estimated and the determined frequencies are then used for calculation.

"Off" The carrier frequencies as defined in the configuration are used; possible offsets are not compensated.

Remote command:

[SENSe:]CARRier:OFFSet:MODE on page 108

[SENSe:]CARRier:OFFSet? on page 110

6.6.2 Calibration

Access: "Overview" > "Multi-Carrier Config" > "Calibration" tab

Or: MEAS CONFIG > "Multi-Carrier Config" > "Calibration" tab



The values defined by the most recently performed or loaded calibration measurement are displayed at the top of the dialog box.

Calibrate (Execute Reference Calibration)	50
Storing Calibration Data	50
Loading Calibration Data	50
Decimal Separator	50

Calibrate (Execute Reference Calibration)

Starts a new sweep to perform a calibration measurement. The status of the running measurement is indicated in a dialog box. During this time, no other actions can be performed on the R&S FSW. The results are used as reference data for the group delay and gain calculation.

The date and time of the most recently performed or loaded calibration measurement is indicated in the channel bar and at the top of the dialog box.

Remote command:

[CALibration:MCGD](#) on page 113

Storing Calibration Data

Stores the calibration data (reference data) to the selected file (.csv format)

Remote command:

[MMEMemory:STORe:MCGD:RCALibration](#) on page 114

Loading Calibration Data

Loads the calibration data (reference data) from the selected file (.csv format) to the instrument. The current reference data in the MCGD application is overwritten; the loaded data is used for the group delay calculation.

Remote command:

[MMEMemory:LOAD:MCGD:RCALibration](#) on page 114

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 132

6.7 Sweep Settings

Access: SWEEP menu

The sweep settings define how often data from the input signal is acquired and then evaluated.

Continuous Sweep/RUN CONT	51
Single Sweep/ RUN SINGLE	51
Continue Single Sweep	51
Sweep Count	51

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. 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 123

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. 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 124

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 123

Sweep Count

Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 32767 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in all diagrams.

During calibration measurements, the phase and amplitude values are averaged over the defined number of sweeps.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, this value also determines the number of averaging or maximum search procedures.

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 sweeps. For sweep count = 1, no averaging, Max Hold or Min Hold operations are performed.

Remote command:

`[SENSe:]SWEep:COUNT` on page 126

6.8 Output Settings

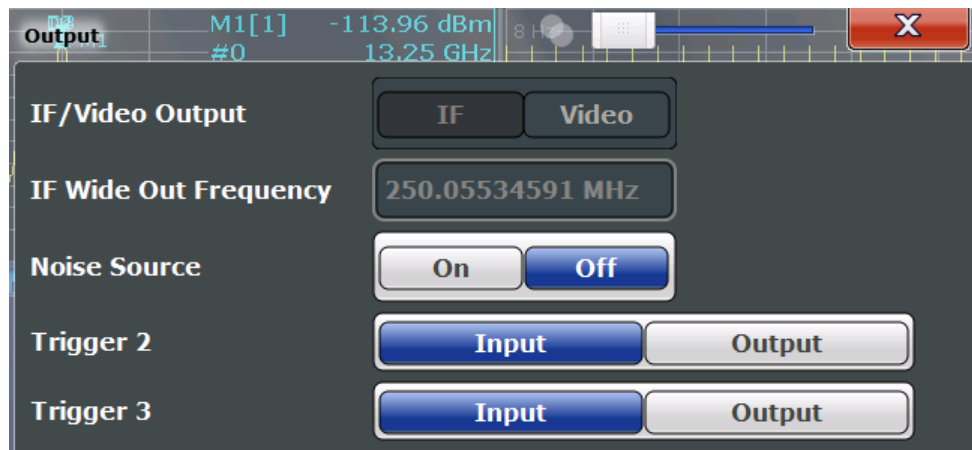
Access: INPUT/OUTPUT > "Output"

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.



Noise Source.....52
 Trigger 2/3.....52
 L Output Type.....53
 L Level.....53
 L Pulse Length.....54
 L Send Trigger.....54

Noise Source

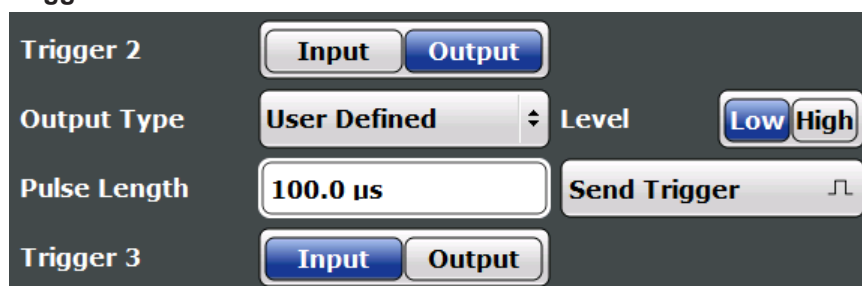
This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the R&S FSW on and off.

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 111

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 104

Output Type ← Trigger 2/3

Type of signal to be sent to the output

"Device Trig- (Default) Sends a trigger when the R&S FSW triggers.
gered"

"Trigger Sends a (high level) trigger when the R&S FSW is in "Ready for trig-
Armed" ger" 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.

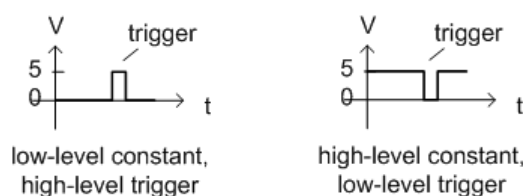
Remote command:

[OUTPut:TRIGger<port>:OTYPe](#) on page 105

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.



Remote command:

[OUTPut:TRIGger<port>:LEVel](#) on page 105

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 106

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 106

6.9 Automatic Settings

Access: AUTO SET menu

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings and signal characteristics.

Setting the Reference Level Automatically (Auto Level)	54
Resetting the Automatic Measurement Time (Meastime Auto)	54
Changing the Automatic Measurement Time (Meastime Manual)	55
Upper Level Hysteresis	55
Lower Level Hysteresis	55

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.

You can change the measurement time for the level measurement if necessary (see "[Changing the Automatic Measurement Time \(Meastime Manual\)](#)" on page 55).

Remote command:

[\[SENSe:\]ADJust:LEVel](#) on page 113

Resetting the Automatic Measurement Time (Meastime Auto)

Resets the measurement duration for automatic settings to the default value.

Remote command:

`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 111

Changing the Automatic Measurement Time (Meastime Manual)

This function allows you to change the measurement duration for automatic setting adjustments. Enter the value in seconds.

Remote command:

`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 111

`[SENSe:]ADJust:CONFigure:DURation` on page 111

Upper Level Hysteresis

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

Remote command:

`[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer` on page 112

Lower Level Hysteresis

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

Remote command:

`[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer` on page 112

7 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.

- [Trace Settings](#)..... 56
- [Trace / Data Export Configuration](#).....59
- [Markers](#)..... 61
- [Display Configuration](#)..... 69

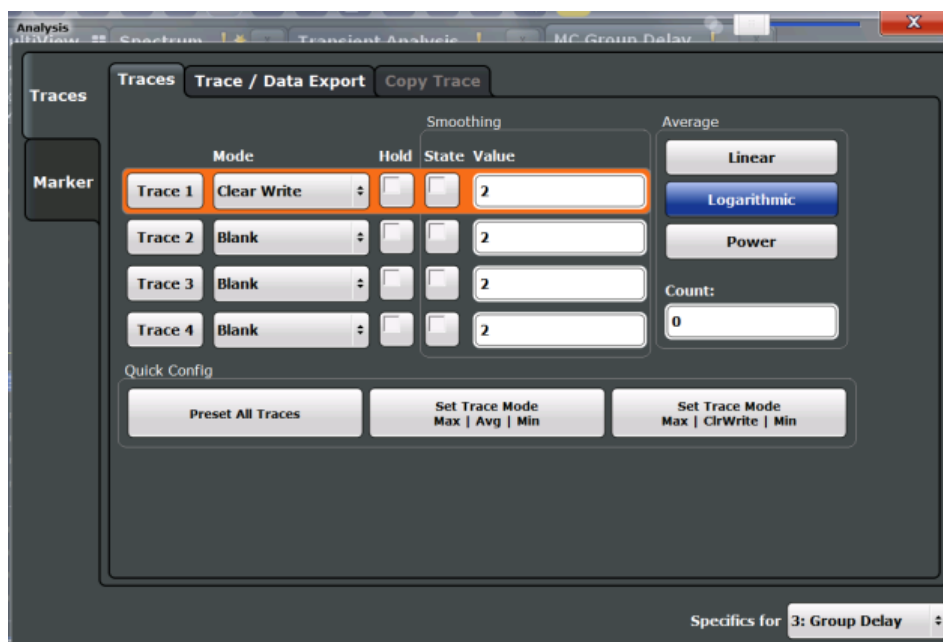
7.1 Trace Settings

The trace settings determine how the measured data is analyzed and displayed in the window. Depending on the result display, between 1 and 4 traces may be displayed.

Trace settings can be configured via the TRACE key, in the "Traces" dialog box, or in the vertical "Traces" tab of the "Analysis" dialog box.



Trace data can also be exported to an ASCII file for further analysis. For details see [Chapter 7.2, "Trace / Data Export Configuration"](#), on page 59.



Trace 1/Trace 2/Trace 3/Trace 4	57
Mode	57
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Smoothing	57
Average Mode	58

Average Count.....	58
Predefined Trace Settings - Quick Config.....	58
Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys).....	59

Trace 1/Trace 2/Trace 3/Trace 4

Selects the corresponding trace for configuration. The currently selected trace is highlighted orange.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 136

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.
"Min Hold"	The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.
"Average"	The average is formed over several sweeps. The "Average Count" on page 58 determines the number of averaging procedures.
"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 133

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 134

Smoothing

If enabled, the Group Delay trace is smoothed by the specified value (between 1 % and 50 %). The smoothing value is defined as a percentage of the display width. The larger the smoothing value, the greater the smoothing effect.

This setting is not available for Phase, Phase Reference, and Magnitude Reference (vs Frequency) results.

For more information see [Chapter 5.5, "Trace Smoothing"](#), on page 23.

Remote command:

[DISPlay\[:WINDow<n>\]:TRACe<t>:SMOothing\[:STATe\]](#) on page 135

[DISPlay\[:WINDow<n>\]:TRACe<t>:SMOothing:APERture](#) on page 135

Average Mode

Defines the mode with which the trace is averaged over several sweep s. A different averaging mode can be defined for each trace.

This setting is only applicable if trace mode "Average" is selected.

How many sweep s are averaged is defined by the "[Average Count](#)" on page 58.

"Linear" The power level values are converted into linear units prior to averaging. After the averaging, the data is converted back into its original unit.

"Logarithmic" For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.

"Power" Activates linear power averaging.
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.
Use this mode to average power values in Volts or Amperes correctly.

Remote command:

[\[SENSe:\]AVERAge<n>:TYPE](#) on page 137

Average Count

Determines the number of averaging or maximum search procedures If the trace modes "Average", "Max Hold" or "Min Hold" are set.

In continuous sweep mode, if sweep count = 0 (default), averaging is performed over 10 sweep s. For sweep count =1, no averaging, Max Hold or Min Hold operations are performed.

This value is identical to the [Sweep Count](#) setting in the "Sweep" and "Multi-carrier" configuration.

Remote command:

[\[SENSe:\]AVERAge<n>:COUNT](#) on page 136

Predefined Trace Settings - Quick Config

Commonly required trace settings have been predefined and can be applied very quickly by selecting the appropriate button.

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write
	Traces 2-4:	Blank
Set Trace Mode	Trace 1:	Max Hold

Function	Trace Settings	
Max Avg Min	Trace 2:	Average
	Trace 3:	Min Hold
	Trace 4:	Blank
Set Trace Mode Max ClrWrite Min	Trace 1:	Max Hold
	Trace 2:	Clear Write
	Trace 3:	Min Hold
	Trace 4:	Blank

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)

Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 136

7.2 Trace / Data Export Configuration



Access: "Save" > "Export" > "(Trace) Export Config"

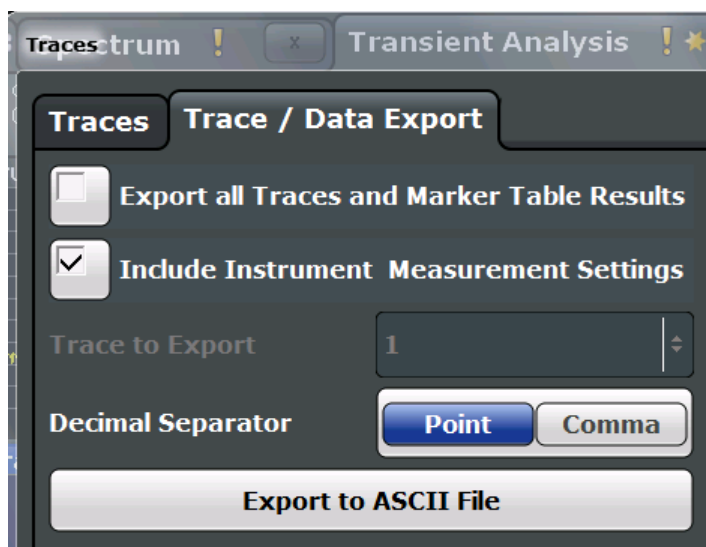
Or: TRACE > "Trace Config" > "Trace/Data Export"

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.....	60
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Decimal Separator.....	60
Export Trace to ASCII File.....	61

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 132

Include Instrument Measurement Settings

Includes additional instrument and measurement settings in the header of the export file for result data.

See [Chapter 12.2, "Reference: ASCII File Export Format"](#), on page 157 for details.

Remote command:

[FORMat:DEXPort:HEADer](#) on page 132

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 132

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.

Both measurement and reference (calibration) traces can be exported to an ASCII file. However, the calibration data stored in an ASCII file cannot be re-imported to the R&S FSW (to re-import the data use [Storing Calibration Data](#) instead).

Note: To store the measurement results for **all** traces in all windows in .csv format, use the [Storing Measurement Results](#) command in the "Save/Recall" > "Export" menu. For details on the file formats, see [Chapter 12, "Annex"](#), on page 157.

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 131

7.3 Markers

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display.

Markers are configured in the "Marker" dialog box which is displayed when you do one of the following:

- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab.
- Press the MKR key, then select the "Marker Config" softkey.
- [Marker Settings](#)..... 61
- [Marker Search Settings and Positioning Functions](#)..... 66

7.3.1 Marker Settings

Marker settings can be configured via the MARKER key or in the "Marker" dialog box. To display the "Marker" dialog box, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab.

The remote commands required to define these settings are described in [Chapter 11.9.3, "General Marker Settings"](#), on page 143.

- [Individual Marker Setup](#)..... 62
- [General Marker Settings](#)..... 65

7.3.1.1 Individual Marker Setup

In the Multi-Carrier Group Delay application, up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.



The markers are distributed among 3 tabs for a better overview. By default, the first marker is defined as a normal marker, whereas all others are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is active.

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- [Selected Marker](#)..... 63
- [Marker State](#)..... 63
- [Marker Position \(X-value\)](#)..... 63
- [Marker Type](#)..... 63
- [Reference Marker](#)..... 64
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- [All Markers Off](#)..... 64

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 141

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 140

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 141

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 140

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 142

[CALCulate<n>:DELTAmarker<m>:X](#) on page 140

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 141

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 140

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.

If the reference marker is deactivated, a different reference marker is automatically selected; the delta marker remains active.

Remote command:

[CALCulate<n>:DELTAmarker<m>:MREF](#) on page 139

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 141

[CALCulate<n>:DELTAmarker<m>:LINK:TO:MARKer<m>](#) on page 139

[CALCulate<n>:DELTAmarker<m>:LINK](#) on page 138

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 142

All Markers Off

Deactivates all markers in one step.

Remote command:

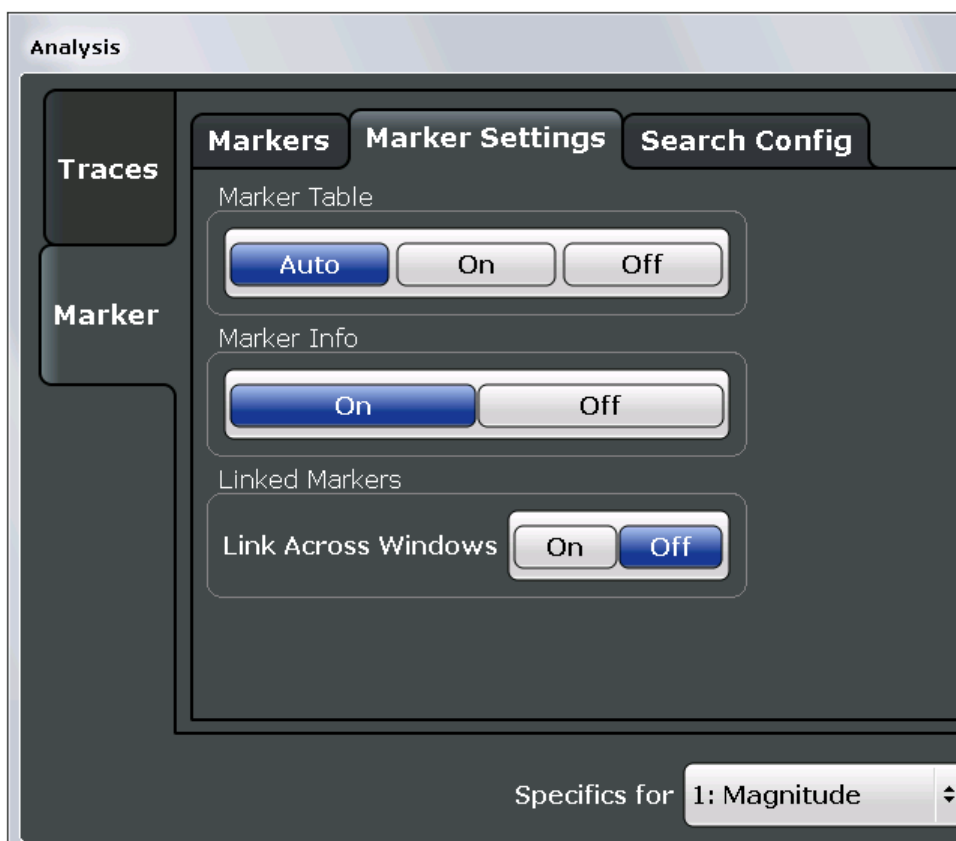
[CALCulate<n>:MARKer<m>:AOFF](#) on page 141

7.3.1.2 General Marker Settings

Some general marker settings allow you to influence the marker behavior for all markers.

These settings are located in the "Marker Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab. Then select the horizontal "Marker Settings" tab.



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Marker Info.....	66
Linked Markers.....	66

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 143

Marker Info

Turns the marker information displayed in the diagram on and off.



Remote command:

[DISPlay:MINFo\[:STAT\]](#) on page 143

Linked Markers

If enabled, the markers in all diagrams 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.

Linking markers is only possible if compatible reference data is available, or no reference data at all. Compatible reference data means the settings used to perform calibration were the same as the currently active measurement settings. If measurement settings are changed that do not match the reference data, linking markers is no longer possible and the function is automatically deactivated.

An exception to this rule is the center frequency. If a different center frequency was used for calibration, the markers can still be linked. However, in this case the markers are not moved to a specific x-value, but to the same horizontal position relative to the diagram edge.

Remote command:

[CALCulate<n>:MARKer<m>:LINK](#) on page 143

7.3.2 Marker Search Settings and Positioning Functions

Several functions are available to set the marker to a specific position very quickly and easily, or to use the current marker position to define another characteristic value. In order to determine the required marker position, searches may be performed. The search results can be influenced by special settings.

Most marker positioning functions and the search settings are available in the MKR -> menu.

Search settings are also available via the MARKER key or in the vertical "Marker Config" tab of the "Analysis" dialog box (horizontal "Search Settings" tab).

The remote commands required to define these settings are described in [Chapter 11.9.4, "Searching for Peaks and Positioning the Marker"](#), on page 144.

- [Marker Search Settings](#).....67
- [Positioning Functions](#).....67

7.3.2.1 Marker Search Settings

Markers are commonly used to determine peak values, i.e. maximum or minimum values, in the measured signal. Configuration settings allow you to influence the peak search results.

These settings are available as softkeys in the Marker To menu, or in the "Search Settings" tab of the "Marker" dialog box. To display this tab, do one of the following:

- Press the MKR key, then select the "Marker Config" softkey. Then select the horizontal "Search Settings" tab.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Config" tab. Then select the horizontal "Search Settings" tab.

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Search Mode for Next Peak

Selects the search mode for the next peak search.

"Left"	Determines the next maximum/minimum to the left of the current peak.
"Absolute"	Determines the next maximum/minimum to either side of the current peak.
"Right"	Determines the next maximum/minimum to the right of the current peak.

Remote command:

[Chapter 11.9.4, "Searching for Peaks and Positioning the Marker"](#), on page 144

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 144

7.3.2.2 Positioning Functions

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value. These functions are available as softkeys in the "Marker To" menu, which is displayed when you press the MKR -> key, or in the "Marker" menu.

Select Marker	67
Peak Search	68
Search Next Peak	68
Search Minimum	68
Search Next Minimum	69

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 141

[CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 140

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 145

[CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 148

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 145

[CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 146

[CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 145

[CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 148

[CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 148

[CALCulate<n>:DELTamarker<m>:MAXimum:LEFT](#) on page 147

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 146

[CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 149

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 146

`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 146

`CALCulate<n>:MARKer<m>:MINimum:RIGHT` on page 147


`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 149

`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 148

`CALCulate<n>:DELTamarker<m>:MINimum:RIGHT` on page 149

7.4 Display Configuration

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the Multi-Carrier Group Delay application are displayed in the evaluation bar in SmartGrid mode when you do one of the following:

- Select the  "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the "Overview".
- Press the MEAS key.
- Select the "Display Config" softkey in any Multi-Carrier Group Delay menu.

Up to 6 evaluation methods can be displayed simultaneously in separate windows. The Multi-Carrier Group Delay evaluation methods are described in [Chapter 4.1, "Evaluation Methods for Multi-Carrier Group Delay"](#), on page 15.



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

8 Importing and Exporting Results

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 results from the calibration measurements can also be re-imported to the R&S FSW MCGD application as reference data for further measurements.



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.

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- [Import Functions](#)..... 71

8.1 Export Functions



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



functions are also available via softkeys or dialog boxes in the corresponding menus, e.g. trace data or calibration data.

Storing Calibration Data	70
Storing Measurement Results	70
Export Trace to ASCII File	71
Decimal Separator	71

Storing Calibration Data

Stores the calibration data (reference data) to the selected file (.csv format)

Remote command:

[MMEMory:STORe:MCGD:RCALibration](#) on page 114

Storing Measurement Results

Stores the currently displayed measurement results (i.e. all traces in all windows) to the selected file (.csv format).

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.

Note: To store the results of an individual trace or all traces in ASCII format (.dat), use the [Export Trace to ASCII File](#) function.

Remote command:

[MMEMory:STORe:MCGD:MEAS](#) on page 130

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.

Both measurement and reference (calibration) traces can be exported to an ASCII file. However, the calibration data stored in an ASCII file cannot be re-imported to the R&S FSW (to re-import the data use [Storing Calibration Data](#) instead).

Note: To store the measurement results for **all** traces in all windows in .csv format, use the [Storing Measurement Results](#) command in the "Save/Recall" > "Export" menu. For details on the file formats, see [Chapter 12, "Annex"](#), on page 157.

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 131

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 132

8.2 Import Functions



The following import functions are available via softkeys in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar. Calibration data can also be imported from the "Calibration" configuration dialog box.



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Loading Calibration Data

Loads the calibration data (reference data) from the selected file (.csv format) to the instrument. The current reference data in the MCGD application is overwritten; the loaded data is used for the group delay calculation.

Remote command:

[MMEMory:LOAD:MCGD:RCALibration](#) on page 114

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 132

9 How to Perform Measurements in the Multi-Carrier Group Delay Application

The following step-by-step instructions demonstrate how to perform a Multi-Carrier Group Delay measurement with the R&S FSW-K17 option. For details on the individual functions and settings see [Chapter 6, "Configuration"](#), on page 25.

Additionally, the procedure to generate the multi-carrier signal for the frequency range to be analyzed on a signal generator is described, using the R&S SMW as an example. For details on configuring the signal generator, see the R&S SMW User Manual.

To generate a multi-carrier signal for the frequency range of the DUT on an R&S SMW

1. Preset the signal generator.
2. In the "Baseband A" menu, select "Multicarrier CW". (Alternatively, the R&S SMW can produce multi-carrier signals using the "ARB" option.)
3. In the "General" tab, define the "No of Carriers" and "Carrier Spacing" such that the generated signal covers the frequency range in which the DUT is to be analyzed.
4. In the "Optimize Crest Factor Mode" field, select "Chirp" to improve the SNR in the MC Group Delay measurement.
5. To improve measurement accuracy, send a trigger signal to the R&S FSW:
 - a) Select the "Trigger In" tab.
 - b) For "Mode", select "Auto".
 - c) Select the "Marker" tab.
 - d) For "Marker 1", select "Restart".
6. In the "General" tab, activate the multi-carrier signal by switching the state to "ON".
7. Close the "Multi Carrier CW A" menu.
8. Set "RF A" to "ON" to activate the RF modulation.
9. Select the FREQ key to define the center frequency of the test signal.
10. Select the LEVEL key to define the generator's output power.

To perform the MC Group Delay measurement on the R&S FSW

1. To use the trigger from the signal generator on the R&S FSW, for example to calculate an absolute group delay, connect the trigger output of the signal generator to the trigger input of the R&S FSW.
2. To synchronize the reference frequencies used by the signal generator and the R&S FSW, use an external reference frequency:
 - a) Connect the external reference output of the signal generator (REF OUT) to the external reference input on the rear panel of the R&S FSW (REF INPUT 1..20 MHz).

- b) On the R&S FSW, press the SETUP key, then select the "Reference" softkey.
- c) In the "Reference Frequency Input" area select the used external reference.
3. Connect the RF A output of the signal generator to the RF INPUT connector on the front panel of the R&S FSW **without the DUT**.
4. Configure the signal generator to output a multi-carrier signal in the frequency range in which the DUT is to be analyzed (as described in ["To generate a multi-carrier signal for the frequency range of the DUT on an R&S SMW"](#) on page 73).
5. Press the MODE key on the front panel of the R&S FSW and select the "MC Group Delay" application.
6. Select the "Overview" softkey to display the "Overview" for a Multi-Carrier Group Delay measurement.
7. Select the "Amplitude" button and define the required attenuation and reference level for the generated input signal.


Note: Correct attenuation and reference level settings are an important factor for accurate group delay measurement results. You can also use the auto leveling function in the R&S FSW Spectrum application before starting the MCGD application. The attenuation and reference level values are then passed on to the new MCGD measurement channel.
8. Select the "Frequency" button to define the input signal's center frequency.
9. To measure the absolute group delay select the "Trigger" button and select the trigger source "External Trigger1".
10. Select the "Multi-Carrier Config" button to describe the signal and define measurement settings:
 - a) Define the carrier spacing.
 - b) Define the number of carriers (tones) or the frequency span according to the settings on the generator.
 - c) If the measurement time determined automatically is not adequate, define it manually.
 - d) To average the results over several sweeps, increase the sweep count.
 - e) To calculate an absolute group delay, select "Absolute" mode for the group delay result.

Check the displayed results to ensure the measurement configuration is adequate.
11. Press the RUN SINGLE key to stop the continuous sweep mode.
12. Select the "Multi-Carrier Config" softkey to re-open the "Multi-Carrier Config" dialog box and switch to the "Calibration" tab.
13. Select the "Calibrate" button to perform a calibration measurement.

Alternatively, if a calibration measurement has already been performed with the same measurement setup, select the "Load Calibration Data" button to load stored reference data.

The calibration measurement is performed. The status of the running measurement is indicated in a dialog box. During this time, no other actions can be performed on the R&S FSW.

The "Calibration" tab displays date and time, center frequency, reference level and further parameters of the most recently performed or loaded calibration measurement.

14. Optionally, to store the results from the performed calibration measurement to a CSV file for later use, select the "Store Calibration Data" button.
15. Once the reference data is available in the Multi-Carrier Group Delay application, connect the DUT between the signal generator and the R&S FSW.
16. On the R&S FSW, select the "Display Config" button to enter the SmartGrid mode and select the displays that are of interest to you (up to 6).
Arrange them on the display to suit your preferences, then exit the SmartGrid mode.
17. Press the RUN SINGLE key to start a new measurement.
The group delay is calculated and the selected results are displayed.
18. To store the displayed results in a CSV file:
 - a) Select the  "Save" icon in the toolbar.
 - b) Select the "Export" softkey.
 - c) If necessary, change the decimal separator to be used for the export file.
 - d) Select the "Store Measurement Data" softkey.
 - e) Define a file name and storage location for the results file.
19. To make use of the advanced analysis functions in the displays, select the "Analysis" button in the "Overview".
 - Configure a trace to display the average over a series of sweeps (on the "Trace" tab; if necessary, increase the "Sweep Count" in the "Multi-Carrier Config" settings).
This is recommended for absolute group delay trace results.
 - Configure markers and delta markers to determine deviations and offsets within the signal (on the "Marker" tab).
20. 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".

10 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, try the following methods to optimize the measurement:

Calibration fails

- Check the connection from the signal generator to the R&S FSW.
- Check the settings on the signal generator.
- Check the input signal at the R&S FSW.

No trace visible in "Magnitude Reference" and "Phase Reference" windows

- No calibration data is available, perform a calibration measurement (without the DUT) or load stored calibration data.

No trace visible in "Group Delay" window

- No calibration data is available, perform a calibration measurement (without the DUT) or load stored calibration data.
- MCGD configuration is not compatible to the current calibration (reference) data. Perform a new calibration or adjust measurement settings to fit the calibration data (see [Chapter 6.6.2, "Calibration"](#), on page 49).

Group delay results are not calculated correctly

- Check the connections from the DUT to the R&S FSW and to the signal generator.
- Repeat the calibration measurement (without the DUT) or load stored calibration data from the same measurement setup.
- Check if the MCGD configuration on the R&S FSW fits to the signal sent by the generator.
- Connect an external reference to the R&S FSW to improve accuracy (see the R&S FSW User Manual).
- Check level settings on both the signal generator in use and the R&S FSW MCGD application. Increase the generator's output level and adjust the reference level of the MCGD application accordingly.
- Check the measurement time. Longer measurement times result in better signal to noise ratios in the group delay calculation. The "Meas Time Auto" mode should provide a suitable value in most cases (see ["Measurement Time"](#) on page 47).
- For absolute group delay calculation an external trigger has to be used. Check whether an external trigger is connected and is being sent to the R&S FSW. The trigger periodicity has to be an integer multiple of the signal's periodicity, which is 1/ carrier spacing.
- Increase the sweep count for absolute group delay calculation (for example 100 sweeps) to improve the measurement result. Use the sweep count for calibration as well as for group delay measurement (trace averaging) to compensate for trigger inaccuracies.
- Increase the carrier spacing on the used multi-carrier signal to reduce noise in the group delay calculation. Reducing the carrier spacing for multi-carrier signals leads

to a better frequency resolution, but also causes more noise in the calculated group delay.

- For very low signal levels and short measurement times, the frequency estimation used by the MCGD application to determine the exact position of the carriers can degrade the measurement result due to uncompensated intercarrier interference. Increase the signal generator's output level.

10.1 Error and Status Messages

Error messages are entered in the error/event queue of the status reporting system in the remote control mode and can be queried with the command `SYSTem:ERRor?`.

Warnings are not indicated in the status reporting system, but are displayed in the status bar. A short explanation of the warning messages for the R&S FSW MCGD application is given below.

Table 10-1: Status messages for the R&S FSW MCGD application

Status bar message	Description
"No Calibration Data"	The calibration measurement has not yet been performed, nor have stored settings been loaded.
"Measurement Configuration not compatible to Calibration Data"	MCGD configuration contains a setting that is not compatible to the current calibration (reference) data. Solution: Repeat the calibration measurement (without the DUT) or change the measurement settings.
"Activate external Trigger to measure absolute Group Delay"	The R&S FSW MCGD application is configured to measure the absolute group delay, but no trigger is used. Solution: Activate an external trigger for absolute group delay measurements.

11 Remote Commands to Perform Multi-Carrier Group Delay Measurements

The following commands are required to perform measurements in the Multi-Carrier Group Delay 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 topics specific to Multi-Carrier Group Delay application are described here:

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• Measuring, Loading and Storing Calibration Data	113
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11.1 Introduction

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

The syntax of a SCPI command consists of a header and, 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.

- [Numeric Values](#).....81
- [Boolean](#).....82
- [Character Data](#).....82
- [Character Strings](#).....83
- [Block Data](#).....83

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 80.

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 MCGD application, the following common suffixes are used in remote commands:

Table 11-1: Common suffixes used in remote commands in the R&S FSW MCGD application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 6	Window (in the currently selected measurement channel)
<t>	1 to 4	Trace
<k>	not applicable	Limit line

11.3 Activating Multi-Carrier Group Delay Measurements

Multi-Carrier Group Delay measurements requires a special application on the R&S FSW. A measurement is started immediately with the default settings.

INSTrument:CREate:DUPLicate	84
INSTrument:CREate[:NEW]	84
INSTrument:CREate:REPLace	84
INSTrument:DELeTe	85
INSTrument:LIST?	85
INSTrument:REName	86
INSTrument[:SELeCt]	87
SYSTem:PRESet:CHANnel[:EXECute]	87

INSTrument:CREate:DUPLicate

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

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

Example:

```
INST:SEL 'IQAnalyzer'
```

```
INST:CRE:DUPL
```

Duplicates the channel named 'IQAnalyzer' and creates a new measurement channel named 'IQAnalyzer2'.

Usage: Event

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

This command adds an additional measurement channel.

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

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see [INSTrument:LIST?](#) on page 85.

<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 85).

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 85.
<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 85).
Example:	<code>INST:CRE:REPL 'IQAnalyzer2', IQ, 'IQAnalyzer'</code> 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
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> | <ChannelName>

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 84.

Parameters:

<ChannelType> **MCGD**
Multi-Carrier Group Delay application, R&S FSW-K17
For a list of available channel types see [Table 11-2](#).

<ChannelName> String containing the name of the channel.

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:PRESet:CHAN:EXEC
```

Restores the factory default settings to the "Spectrum2" channel.

Usage:

Event

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

11.4 Configuring Multi-Carrier Group Delay Measurements

The commands required to configure a Multi-Carrier Group Delay measurement in a remote environment are described here.

- [RF Input](#)..... 88
- [Configuring the Vertical Axis \(Amplitude, Scaling\)](#)..... 90
- [Frequency](#)..... 98
- [Triggering Measurements](#)..... 100

- [Multi-Carrier Configuration](#)..... 106
- [Configuring the Outputs](#)..... 110
- [Automatic Settings](#)..... 111

11.4.1 RF Input

INPut:ATTenuation:PROTection:RESet	88
INPut:COUPling	88
INPut:DPATH	88
INPut:FILTer:HPASS[:STATe]	89
INPut:FILTer:YIG[:STATe]	89
INPut:IMPedance	90
INPut:SELEct	90

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.

(For details on the status register see the R&S FSW User Manual).

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 28

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 29**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 29**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 29.

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 29

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 28

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 is supported.

Parameters:

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

Manual operation: See "[Radio Frequency State](#)" on page 28

11.4.2 Configuring the Vertical Axis (Amplitude, Scaling)

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

- [Amplitude Settings](#)..... 90
- [Attenuation](#)..... 91
- [Configuring a Preamplifier](#).....93
- [Scaling the Y-Axis \(+Units\)](#)..... 94

11.4.2.1 Amplitude Settings

- [DISPlay\[:WINDow<n>\]:TRACe<t>:Y\[:SCALe\]:RLEVel](#)..... 90
- [DISPlay\[:WINDow<n>\]:TRACe<t>:Y\[:SCALe\]:RLEVel:OFFSet](#)..... 91

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

This command defines the reference level (for all traces in all windows).

With a reference level offset $\neq 0$, the value range of the reference level is modified by the offset.

Suffix:

<n>, <t> irrelevant

Parameters:

<ReferenceLevel> The unit is variable.
 Range: see datasheet
 *RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "[Reference Level](#)" on page 31

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 31

11.4.2.2 Attenuation

INPut:ATTenuation	91
INPut:ATTenuation:AUTO	92
INPut:EATT	92
INPut:EATT:AUTO	92
INPut:EATT:STATe	93

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If an electronic attenuator is available and active, the command defines a mechanical attenuation (see [INPut:EATT:STATe](#) on page 93).

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 31

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 31

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 92).

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 32

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 32

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 32

11.4.2.3 Configuring a Preampifier

INPut:GAIN:STATe.....	93
INPut:GAIN[:VALue].....	93

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 32

INPut:GAIN[:VALue] <Gain>

This command selects the gain if the preamplifier is activated (INP:GAIN:STAT ON, see INPut:GAIN:STATe on page 93).

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 32

11.4.2.4 Scaling the Y-Axis (+Units)

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe].....	94
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum.....	94
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum.....	95
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE.....	95
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision.....	96
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition.....	96
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue.....	96
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing.....	97
UNIT:ANGLE.....	97

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 34

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 ["Defining Min and Max Values"](#) on page 35

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 ["Defining Min and Max Values"](#) on page 35

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

This command selects the type of scaling of the y-axis (for all traces).

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

Suffix:

<n> [Window](#)
 <t> irrelevant

Parameters:

<Mode> **ABSolute**
 absolute scaling of the y-axis
RELative
 relative scaling of the y-axis
 *RST: ABSolute

Example:

```
DISP:TRAC:Y:MODE REL
```

Manual operation: See ["Scaling"](#) on page 35
See ["Scale Mode"](#) on page 36

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

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

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 ["Range per Division"](#) on page 35

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 Level Position"](#) on page 34
See ["Y-Axis Reference Position"](#) on page 35

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

The command defines the power value assigned to the reference position in the grid (for all traces).

For external generator calibration measurements (requires the optional External Generator Control), this command defines the power offset value assigned to the reference position.

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

<Value> *RST: 0 dBm, coupled to reference level

Example:

DISP:TRAC:Y:RVAL -20dBm

Sets the power value assigned to the reference position to -20 dBm

Manual operation: See "[Y-Axis Reference Value](#)" on page 35

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

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

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<ScalingType> **LOGarithmic**
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example:

DISP:TRAC:Y:SPAC LIN

Selects linear scaling in %.

Usage: SCPI confirmed

Manual operation: See "[Scaling](#)" on page 35

UNIT:ANGLe <Unit>

This command selects the unit for angles (for phase displays).

Parameters:

<Unit> DEG | RAD

*RST: DEG

Example:

UNIT:ANGL DEG

Manual operation: See "Phase Unit (Rad/Deg)" on page 36

11.4.3 Frequency

[SENSe:]FREQUENCY:CENTer.....	98
[SENSe:]FREQUENCY:CENTer:STEP.....	98
[SENSe:]FREQUENCY:CENTer:STEP:AUTO.....	99
[SENSe:]FREQUENCY:CENTer:STEP:LINK.....	99
[SENSe:]FREQUENCY:CENTer:STEP:LINK:FACTor.....	99
[SENSe:]FREQUENCY:OFFSet.....	99

[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: $f_{\max}/2$

Default unit: Hz

Example:

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

Usage: SCPI confirmed

Manual operation: See "Center frequency" on page 37

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

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the SENS:FREQ UP AND SENS:FREQ DOWN commands, see [SENSe:]FREQUENCY:CENTer on page 98.

Parameters:

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

Range: 1 to f_{\max}

*RST: 0.1 x span

Default unit: Hz

Example:

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Sets the center frequency to 110 MHz.

Manual operation: See "[Center Frequency Stepsize](#)" on page 37

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

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

Parameters:

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

Example:

```
FREQ:CENT:STEP:AUTO ON
```

Activates the coupling of the step size to the span.

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

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

Parameters:

<CouplingType> **SPAN**
Couples the step size to the span. Available for measurements in the frequency domain.
OFF
Decouples the step size.
*RST: SPAN

Example:

```
FREQ:CENT:STEP:LINK SPAN
```

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTOR <Factor>

This command defines a step size factor if the center frequency step size is coupled to the span.

Parameters:

<Factor> 1 to 100 PCT
*RST: 10

Example:

```
FREQ:CENT:STEP:LINK:FACT 20PCT
```

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

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

See also "Frequency Offset" on page 38.

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 38

11.4.4 Triggering Measurements

Useful commands for triggering described elsewhere:

- `[SENSe:]FREQuency:CENTer` on page 98

Remote commands exclusive to triggering:

- [Configuring the Triggering Conditions](#).....100
- [Configuring the Trigger Output](#).....104

11.4.4.1 Configuring the Triggering Conditions

<code>TRIGger[:SEQuence]:DTIME</code>	100
<code>TRIGger[:SEQuence]:HOLDoff[:TIME]</code>	100
<code>TRIGger[:SEQuence]:IFPower:HOLDoff</code>	101
<code>TRIGger[:SEQuence]:IFPower:HYSTeresis</code>	101
<code>TRIGger[:SEQuence]:LEVel[:EXTernal<port>]</code>	101
<code>TRIGger[:SEQuence]:LEVel:IFPower</code>	102
<code>TRIGger[:SEQuence]:LEVel:IQPower</code>	102
<code>TRIGger[:SEQuence]:LEVel:RFPower</code>	102
<code>TRIGger[:SEQuence]:RFPower:HOLDoff</code>	103
<code>TRIGger[:SEQuence]:SLOPe</code>	103
<code>TRIGger[:SEQuence]:SOURce</code>	103

`TRIGger[:SEQuence]:DTIME` <DropoutTime>

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

Parameters:

<DropoutTime> Dropout time of the trigger.
 Range: 0 s to 10.0 s
 *RST: 0 s

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

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

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

Parameters:

<Offset> *RST: 0 s

Example: TRIG:HOLD 500us

Manual operation: See ["Trigger Offset"](#) on page 41

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

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

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

Parameters:

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

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

Manual operation: See ["Trigger Holdoff"](#) on page 42

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

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

Parameters:

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

Example: TRIG:SOUR IFP
Sets the IF power trigger source.
TRIG:IFP:HYST 10DB
Sets the hysteresis limit value.

Manual operation: See ["Hysteresis"](#) on page 42

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

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

Note that the variable INPUT/OUTPUT connectors (ports 2+3) must be set for use as input using the [OUTPut:TRIGger<port>:DIRection](#) command.

Suffix:

<port> 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 41

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

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

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.
 *RST: -10 dBm

Example: TRIG:LEV:IFP -30DBM

Manual operation: See "[Trigger Level](#)" on page 41

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

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

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
 *RST: -20 dBm

Example: TRIG:LEV:IQP -30DBM

Manual operation: See "[Trigger Level](#)" on page 41

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]:RFPower:HOLDoff <Time>

This command defines the holding time before the next trigger event. Note that this command is available for any trigger source, not just RF Power.

Note that this command is maintained for compatibility reasons only. Use the [TRIGger\[:SEQuence\]:IFPower:HOLDoff](#) on page 101 command for new remote control programs.

Parameters:

<Time> Default unit: S

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

<Type> POSitive | NEGative

POSitive

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

NEGative

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

*RST: POSitive

Example:

TRIG:SLOP NEG

Manual operation: See "[Slope](#)" on page 42

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

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

Parameters:

<Source>

IMMediate

Free Run

EXTernal

Trigger signal from the TRIGGER INPUT connector.

EXT2

Trigger signal from the TRIGGER INPUT/OUTPUT connector.

Note: Connector must be configured for "Input".

EXT3

Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector.

Note: Connector must be configured for "Input".

RFPower

First intermediate frequency

IFPower

Second intermediate frequency

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 39See ["Free Run"](#) on page 40See ["External Trigger 1/2/3"](#) on page 40See ["IF Power"](#) on page 40See ["RF Power"](#) on page 41See ["I/Q Power"](#) on page 41See ["Trigger Source"](#) on page 48**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.....	104
OUTPut:TRIGger<port>:LEVel.....	105
OUTPut:TRIGger<port>:OTYPe.....	105
OUTPut:TRIGger<port>:PULSe:IMMediate.....	106
OUTPut:TRIGger<port>:PULSe:LENGth.....	106

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 42

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 43

OUTPut:TRIGger<port>:OTYPe <OutputType>

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

Suffix:
 <port> Selects the trigger port to which the output is sent.
 2 = trigger port 2 (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.

UDEfinedSends a user defined trigger signal. For more information see [OUTPut:TRIGger<port>:LEVel](#).

*RST: DEvice

Manual operation: See "[Output Type](#)" on page 43

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 43

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

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

Suffix:

<port>

Selects the trigger port to which the output is sent.

2 = trigger port 2 (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 43

11.4.5 Multi-Carrier Configuration

The following commands are required to configure the multi-carrier measurement.

CALCulate:GRPDelay:MODE	107
CALCulate:GRPDelay:REFerence	107
CALCulate:GRPDelay:REFerence:FREQuency	108
[SENSe:]BANDwidth:DEMod?	108
[SENSe:]BWIDth:DEMod?	108

[SENSe:]CARRier:COUNT.....	108
[SENSe:]CARRier:OFFSet:MODE.....	108
[SENSe:]CARRier:SPACing.....	109
[SENSe:]FREQuency:SPAN.....	109
[SENSe:]MTIME:AUTO.....	109
[SENSe:]MTIME?.....	110
[SENSe:]CARRier:OFFSet?.....	110
[SENSe:]RLENgth?.....	110
[SENSe:]SRATE?.....	110

CALCulate:GRPDelay:MODE <GroupDelayAbsRel>

This command sets the group delay mode for multi carriers to either absolute or relative or queries its current state.

Parameters:

<GroupDelayAbsRel> ABSolute | RELative

ABSolute

Calculates the absolute group delay; requires an external trigger

RELative

Calculates the relative group delay; the reference is configured by `CALCulate:GRPDelay:REFerence`.

*RST: RELative

Manual operation: See "[Group Delay Mode](#)" on page 47

CALCulate:GRPDelay:REFerence <RefType>

Determines the reference used for relative group delay measurement.

Parameters:

<RefType>

AVERage

(Default:) The average group delay is used as a reference

CENTer

The group delay measured for the center frequency is used as a reference

MANual

The group delay measured at the user-defined reference carrier frequency is used as a reference (see `CALCulate:GRPDelay:REFerence:FREQuency` on page 108)

*RST: AVERage

Example:

```
CALC:GRPD:MODE REL
CALC:GRPD:REF MAN
CALC:GRPD:REF:FREQ 5GHZ
```

Manual operation: See "[Reference for relative Calculation / Reference Carrier Frequency](#)" on page 48

CALCulate:GRPDelay:REFerence:FREQuency <RefCarrFreq>

Determines the frequency of the reference carrier used for relative group delay calculation. The group delay measured at this frequency is used as a reference.

Parameters:

<RefCarrFreq> <numeric value>

Example:

```
CALC:GRPD:MODE REL
CALC:GRPD:REF MAN
CALC:GRPD:REF:FREQ 5GHZ
```

Manual operation: See ["Reference for relative Calculation / Reference Carrier Frequency"](#) on page 48

[SENSe:]BANDwidth:DEMod?**[SENSe:]BWIDth:DEMod?**

Queries the measurement bandwidth in Hz

Return values:

<Bandwidth> Default unit: HZ

Usage: Query only

[SENSe:]CARRier:COUNT <Count>

Sets/queries the number of carriers.

Parameters:

<Count>

Manual operation: See ["Number of Carriers"](#) on page 47

[SENSe:]CARRier:OFFSet:MODE <CarrierOffsetMode>

This command is maintained for compatibility reasons only. If estimation is active, the carrier estimation is always used.

Parameters:

<CarrierOffsetMode> ESTimate | FIXed | CARRiers

FIXed

No estimation is performed. The carrier frequencies as defined in the configuration are used; possible offsets or Doppler-effects are not compensated.

(Corresponds to the manual setting "OFF")

CARRiers

The frequency offset of each carrier is estimated and compensated when calculating the group delay.

(Corresponds to the manual setting "All Carriers")

ESTimate

A fixed offset is estimated and used for all carriers.

(Corresponds to the manual setting "Offset")

*RST: CARRiers

Manual operation: See "[Carrier Estimation](#)" on page 48

[SENSe:]CARRier:SPACing <CarrierSpacing>

Sets/queries the carrier spacing in Hz between the multiple carriers.

Parameters:

<CarrierSpacing> Default unit: HZ

Manual operation: See "[Carrier Spacing](#)" on page 47

[SENSe:]FREQuency:SPAN <Frequency>

Sets/queries the frequency span in Hz

Parameters:

<Frequency> Default unit: HZ

Manual operation: See "[Span](#)" on page 37

[SENSe:]MTIME:AUTO <MeasTimeAutoMode>

This command enables or disables automatic measurement time selection.

Parameters:

<MeasTimeAutoMode> ON | 1

Enables automatic measurement time selection.

OFF | 0

Measurement time is defined manually.

*RST: 1

Manual operation: See "[Measurement Time](#)" on page 47

[SENSe:]MTIME? <MeasTime>

This command queries or sets the measurement time.

Parameters:

<MeasTime> The measurement time.
 *RST: 25 ms
 Default unit: S

Usage: Query only

Manual operation: See "[Measurement Time](#)" on page 47

[SENSe:]CARRier:OFFSet?

Queries the offset in Hz of the multi-carrier signal compared to the center frequency.

Return values:

<CarrierOffset> Range: - (Carrier spacing / 2) to + (Carrier spacing / 2)
 Default unit: HZ

Usage: Query only

Manual operation: See "[Carrier Estimation](#)" on page 48

[SENSe:]RLENgth?

This command returns the record length determined by the current measurement settings.

Return values:

<SampleCount> Number of samples captured in one sweep.

Usage: Query only

[SENSe:]SRATe?

This command returns the sample rate set up for current measurement settings.

Return values:

<SampleRate> Current sample rate used by the application.

Usage: Query only

11.4.6 Configuring the Outputs



Configuring trigger input/output is described in [Chapter 11.4.4.2, "Configuring the Trigger Output"](#), on page 104.

[DIAGnostic:SERvice:NSource](#)..... 111

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 52

11.4.7 Automatic Settings

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings and signal characteristics.

[SENSe:]ADJust:CONFigure:DURation	111
[SENSe:]ADJust:CONFigure:DURation:MODE	111
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer	112
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer	112
[SENSe:]ADJust:LEVel	113

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

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

Parameters:

<Duration> Numeric value in seconds
Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example:

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

Manual operation: See "[Changing the Automatic Measurement Time \(Meastime Manual\)](#)" on page 55

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

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

Parameters:

<Mode>

AUTO

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

MANual

The R&S FSW uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 111.

*RST: AUTO

Manual operation:

See "[Resetting the Automatic Measurement Time \(Meastime Auto\)](#)" on page 54

See "[Changing the Automatic Measurement Time \(Meastime Manual\)](#)" on page 55

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

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 113 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>

Range: 0 dB to 200 dB

*RST: +1 dB

Default unit: dB

Example:

```
SENS:ADJ:CONF:HYST:LOW 2
```

For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation:

See "[Lower Level Hysteresis](#)" on page 55

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

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 113 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>

Range: 0 dB to 200 dB

*RST: +1 dB

Default unit: dB

Example:

```
SENS:ADJ:CONF:HYST:UPP 2
```

Example:

For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual operation: See ["Upper Level Hysteresis"](#) on page 55

[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 54

11.5 Measuring, Loading and Storing Calibration Data

The following commands are required to perform the calibration measurement and load and store the calibration data.

CALibration:MCGD	113
CALibration:MCGD:STATe?	113
MMEMory:LOAD:MCGD:RCALibration	114
MMEMory:STORe:MCGD:RCALibration	114

CALibration:MCGD

This command initiates a new calibration. You can synchronize to the end of the measurement as usual with *OPC, *OPC? or *WAI.

Example: CAL:MCGD;*WAI
Performs a calibration measurement and waits for the results.

Usage: Event

Manual operation: See ["Calibrate \(Execute Reference Calibration\)"](#) on page 50

CALibration:MCGD:STATe?

This command queries the calibration status of the Multi Carrier Group Delay application.

Return values:

<State> **ON | 1**
Calibration has been performed, reference data is available.

OFF | 0

Calibration has not yet been performed or is currently running, reference data is not yet available.

Usage: Query only

MMEMory:LOAD:MCGD:RCALibration <File>

This command loads the calibration data stored in the selected file and replaces the current data.

Setting parameters:

<File> path and file name of the .csv file that contains the calibration data

Usage: Setting only

Manual operation: See "[Loading Calibration Data](#)" on page 50

MMEMory:STORe:MCGD:RCALibration <File>

This command stores the current calibration data to the selected file.

Setting parameters:

<File> path and file name of the .csv file that will contain the calibration data

Usage: Setting only

Manual operation: See "[Storing Calibration Data](#)" on page 50

11.6 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

- [General Window Commands](#)..... 114
- [Working with Windows in the Display](#)..... 115

11.6.1 General Window Commands

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see [INSTRument\[:SElect\]](#) on page 87).

[DISPlay:FORMat](#)..... 114

[DISPlay\[:WINDow<n>\]:SIZE](#)..... 115

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 118).

Suffix:

<n>

Window

Parameters:

<Size>

LARGe

Maximizes the selected window to full screen. Other windows are still active in the background.

SMALI

Reduces the size of the selected window to its original size. If more than one measurement window was displayed originally, these are visible again.

*RST: SMALI

Example:

DISP:WIND2:SIZE LARG

11.6.2 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 87).

LAYout:ADD[:WINDow]?	116
LAYout:CATalog[:WINDow]?	117
LAYout:IDENtify[:WINDow]?	117
LAYout:REMove[:WINDow]	118
LAYout:REPLace[:WINDow]	118
LAYout:SPLitter	118
LAYout:WINDow<n>:ADD?	120

LAYout:WINDow<n>:IDENtify?	120
LAYout:WINDow<n>:REMove	121
LAYout:WINDow<n>:REPLace	121

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 "[Magnitude](#)" on page 15
 See "[Magnitude Reference](#)" on page 16
 See "[Phase](#)" on page 16
 See "[Phase Difference](#)" on page 16
 See "[Phase Reference](#)" on page 17
 See "[Group Delay](#)" on page 17
 See "[Gain](#)" on page 18
 See "[Marker Table](#)" on page 18

Table 11-3: <WindowType> parameter values for Multi-Carrier Group Delay (K17) application

Parameter value	Window type
DPHase	Phase Difference vs. frequency
GAIN	Gain

Parameter value	Window type
GDElay	Group Delay vs. frequency
MAGNitude	Magnitude vs. frequency (Measurement data)
MTABle	Marker Table
PHASe	Phase vs. frequency (Measurement data)
RMAGnitude	Magnitude vs. frequency (Reference data)
RPHase	Phase vs. frequency (Reference data)

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 116 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 115 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.

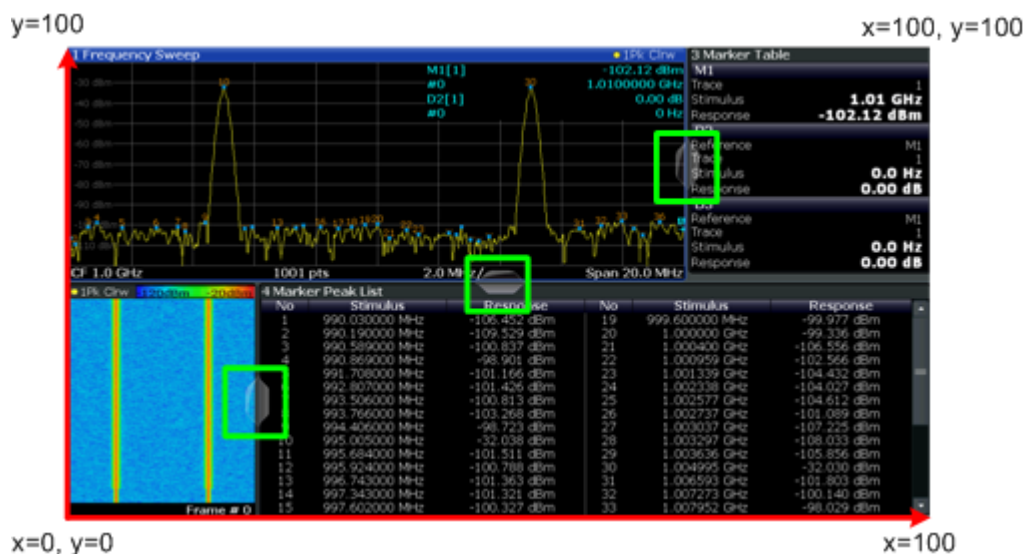


Figure 11-1: SmartGrid coordinates for remote control of the splitters

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 4 ('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 116 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 116 for a list of available window types.

Example:

`LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

11.7 Configuring and Performing Sweeps

When the MCGD application is activated, a continuous sweep is performed automatically. However, you can stop and start a new measurement any time.

Furthermore, you can perform a sequence of measurements using the Sequencer (see "[Multiple Measurement Channels and Sequencer Function](#)" on page 10).

Useful commands for configuring sweeps described elsewhere:

- `[SENSe:]AVERage<n>:COUNT` on page 136

Remote commands exclusive to

<code>ABORT</code>	122
<code>INITiate<n>:CONMeas</code>	123
<code>INITiate<n>:CONTinuous</code>	123

INITiate<n>[:IMMEDIATE].....	124
INITiate<n>:SEQuencer:ABORt.....	124
INITiate<n>:SEQuencer:IMMEDIATE.....	124
INITiate<n>:SEQuencer:MODE.....	125
SYSTem:SEQuencer.....	125
[SENSe:]SWEep:COUNT.....	126
[SENSe:]SWEep:COUNT:CURRent?.....	127

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 sweep mode.

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

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

Suffix:

<n> irrelevant

Usage:

Event

Manual operation: See "[Continue Single Sweep](#)" on page 51

INITiate<n>:CONTinuous <State>

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

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

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

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate<n>:SEQuencer:IMMediate` on page 124) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF | 0 | 1
ON | 1
 Continuous sweep
OFF | 0
 Single sweep
 *RST: 1

Example:

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

Manual operation: See "[Continuous Sweep/RUN CONT](#)" on page 51

INITiate<n>[:IMMEDIATE]

This command starts a (single) new measurement.

With sweep count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

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

For details on synchronization see 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 51

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 124.

To deactivate the Sequencer use [SYSTem:SEQuencer](#) on page 125.

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 125).

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 125).

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.

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

[SENSe:]SWEep:COUNT <SweepCount>

This command defines the number of sweeps the R&S FSW uses to average traces.

During calibration measurements, the phase and amplitude values are averaged over the defined number of sweeps.

In case of continuous sweeps, the R&S FSW calculates the moving average over the average count.

In case of single sweep measurements, the R&S FSW stops the measurement and calculates the average after the average count has been reached.

Parameters:

<SweepCount>

If you set a sweep count of 0 or 1, the R&S FSW performs one single sweep in single sweep mode.

In continuous sweep mode, if the sweep count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 32767

*RST: 0

Example:

SWE:COUN 64

Sets the number of sweeps to 64.

INIT:CONT OFF

Switches to single sweep mode.

INIT;*WAI

Starts a sweep and waits for its end.

Usage:

SCPI confirmed

Manual operation:See "[Sweep Count](#)" on page 48

[SENSe:]SWEep:COUNT:CURRent?

This query returns the current number of started sweeps or measurements. This command is only available if a sweep count value is defined and the instrument is in single sweep mode.

Example:

```
SWE:COUNT 64
Sets sweep count to 64
INIT:CONT OFF
Switches to single sweep mode
INIT
Starts a sweep (without waiting for the sweep end!)
SWE:COUN:CURR?
Queries the number of started sweeps
```

Usage: Query only

11.8 Retrieving Results

The following commands are required to retrieve the results in a remote environment.

- [Retrieving Marker Results](#)..... 127
- [Retrieving Trace Results](#)..... 129
- [Exporting Trace Results](#)..... 131

11.8.1 Retrieving Marker Results

Useful commands for retrieving results described elsewhere:

- [CALCulate<n>:DELTaMarker<m>:X](#) on page 140
- [CALCulate<n>:MARKer<m>:X](#) on page 142

Remote commands exclusive to retrieving marker results:

- [CALCulate<n>:DELTaMarker<m>:X:RELative?](#)..... 127
- [CALCulate<n>:DELTaMarker<m>:Y?](#)..... 128
- [CALCulate<n>:MARKer<m>:Y?](#)..... 128

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 123.

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

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 sweep mode.

See also `INITiate<n>:CONTinuous` on page 123.

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 18

11.8.2 Retrieving Trace Results

The following remote commands are required to retrieve the trace results in a remote environment.

DISPlay[:WINDow<n>]:TRACe<t>:LENGth?	129
FORMat[:DATA]	129
MMEMory:STORe:MCGD:MEAS	130
TRACe<n>[:DATA]?	130
TRACe<n>[:DATA]:X?	131

DISPlay[:WINDow<n>]:TRACe<t>:LENGth?

Queries the trace length.

Return values:

<TraceLength> Number of trace points

Usage:

Query only

FORMat[:DATA] <Format>

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

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

Parameters:

<Format>

AScii

AScii format, separated by commas.

This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32

32-bit IEEE 754 floating-point numbers in the "definite length block format".

In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.

For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example:

```
FORM REAL, 32
```

Usage:

SCPI confirmed

MMEMory:STORe:MCGD:MEAS <File>

This command stores the current measurement results (all active traces in all windows, including calibration traces) to the selected file.

Setting parameters:

<File>

path and file name of the `.CSV` file that contains the measured data

Usage:

Setting only

Manual operation: See ["Storing Measurement Results"](#) on page 70

TRACe<n>[:DATA]? <Trace>

This command queries current trace data and measurement results for the specified window. For each of the measurement points (number is determined by record length, see [\[SENSe:\]RLENgth?](#) on page 110) the power level, phase or group delay value is returned.

Query parameters:

<Trace>

TRACE1 | TRACE2 | TRACE3 | TRACE4

Defines the trace whose data is returned.

Example:

```
TRAC3:DATA? TRACE1
```

Returns the measured values for trace 1 in window 3.

Usage:

Query only

TRACe<n>[:DATA]:X? <TraceNumber>

This command queries the horizontal trace data for each sweep point in the specified window, for example the frequency in frequency domain or the time in time domain measurements.

Suffix:

<n> [Window](#)

Query parameters:

<TraceNumber> Trace number.

TRACE1 | ... | TRACE4

Example:

TRAC3:X? TRACE1

Returns the x-values for trace 1 in window 3.

Usage:

Query only

11.8.3 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.

MMEMory:STORe<n>:TRACe	131
FORMat:DEXPort:DSEParator	132
FORMat:DEXPort:HEADer	132
FORMat:DEXPort:TRACes	132

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

For details on the file format see [Chapter 12.2, "Reference: ASCII File Export Format"](#), on page 157.

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
 (This parameter is ignored if the option "Export all Traces and all Table Results" is activated in the Export configuration settings, see [FORMat:DEXPort:TRACes](#) on page 132).

<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 61

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 50

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

See [Chapter 12.2, "Reference: ASCII File Export Format"](#), on page 157 for details.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

Manual operation: See "[Include Instrument Measurement Settings](#)" on page 60

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see [MMEMory:STORe<n>:TRACe](#) on page 131).

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 60

11.9 Analyzing Multi-Carrier Group Delay Measurements

The following commands are required to analyze MCGD measurements in a remote environment.

- [Configuring Standard Traces](#)..... 133
- [Setting Up Individual Markers](#)..... 138
- [General Marker Settings](#)..... 143
- [Searching for Peaks and Positioning the Marker](#)..... 144

11.9.1 Configuring Standard Traces

Useful commands for trace configuration described elsewhere

- `DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 97
- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 94

Remote commands exclusive to trace configuration

<code>DISPlay[:WINDow<n>]:TRACe<t>:MODE</code>	133
<code>DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous</code>	134
<code>DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture</code>	135
<code>DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]</code>	135
<code>DISPlay[:WINDow<n>]:TRACe<t>[:STATe]</code>	136
<code>[SENSe:]AVERAge<n>:COUNT</code>	136
<code>[SENSe:]AVERAge<n>[:STATe<t>]</code>	137
<code>[SENSe:]AVERAge<n>:TYPE</code>	137

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

This command selects the trace mode.

In case of max hold, min hold or average trace mode, you can set the number of single measurements with [Sweep Count](#). Note that synchronization to the end of the measurement is possible only in single sweep 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 57

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 57

DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture <Percentage>

This command defines the degree (aperture) of the trace smoothing, if [DISPlay\[:WINDow<n>\]:TRACe<t>:SMOothing\[:STATe\]](#) TRUE.

This setting is not available for Phase and Phase Reference vs. frequency results.

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<Percentage> Range: 1 to 50

*RST: 2

Default unit: PCT

Example: DISP3:TRAC2:SMO:APER 5
Defines an aperture of 5% for trace 2 in window 3 (assuming this is not a Phase, Phase Reference, or Magnitude Reference vs. frequency result display).

Manual operation: See "[Smoothing](#)" on page 57

DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe] <State>

This command turns trace smoothing for a particular trace on and off.

If enabled, the trace is smoothed by the value specified using [DISPlay\[:WINDow<n>\]:TRACe<t>:SMOothing:APERture](#) on page 135.

This setting is not available for Phase, Phase Reference, and Magnitude Reference (vs Frequency) results.

Suffix:<n> [Window](#)<t> [Trace](#)**Parameters:**<State> ON | OFF
*RST: OFF**Example:**DISP3:TRAC2:SMO ON
Turns on trace smoothing for trace 2 in window 3
(assuming this is a Group Delay result display).**Usage:** SCPI confirmed**Manual operation:** See "[Smoothing](#)" on page 57**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](#)**Parameters:**<State> ON | OFF | 1 | 0
*RST: Trace 1: 1, Trace 2-4: 0**Example:**

DISP:TRAC3 ON

Usage: SCPI confirmed**Manual operation:** See "[Trace 1/Trace 2/Trace 3/Trace 4](#)" on page 57
See "[Trace 1/Trace 2/Trace 3/Trace 4 \(Softkeys\)](#)" on page 59**[SENSe:]AVERAge<n>:COUNT <AverageCount>**

This command defines the number of sweep s that the application uses to average traces.

During calibration measurements, the phase and amplitude values are averaged over the defined number of sweeps.

In case of continuous sweep mode, the application calculates the moving average over the average count.

In case of single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Suffix:

<n> irrelevant

Parameters:

<AverageCount> If you set an average count of 0 or 1, the application performs one single sweep in single sweep mode. In continuous sweep mode, if the average count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 32767
*RST: 0

Usage: SCPI confirmed

Manual operation: See "Average Count" on page 58

[SENSe:]AVERAge<n>[:STATe<t>] <State>

This command turns averaging for a particular trace in a particular window on and off.

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<State> ON | OFF

Usage: SCPI confirmed

[SENSe:]AVERAge<n>:TYPE <Mode>

This command selects the trace averaging mode.

Suffix:

<n> [Window](#)

Parameters:

<Mode>

VIDeo

The logarithmic power values are averaged.

LINear

The power values are averaged before they are converted to logarithmic values.

POWER

The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.

*RST: VIDeo

Example:

AVER:TYPE LIN

Switches to linear average calculation.

Usage: SCPI confirmed

Manual operation: See "Average Mode" on page 58

11.9.2 Setting Up Individual Markers

The following commands define the position of markers in the diagram.

CALCulate<n>:DELTamarker<m>:AOFF.....	138
CALCulate<n>:DELTamarker<m>:LINK.....	138
CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m>.....	139
CALCulate<n>:DELTamarker<m>:MODE.....	139
CALCulate<n>:DELTamarker<m>:MREF.....	139
CALCulate<n>:DELTamarker<m>[:STATe].....	140
CALCulate<n>:DELTamarker<m>:TRACe.....	140
CALCulate<n>:DELTamarker<m>:X.....	140
CALCulate<n>:MARKer<m>:AOFF.....	141
CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>.....	141
CALCulate<n>:MARKer<m>[:STATe].....	141
CALCulate<n>:MARKer<m>:TRACe.....	142
CALCulate<n>:MARKer<m>:X.....	142

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 64

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 64

CALCulate<n>:DELTamarker<m>:MODE <Mode>

This command defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker.

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see [CALCulate<n>:DELTamarker<m>:X](#) on page 140)!

Suffix:

<n> [Window](#)

<m> irrelevant

Parameters:

<Mode>

ABSolute

Delta marker position in absolute terms.

RELative

Delta marker position in relation to a reference marker.

*RST: RELative

Example:

CALC:DELT:MODE ABS

Absolute delta marker position.

CALCulate<n>:DELTamarker<m>: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 64

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 DELTmarker 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 ["Select Marker"](#) on page 62
See ["Marker State"](#) on page 63
See ["Marker Type"](#) on page 63

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](#)**Parameters:**<Position> Numeric value that defines the marker position on the x-axis.
The unit is s.**Example:**

CALC:DELT:X?

Outputs the absolute x-value of delta marker 1.

Manual operation: See "[Marker Position \(X-value\)](#)" on page 63**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 64**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 64**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 ["Select Marker"](#) on page 62
 See ["Marker State"](#) on page 63
 See ["Marker Type"](#) on page 63

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 64

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.
 The unit is s.

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 18
 See "[Marker Position \(X-value\)](#)" on page 63

11.9.3 General Marker Settings

The following commands control general marker functionality.

<code>CALCulate<n>:MARKer<m>:LINK</code>	143
<code>DISPlay:MINFo[:STAT]</code>	143
<code>DISPlay:MTABLE</code>	143

`CALCulate<n>:MARKer<m>:LINK <State>`

This command sets whether all markers will be linked across all display windows or queries the current setting.

Parameters:
 <State>

Manual operation: See "[Linked Markers](#)" on page 66

`DISPlay:MINFo[:STAT] <DisplayMode>`

This command turns the marker information in all diagrams on and off.

Parameters:
 <DisplayMode> **ON**
 Displays the marker information in the diagrams.
 OFF
 Hides the marker information in the diagrams.
 *RST: ON

Example: `DISP:MINF OFF`
 Hides the marker information.

Manual operation: See "[Marker Info](#)" on page 66

`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 65

11.9.4 Searching for Peaks and Positioning the Marker

The following remote commands are required to search for peaks and position the marker on a trace.

- [Searching for Peaks](#)..... 144
- [Positioning Markers](#) 145
- [Positioning Delta Markers](#)..... 147

11.9.4.1 Searching for Peaks

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.

Application/Result display	Unit
Spectrum	dB
MCGD	dBm, DEG, RAD, S, MS, US, NS, PS, SC

Suffix:

<n>, <m> irrelevant

Parameters:

<Excursion> The excursion is the distance to a trace maximum that must be attained before a new maximum is recognized, or the distance to a trace minimum that must be attained before a new minimum is recognized

 Range: 0 to 80 dB (MCGD: 60 dBm)

 *RST: 6.0

Manual operation: See "[Peak Excursion](#)" on page 67

11.9.4.2 Positioning Markers

The following commands position markers on the trace.

Useful commands for positioning markers described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X` on page 140

Remote commands exclusive to positioning markers

<code>CALCulate<n>:MARKer<m>:MAXimum:LEFT</code>	145
<code>CALCulate<n>:MARKer<m>:MAXimum:NEXT</code>	145
<code>CALCulate<n>:MARKer<m>:MAXimum[:PEAK]</code>	145
<code>CALCulate<n>:MARKer<m>:MAXimum:RIGHT</code>	146
<code>CALCulate<n>:MARKer<m>:MINimum:LEFT</code>	146
<code>CALCulate<n>:MARKer<m>:MINimum:NEXT</code>	146
<code>CALCulate<n>:MARKer<m>:MINimum[:PEAK]</code>	146
<code>CALCulate<n>:MARKer<m>:MINimum:RIGHT</code>	147

`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 68

`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 68

`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 68

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 68

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 69

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 69

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 68

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 69

11.9.4.3 Positioning Delta Markers

The following commands position delta markers on the trace.

Useful commands for positioning delta markers described elsewhere:

- [CALCulate<n>:MARKer<m>:X](#) on page 142

Remote commands exclusive to positioning delta markers

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT	147
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT	148
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]	148
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT	148
CALCulate<n>:DELTamarker<m>:MINimum:LEFT	148
CALCulate<n>:DELTamarker<m>:MINimum:NEXT	149
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]	149
CALCulate<n>:DELTamarker<m>:MINimum:RIGHT	149

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 68

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 68

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 68

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 68

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 69

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 69

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 68

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 69

11.10 Deprecated Commands

The following commands are provided for compatibility to other signal analyzers only. For new remote control programs use the specified alternative commands.



To set the R&S FSW to compatible mode for previous signal analyzers, use the `SYST:LANG` command.

For details see the R&S FSW User Manual.

<code>CALCulate<n>:FEED</code>	150
<code>DISPlay[:WINDow<n>]:TYPE</code>	150
<code>[SENSe:]ADEMod:BANDwidth:DEModulation?</code>	151
<code>[SENSe:]ADEMod:BWIDth:DEModulation?</code>	151
<code>[SENSe:]ADEMod:MCPHase:METHod</code>	151
<code>[SENSe:]ADEMod:MCPHase:SPACing</code>	151
<code>[SENSe:]ADEMod:MCPHase[:STATe]</code>	151
<code>[SENSe:]ADEMod:SPECtrum:PHASe:RESult?</code>	152
<code>[SENSe:]ADEMod:SPECtrum:PHASe:TYPE</code>	152
<code>[SENSe:]ADEMod:SPECtrum:SPAN</code>	152
<code>[SENSe:]ADEMod:SPECtrum:SPAN:ZOOM</code>	152
<code>[SENSe:]ADEMod:SPECtrum:SPAN[:MAXimum]</code>	153
<code>[SENSe:]ADEMod:SPECtrum[:MAGNitude]:RESult?</code>	153
<code>[SENSe:]ADEMod:SPECtrum[:MAGNitude][:TYPE]</code>	153
<code>[SENSe:]ADEMod:MTIme?</code>	153
<code>[SENSe:]ADEMod:MTIme:AUTO</code>	153
<code>[SENSe:]ADEMod:RELEngth?</code>	154
<code>[SENSe:]ADEMod:SRATe?</code>	154
<code>[SENSe:]ADEMod[:STATe]</code>	154

CALCulate<n>:FEED <Evaluation>

This command selects the evaluation method of the measured data that is to be displayed in the specified window.

This command queries or sets the diagram type (for magnitude or for phase).

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see [Chapter 11.6.2, "Working with Windows in the Display"](#), on page 115).

Parameters:

<Evaluation>	'XFRequency:SPECtrum[:MAGNitude]' Magnitude diagram
	'XFRequency:SPECtrum:PHASe' Phase diagram

DISPlay[:WINDow<n>]:TYPE <ResultType>

This command selects the results displayed in a measurement window.

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see [Chapter 11.6.2, "Working with Windows in the Display"](#), on page 115).

Parameters:

<ResultType>

Table 11-4: <WindowType> parameter values for Multi-Carrier Group Delay (K17) mode

Parameter value	Window type
DPHase	Phase Difference
GAIN	Gain
GDElay	Group Delay
MAGNitude	Magnitude (Measurement data)
MTABle	Marker table
PHASe	Phase (Measurement data)
RMAGNitude	Magnitude (Reference data)
RPHase	Phase vs frequency (Reference data)

[SENSe:]ADEMod:BANDwidth:DEModulation?**[SENSe:]ADEMod:BWIDth:DEModulation?**

This command queries the measurement bandwidth.

Note that this command is maintained for compatibility reasons only. Use [\[SENSe:\]BANDwidth:DEMod?](#) on page 108 for new remote control programs.

Return values:

 Default unit: HZ

Usage: Query only

[SENSe:]ADEMod:MCPHase:METHod <Method>

This command selects the method used for group delay measurements. As the R&S FSW MCGD application only supports orthogonal measurements, this command returns an error if the FLATtop parameter is used.

Parameters:

<Method> ORTHogonal | FLATtop

[SENSe:]ADEMod:MCPHase:SPACing <CarrierSpacing>

Sets/queries the carrier spacing in Hz between the multiple carriers.

Note that this command is maintained for compatibility reasons only. Use [\[SENSe:\]CARRier:SPACing](#) on page 109 for new remote control programs.

Parameters:

<CarrierSpacing> Default unit: HZ

[SENSe:]ADEMod:MCPHase[:STATe] <State>

This command switches to the Multi Carrier Group Delay application of the instrument or disables it.

Note that this command is maintained for compatibility reasons only. Use the `INST:SEL MCGD` command for new remote control programs (see `INSTrument[:SElect]` on page 87).

Parameters:

<State>

[SENSe:]ADEMod:SPECTrum:PHASe:RESult? <WindowType>

This command returns the trace data of the first trace of the given type within the phase window.

Note that this command is maintained for compatibility reasons only. Use `TRACe<n>[:DATA]?` on page 130 for new remote control programs.

Query parameters:

<WindowType> WRITe | AVERAge | MINHold | MAXHold

Usage: Query only

[SENSe:]ADEMod:SPECTrum:PHASe:TYPE <Trace1>, <Trace2>, <Trace3>

This command sets the modes of the first three traces of phase windows.

Note that this command is maintained for compatibility reasons only. Use `DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 133 for new remote control programs.

Parameters:

<Trace1> WRITe | AVERAge | MINHold | MAXHold | VIEW | OFF

<Trace2> WRITe | AVERAge | MINHold | MAXHold | VIEW | OFF

<Trace3> WRITe | AVERAge | MINHold | MAXHold | VIEW | OFF

[SENSe:]ADEMod:SPECTrum:SPAN <Frequency>

Sets/queries the frequency span in Hz.

Note that this command is maintained for compatibility reasons only. Use the `[SENSe:]FREQuency:SPAN` on page 109 command for new remote control programs.

Parameters:

<Frequency> Default unit: HZ

[SENSe:]ADEMod:SPECTrum:SPAN:ZOOM <Value>

This command sets the span.

Note that this command is maintained for compatibility reasons only. Use `[SENSe:]FREQuency:SPAN` on page 109 for new remote control programs.

Parameters:

<Value> Default unit: HZ

[SENSe:]ADEMod:SPECTrum:SPAN[:MAXimum] <Value>

This command sets the span.

Note that this command is maintained for compatibility reasons only. Use [\[SENSe:\]FREQuency:SPAN](#) on page 109 for new remote control programs.

Parameters:

<Value> Default unit: HZ

[SENSe:]ADEMod:SPECTrum[:MAGNitude]:RESult? <WindowType>

This command returns the trace data of the first trace of the given type within the magnitude window.

Note that this command is maintained for compatibility reasons only. Use [TRACe<n>\[:DATA\]?](#) on page 130 for new remote control programs.

Query parameters:

<WindowType> WRITe | AVERAge | MINHold | MAXHold

Usage: Query only

[SENSe:]ADEMod:SPECTrum[:MAGNitude][:TYPE] <Trace1>, <Trace2>, <Trace3>

This command sets the modes of the first three traces of magnitude windows.

Note that this command is maintained for compatibility reasons only. Use [DISPlay\[:WINDow<n>\]:TRACe<t>:MODE](#) on page 133 for new remote control programs.

Parameters:

<Trace1> WRITe | AVERAge | MINHold | MAXHold | VIEW | OFF

<Trace2> WRITe | AVERAge | MINHold | MAXHold | VIEW | OFF

<Trace3> WRITe | AVERAge | MINHold | MAXHold | VIEW | OFF

[SENSe:]ADEMod:MTIME? <MeasTime>

This command queries or sets the measurement time.

Note that this command is maintained for compatibility reasons only. Use [\[SENSe:\]MTIME?](#) on page 110 for new remote control programs.

Parameters:

<MeasTime> Default unit: S

Usage: Query only

[SENSe:]ADEMod:MTIME:AUTO <MeasTimeAutoMode>

This command enables or disables automatic measurement time selection.

Note that this command is maintained for compatibility reasons only. Use `[SENSe:]MTIME: AUTO` on page 109 for new remote control programs.

Parameters:

<MeasTimeAutoMode>

[SENSe:]ADEMod:RLENgth?

This command returns the record length set up for current measurement settings.

Note that this command is maintained for compatibility reasons only. Use the `[SENSe:]RLENgth?` on page 110 command for new remote control programs.

Return values:

<SampleCount>

Usage: Query only

[SENSe:]ADEMod:SRATe?

This command returns the sample rate set up for current measurement settings.

Note that this command is maintained for compatibility reasons only. Use `[SENSe:]SRATe?` on page 110 for new remote control programs.

Return values:

<SampleRate>

Usage: Query only

[SENSe:]ADEMod[:STATe] <State>

This command switches to the Analog Demodulation application or disables it.

Note that this command is maintained for compatibility reasons only. Use the `INST:SEL ADEM` command for new remote control programs.

Parameters:

<State>

11.11 Programming Example: Measuring Multi-Carrier Group Delay

This example demonstrates how to perform a multi-carrier group delay measurement in a remote environment. It assumes a multi-carrier signal is being input, for example by a connected signal generator. Furthermore, it assumes an external trigger and an external reference frequency are being provided by a connected signal generator. The commands to set up the signal generator are not provided in this example.

```
//----- Preparing the measurement -----
//Reset the instrument
```

Programming Example: Measuring Multi-Carrier Group Delay

```

*RST
//Configure the use of an external reference frequency at 10 MHz
SENS:ROSC:SOUR EXT
SOUR:EXT:ROSC:EXT:FREQ 10MHZ

//Activate the MCGD measurement application
INST:SEL 'MCGD'

// -----Configuring the measurement -----
//Configure the use of an external trigger at 1.5V
TRIG:SOUR EXT
TRIG:LEV:EXT 1.5V

//Set the center frequency to 100 MHz
FREQ:CENT 100MHZ
//Set the carrier spacing to 200 kHz for 50 carriers
SENS:CARR:SPAC 200 kHz
SENS:CARR:COUN 51
//Query the resulting span (10 MHz)
SENS:FREQ:SPAN?
//Set the attenuation and reference level automatically
SENS:ADJ:LEV
//Set a sweep count of 100
SENS:SWE:COUN 100
//Configure absolute group delay
CALC:GRPD:MODE ABS
//Activate carrier estimation for each carrier
SENS:CARR:OFFS:MODE CARR
//Query the record length and sample rate determined by the meas settings
SENS:RLEN?
SENS:SRAT?

//-----Configuring the calibration measurement-----
//Perform new calibration measurement and wait for completion
CAL:MCGD;*WAI
//Query the state of the calibration measurement
CAL:MCGD:STAT?
//Store the resulting calibration data to a file
MMEM:STOR:MCGD:RCAL 'C:\TESTS\CalData.csv'

//-----Configuring the result displays-----
//Add a Magnitude Reference and replace the Phase by a Gain display:
//Top row: 1) Magnitude (default) 2) Magnitude Reference
//Bottom row: 3) Group Delay (default) 4) Gain
LAY:REPL '2',RMAG
LAY:ADD:WIND? '3',RIGH,GAIN

//-----Performing the Measurement-----
//Switch to single mode, initiate a new measurement and wait
//until the sweep has finished.

```

```
INIT:CONT OFF
INIT;*WAI

//-----Retrieving Results-----
//Store the results of the multicarrier measurement to a file
MMEM:STOR:MCGD:MEAS 'C:\TESTS\MeasResults.csv'
```

12 Annex

- [Formats for Returned Values: ASCII Format and Binary Format](#).....157
- [Reference: ASCII File Export Format](#).....157
- [Reference: CSV File Export Format](#).....159

12.1 Formats for Returned Values: ASCII Format and Binary Format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMat[:DATA]`. The possible formats are described here.

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

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



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

12.2 Reference: ASCII File Export Format

Trace data (both measurement and reference traces) 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 50).

The data of the file header consist of two columns, separated by a semicolon: parameter name; numeric value. The data section contains the measured data in two columns, which are also separated by a semicolon.

Table 12-1: ASCII file format for trace export

File contents	Description
Header data	
Type;R&S FSW;	Instrument model
Version;1.30;	Firmware version
Date;20.Jan 2012;	Date of data set storage
Mode;MCGD	Channel type
Ref Level;0;	Reference level
Level offset;0;	Reference level offset
Rf Att;10;	Input attenuation
EI Att;0;	Electronic attenuation
Center Freq;10000000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;10000000;Hz	Frequency range
Carrier Spacing;10000000;Hz	Distance between two carriers
Meas Time;0.00003128125;s	Measurement time
Group Delay;Absolute;	Value type for group delay
Carrier Offset;AUTO;	Auto mode for carrier offset
Carrier Offset;0;Hz	Carrier offset value
Sweep Count;0;	Number of sweeps set
Preamplifier;OFF	Preamplifier status
Window;1 Magnitude;	Window name containing trace
Trace 1;;;	Selected trace
Trace Mode;Clear Write	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
x-Axis;Linear;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
Start;95000000;Hz Stop;105000000;Hz	Start/stop value of the display range
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Axis;Linear;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN

File contents	Description
Ref Position;100; %	Position of reference value referred to diagram limits (0 % = lower edge)
Ref Value;0.0;dBm	Reference value
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Data section	
Values; 1001;	Number of measurement points
95000000;-20.5 96000000;-20.3 97000000;-24.2 ...;...;	Measured values: <x value>, <y value>

12.3 Reference: CSV File Export Format

Measurement results and calibration data can be exported to a file in CSV format for further evaluation in other applications. Note that as opposed to the [Export Trace to ASCII File](#), storing the measurement results in csv format includes all traces in all windows, not just one single trace.

The file consists of the header containing important parameters and a data section containing the measurement data.

Generally, the format of this CSV 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 50).

The data of the file header consist of three columns; each separated by a semicolon: parameter name; numeric value; basic unit. The data section contains the measured data in two columns, which are also separated by a semicolon.

Table 12-2: CSV file format for calibration data export

File contents	Description
Header data	
Type;R&S FSW-K17 Reference Calibration;	Type of data
Version;1.40;	Firmware version
Date;20.Jan 2012;	Date of data set storage
Mode;MCGD	Channel type
Center Freq;10000000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;10000000;Hz	Frequency range

File contents	Description
Number of Carriers;51;	Number of carriers
Carrier Spacing;10000000;Hz	Distance between two carriers
Meas Time;0.00003128125;s	Measurement time
Sweep Count;0	Sweep count
Trace type;Amplitude Reference Calibration	Data source and result display (Magnitude Reference)
x-Unit;Hz;	Unit of x values
y-Unit;V;	Unit of y values
Data section	
Values; 51;	Number of measurement points
95000000;-20.5 96000000;-20.3 97000000;-24.2 ...;...;	Measured values: <x value>; <y value>

Table 12-3: CSV file format for measurement data export

File contents	Description
Header data	
Type;R&S FSW;	Instrument model
Version;1.30;	Firmware version
Date;20.Jan 2012;	Date of data set storage
Mode;MCGD;DB1.00	Channel type; database version
Ref Level;0;	Reference level
Level offset;0;	Reference level offset
Rf Att;10;	Input attenuation
EI Att;0;	Electronic attenuation
Center Freq;10000000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;10000000;Hz	Frequency range
Number of Carriers;51;	Number of carriers
Carrier Spacing;10000000;Hz	Distance between two carriers
Meas Time;0.00003128125;s	Measurement time
Group Delay;Absolute;	Value type for group delay
Carrier Offset;AUTO;	Auto mode for carrier offset
Carrier Offset;0;Hz	Carrier offset value
Sweep Count;0;	Number of sweeps set

File contents	Description
Preamplifier;OFF	Preamplifier status
Number of windows	Number of windows included in export
Data section for individual window	
Window;1 Magnitude	Name of first window (= result display)
Data section for individual trace	
Trace 1;;	First trace
Trace Mode;Clear Write;	Display mode of trace: CLR/WRITE;AVERAGE;MAXHOLD;MINHOLD
x-Axis;Linear;	Scaling of x-axis: linear (LIN) or logarithmic (LOG)
Start;95000000;Hz Stop;105000000;Hz	Start/stop value of the display range
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Axis;Linear;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG; % with x-axis LIN
Ref Position;100; %	Position of reference value referred to diagram limits (0 % = lower edge)
Ref Value;0.0;dBm	Reference value
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Values; 1001;	Number of measurement points
95000000;-20.5 96000000;-20.3 97000000;-24.2 ...;...;	Measured values: <x value>; <y value>
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 Phase;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

List of Remote Commands (MC Group Delay)

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