

# R&S®ESW

## Spectrum Application

## User Manual



1177630002  
Version 11

**ROHDE & SCHWARZ**  
Make ideas real



This manual describes the following R&S®ESW models:

- R&S®ESW8 (1328.4100K08)
- R&S®ESW8 (1328.4100K09)
- R&S®ESW26 (1328.4100K26)
- R&S®ESW26 (1328.4100K27)
- R&S®ESW44 (1328.4100K44)
- R&S®ESW44 (1328.4100K45)

The contents of this manual correspond to firmware version 3.20 and higher.

The Spectrum application is integral part of the R&S®ESW.

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1177.6300.02 | Version 11 | R&S®ESW

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®ESW is indicated as R&S ESW.

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# 1 Preface

## 1.1 About this manual

This User Manual provides all the information specific to **RF measurements in the Spectrum application**. All other operating modes and applications are described in the specific application manuals.

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

- **Welcome to the R&S ESW**  
Introduction to and getting familiar with the instrument
- **Measurements**  
Descriptions of the individual measurements in the Spectrum application, including result types and configuration settings.
- **Common Measurement Settings**  
Description of the measurement settings common to all measurement types with their corresponding remote control commands
- **Common Measurement Analysis and Display Functions**  
Description of the settings and functions provided to analyze results independently of the measurement type with their corresponding remote control commands
- **Remote Commands**  
Remote commands required to configure and perform measurements in a remote environment, sorted by tasks  
Remote commands required to set up the environment and to perform common tasks on the instrument, sorted by tasks  
Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **List of Commands**  
Alphabetical list of all remote commands described in the manual
- **Index**

## 1.2 Documentation overview

This section provides an overview of the R&S ESW user documentation. Unless specified otherwise, you find the documents at:

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

### 1.2.1 Getting started manual

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

A printed version is delivered with the instrument. A PDF version is available for download on the Internet.

### 1.2.2 User manuals and help

Separate user manuals are provided for the base unit and the firmware applications:

- **Base unit manual**  
Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- **Firmware application manual**  
Contains the description of the specific functions of a firmware application, including remote control commands. Basic information on operating the R&S ESW is not included.

The contents of the user manuals are available as help in the R&S ESW. The help offers quick, context-sensitive access to the complete information for the base unit and the firmware applications.

All user manuals are also available for download or for immediate display on the Internet.

### 1.2.3 Service manual

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

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

<https://gloris.rohde-schwarz.com>

### 1.2.4 Instrument security procedures

Deals with security issues when working with the R&S ESW in secure areas. It is available for download on the internet.



### 1.2.5 Printed safety instructions

Provides safety information in many languages. The printed document is delivered with the product.

### 1.2.6 Specifications and brochures

The specifications document, also known as the data sheet, contains the technical specifications of the R&S ESW. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See [www.rohde-schwarz.com/brochure-datasheet/esw](http://www.rohde-schwarz.com/brochure-datasheet/esw)

### 1.2.7 Release notes and open source acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation.

The firmware uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

See [www.rohde-schwarz.com/firmware/esw](http://www.rohde-schwarz.com/firmware/esw)

### 1.2.8 Application notes, application cards, white papers, etc.

These documents deal with special applications or background information on particular topics.

See [www.rohde-schwarz.com/application/esw](http://www.rohde-schwarz.com/application/esw)

### 1.2.9 Videos

Find various videos on Rohde & Schwarz products and test and measurement topics on YouTube: <https://www.youtube.com/@RohdeundSchwarz>

## 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 and knob names are enclosed by square brackets.  |
| Filenames, commands, program code   | Filenames, 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.   |
| <a href="#">Links</a>               | 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 operating 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 many as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

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 spectrum application

The Spectrum application is a firmware application that adds functionality to perform signal and spectrum analysis to the R&S ESW. The application is part of the R&S ESW firmware.

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 Receiver application and are described in the R&S ESW User Manual. The latest versions of the manuals are available for download at the product homepage.

<http://www2.rohde-schwarz.com/product/ESW.html>.

### Installation

Find detailed installing instructions in the Getting Started or the release notes of the R&S ESW.

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### 2.1 Starting the application


**Access:** [MODE] > "Spectrum"

#### Multiple Measurement Channels and Sequencer Function

When you enter 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 (as well as 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 ESW User Manual.

## 2.2 Understanding the display information

The following figure shows the display as it looks for measurements in spectrum mode. All different information areas are labeled. They are explained in more detail in the following sections.

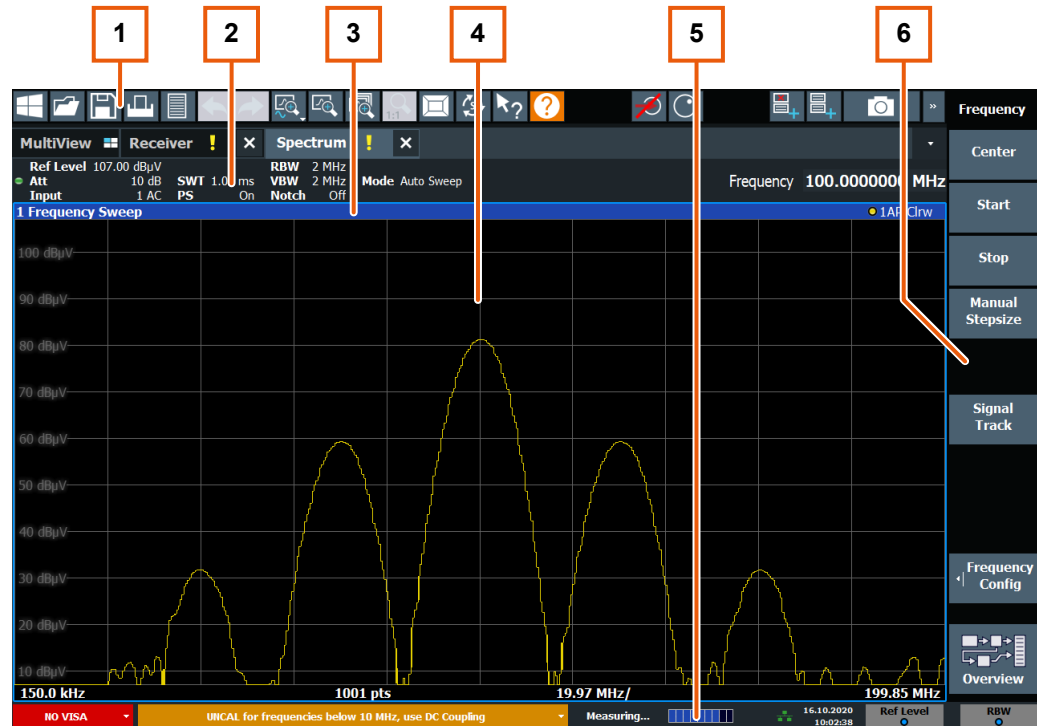


Figure 2-1: Screen layout of the noise figure measurement application

- 1 = Toolbar
- 2 = Channel bar
- 3 = Diagram header
- 4 = Result display
- 5 = Status bar
- 6 = Softkey bar

### Channel bar information

The channel bar contains information about the current measurement setup, progress and results.

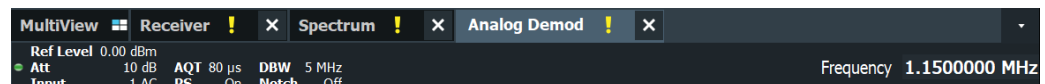


Figure 2-2: Channel bar of the Spectrum application

|                  |                                 |
|------------------|---------------------------------|
| <b>Ref Level</b> | Reference level of the R&S ESW. |
| <b>Att</b>       | Attenuation of the R&S ESW.     |
| <b>Input</b>     | Input and input coupling        |

|                  |   |
|------------------|---|
| <b>SWT</b>       | Sweep time  |
| <b>PS</b>        | Preselector state   |
| <b>RBW</b>       | Resolution bandwidth  |
| <b>VBW</b>       | Video bandwidth   |
| <b>Mode</b>      | Currently selected measurement mode, including the sweep count. |
| <b>Frequency</b> | Center frequency  |

### Window title bar information

For each diagram, the header provides the following information:



**Figure 2-3: Window title bar information for the Noise Figure application**

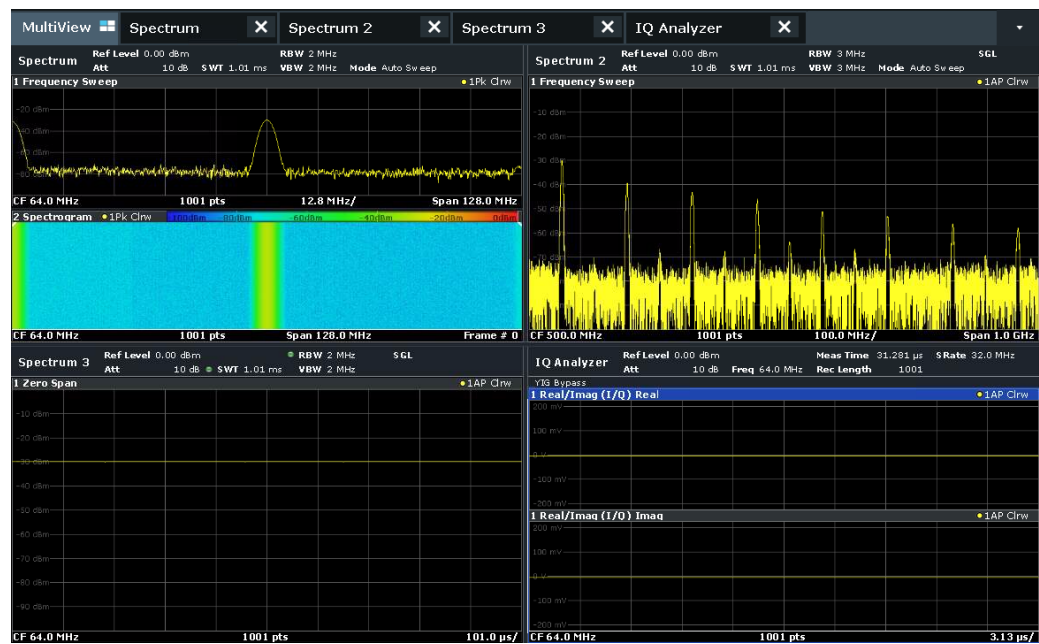
- 1 = Window number
- 2 = Window type
- 3 = Trace color and number
- 4 = Trace mode and detector

### 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.

## 2.3 R&S multiview

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



Remote command:

DISPlay:FORMat on page 461

### 3 Measurements and results

**Access:** "Overview" > "Select Measurement"

**Or:** [MEAS]

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

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

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

The measurement function determines which settings, functions and evaluation methods are available in the R&S ESW. The various measurement functions are described in detail here.

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

The easiest way to configure measurements is using the configuration "Overview", see [Chapter 4.2, "Configuration overview"](#), on page 221.

In addition to the measurement-specific parameters, the general parameters can be configured as usual, see [Chapter 4, "Common measurement settings"](#), on page 221. Many measurement functions provide special result displays or evaluation methods; however, in most cases the general evaluation methods are also available, see [Chapter 5, "Common analysis and display functions"](#), on page 331.

The remote commands required to retrieve measurement results are described in [Chapter 6.9.2.1, "Trace data retrieval"](#), on page 689.

|   |     |
|---|-----|
| • <a href="#">Basic measurements</a> .....  | 20  |
| • <a href="#">Channel power and adjacent-channel power (ACLR) measurement</a> ..... | 40  |
| • <a href="#">Carrier-to-noise measurements</a> .....                               | 90  |
| • <a href="#">Occupied bandwidth measurement (OBW)</a> .....                        | 94  |
| • <a href="#">Spectrum emission mask (SEM) measurement</a> .....                    | 100 |
| • <a href="#">Spurious emissions measurement</a> .....                              | 145 |
| • <a href="#">Statistical measurements (APD, CCDF)</a> .....                        | 158 |
| • <a href="#">Time domain power measurement</a> .....                               | 172 |
| • <a href="#">Harmonic distortion measurement</a> .....                             | 178 |
| • <a href="#">Third order intercept (TOI) measurement</a> .....                     | 184 |
| • <a href="#">AM modulation depth measurement</a> .....                             | 194 |
| • <a href="#">Electromagnetic interference (EMI) measurement</a> .....              | 197 |

## 3.1 Basic measurements

Basic measurements are common sweeps in the time or frequency domain which provide an overview of the basic input signal characteristics.

If no other measurement function is selected, or if all measurement functions are switched off, the R&S ESW performs a basic frequency or time sweep.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 4, "Common measurement settings"](#), on page 221).

### 3.1.1 Basic measurement types

|                        |    |
|------------------------|----|
| Frequency Sweep.....   | 20 |
| Zero Span.....         | 20 |
| All Functions Off..... | 21 |

#### Frequency Sweep

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

Various other measurements are based on the common frequency sweep, but require additional configuration of sweep spans or amplitude limits, for example.

Examples for frequency sweep measurements are:

- Adjacent channel power (ACP)
- Carrier-to-noise (C/N)
- Occupied bandwidth (OBW)
- Spectrum emission mask (SEM)
- Spurious emissions
- Third order intercept (TOI)
- AM modulation depth
- Electromagnetic interference (EMI)

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 4, "Common measurement settings"](#), on page 221).

Remote command:

[SENSe:] FREQuency: START on page 655, [SENSe:] FREQuency: STOP on page 655

INITiate<mt>[: IMMediate] on page 470

INITiate<n>: CONTInuous on page 471

#### Zero Span

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

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 4, "Common measurement settings"](#), on page 221).



Most result evaluations can also be used for zero span measurements, although some functions (e.g. markers) may work slightly differently and some may not be available. If so, this will be indicated in the function descriptions (see [Chapter 5, "Common analysis and display functions"](#), on page 331).

Remote command:

[SENSe:]FREQuency:SPAN on page 654

INITiate<mt>[:IMMediate] on page 470

INITiate<n>:CONTinuous on page 471

### All Functions Off

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

Selecting "Frequency Sweep" has the same effect.

## 3.1.2 How to perform a basic sweep measurement

The following step-by-step instructions demonstrate how to perform basic sweep measurements.



For remote operation, see [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617.

### To perform one or more single sweeps

1. Configure the frequency and span to be measured ("Frequency" dialog box, see [Chapter 4.4, "Frequency and span configuration"](#), on page 281).
2. Configure the number of sweeps to be performed in a single measurement ("Sweep Config" dialog box, see ["Sweep/Average Count"](#) on page 307).
3. If necessary, configure how the signal is processed internally ("Bandwidth" dialog box, see ["Sweep Type"](#) on page 309).
4. If necessary, configure a trigger for the measurement ("Trigger/ Gate Config" dialog box.  
See [Chapter 4.7, "Trigger and gate configuration"](#), on page 312
5. Define how the results are evaluated for display ("Trace" dialog box, see [Chapter 5.3.2.1, "Trace settings"](#), on page 366).
6. If necessary, configure the vertical axis of the display ("Amplitude" dialog box, see [Chapter 4.5.3, "Scaling the y-axis"](#), on page 295).
7. To start the measurement, select one of the following:
  - [RUN SINGLE]
  - "Single Sweep" in the "Sweep" menu

The defined number of sweeps are performed, then the measurement is stopped. While the measurement is running, the [RUN SINGLE] key is highlighted. To abort the measurement, press [RUN SINGLE] again. The key is no longer highlighted. The results are not deleted until a new measurement is started.

8. To repeat the same number of sweeps without deleting the last trace, select "Continue Single Sweep" in the "Sweep" menu.

#### To start continuous sweeping

1. If you want to average the trace or search for a maximum over more (or less) than 10 sweeps, configure the "Sweep/Average Count" ("Sweep Config" dialog box, see ["Sweep/Average Count"](#) on page 307).
2. To start the measurement, select one of the following:
  - [RUN CONT]
  - "Continuous Sweep" in the "Sweep" menu

After each sweep is completed, a new one is started automatically. While the measurement is running, the [RUN CONT] key is highlighted. To stop the measurement, press [RUN CONT] again. The key is no longer highlighted. The results are not deleted until a new measurement is started.

### 3.1.3 Measurement examples - measuring a sinusoidal signal

One of the most common measurement tasks that can be handled using a signal analyzer is determining the level and frequency of a signal. When measuring an unknown signal, you can usually start with the presettings.

#### Test setup

1. Configure the signal generator (e.g. R&S SMW):
    - **Frequency:** 128 MHz
    - **Level:** -30 dBm
  2. **NOTICE!** Signal levels exceeding 30 dBm can damage the RF attenuator or the input mixer. When calculating the expected power level, consider the total power of all occurring signals.  
If you measure signals higher than +30 dBm (=1 W), insert a power attenuator before the RF input of the analyzer.
  3. Connect the RF output of the signal generator to the RF input of the R&S ESW.
- [Measuring the level and frequency using markers](#).....22
  - [Measuring the signal frequency using the signal counter](#)..... 24

#### 3.1.3.1 Measuring the level and frequency using markers

The level and frequency of a sinusoidal signal can be measured easily using the marker function. The R&S ESW always displays its amplitude and frequency at the marker position. The frequency measurement uncertainty is determined by the reference frequency of the R&S ESW, the resolution of the marker frequency display and the number of sweep points.

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Connect the signal to be measured to the "RF INPUT" connector on the R&S ESW.
4. Set the center frequency to *128 MHz*.
5. Reduce the frequency span to *1 MHz*.

**Note:** Coupled settings. When the frequency span is defined, the resolution bandwidth, the video bandwidth and the sweep time are automatically adjusted, because these functions are defined as coupled functions in the presets.

6. Select [MKR] to activate marker 1 and automatically set it to the maximum of the trace.

The level and frequency values measured by the marker are displayed in the marker information at the top of the display.

**Note:** Performing a peak search. When a marker is initially activated, it automatically performs the peak search function (as shown in the example).

If a marker was already active, select [Peak Search] or the "Peak" softkey in the [MKR >] menu in order to set the currently active marker to the maximum of the displayed signal.

### Increasing the frequency resolution

The frequency resolution of the marker is determined by the resolution of the trace. A trace consists of 1001 trace points, i.e. if the frequency span is 1 MHz, each trace point represents a span of approximately 1 kHz. This corresponds to a maximum uncertainty of +/- 0.5 kHz.

You can increase the resolution of the trace by reducing the frequency span or by using more sweep points.

### Reducing the frequency span to 10 kHz

- Reduce the frequency span to *10 kHz*.

The resolution of the trace is now approximately 10 Hz (10 kHz span / 1001 trace points), thus, the precision of the marker frequency display increases to approximately ±5 Hz.

### Setting the reference level

The reference level is the level at the upper limit of the diagram. To achieve the widest dynamic range possible for a spectrum measurement, use the entire level span of the R&S ESW. In other words, the highest level that occurs in the signal should be located at the top edge of the diagram (= reference level) or immediately below it.



### Low Reference Levels

If the selected reference level is lower than the highest signal that occurs in the spectrum, the signal path in the R&S ESW is overloaded.

In this case, the message "IFOVL" is displayed in the error message field.

In the presets, the value of the reference level is 0 dBm. If the input signal is -30 dBm, the reference level can be reduced by 30 dB without causing the signal path to be overloaded.

### Reducing the reference level by 30 dB

- Set the reference level to *-30 dBm*.

The maximum of the trace is near the maximum of the measurement diagram. The increase in the displayed noise is not substantial. Thus, the distance between the signal maximum and the noise display (=dynamic range) has increased.

### Setting the reference level with the help of a marker

You can also use a marker to shift the maximum value of the trace directly to the top edge of the diagram. If the marker is located at the maximum level of the trace (as in this example), the reference level can be moved to the marker level as follows:

1. Press [MKR ->].
2. Select "Ref Lvl = Mkr Lvl".

The reference level is set to the current marker level.

### 3.1.3.2 Measuring the signal frequency using the signal counter

The built-in signal counter allows you to measure the frequency more accurately than measuring it with the marker. The frequency sweep is stopped at the marker, and the R&S ESW measures the frequency of the signal at the marker position (see also [Chapter 5.4.4.1, "Precise frequency \(signal count\) marker"](#), on page 407).

In the following example, the frequency of the generator at 128 MHz is shown using the marker.

#### Prerequisite

Precise frequency measurements require a precise reference frequency. Therefore, an external reference frequency from the signal generator is used. Connect the signal generator's "Ref OUT" connector to the analyzer's "Ref IN" connector.

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *128 MHz*.
4. Set the frequency span to *1 MHz*.
5. Select "Setup" > "Reference" > "External Reference 10 MHz" to activate the external reference frequency.
6. Select [MKR] to activate marker 1 and automatically set it to the maximum of the trace.

The level and the frequency of the marker are displayed in the marker results in the diagram or the marker table.

7. Select [MKR FUNC] > "Signal Count" to activate the signal counter.

The result of the signal counter is displayed in the marker results.

8. If necessary, increase the resolution of the signal counter by selecting "Signal Count Resolution" (in the "Signal Count" menu).



#### Prerequisites for using the internal signal counter

In order to obtain a correct result when measuring the frequency with the internal signal counter, an RF sinusoidal signal or a spectral line must be available. The marker must be located more than 25 dB above the noise level to ensure that the specified measurement accuracy is adhered to.

### 3.1.4 Measurement example – measuring levels at low S/N ratios

The minimum signal level a signal analyzer can measure is limited by its intrinsic noise. Small signals can be swamped by noise and therefore cannot be measured. For signals that are just above the intrinsic noise, the accuracy of the level measurement is influenced by the intrinsic noise of the R&S ESW.

The displayed noise level of a signal analyzer depends on its noise figure, the selected RF attenuation, the selected reference level, the selected resolution and video bandwidth and the detector.

For details see:

- ["Attenuation"](#) on page 294
- [Chapter 4.5.1.1, "Reference level"](#), on page 290
- [Chapter 4.6.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 298
- [Chapter 4.6.1.2, "Smoothing the trace using the video bandwidth"](#), on page 299
- [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 345

This measurement example shows the different factors influencing the S/N ratio.

**Table 3-1: Signal generator settings (e.g. R&S SMW)**

|           |         |
|-----------|---------|
| Frequency | 128 MHz |
| Level     | -95 dBm |

1. Preset the R&S ESW.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *128 MHz*.
4. Set the span to *100 MHz*.
5. Set the reference level to *-30 dBm*.

The signal is measured with the auto peak detector and is completely hidden in the intrinsic noise of the R&S ESW.

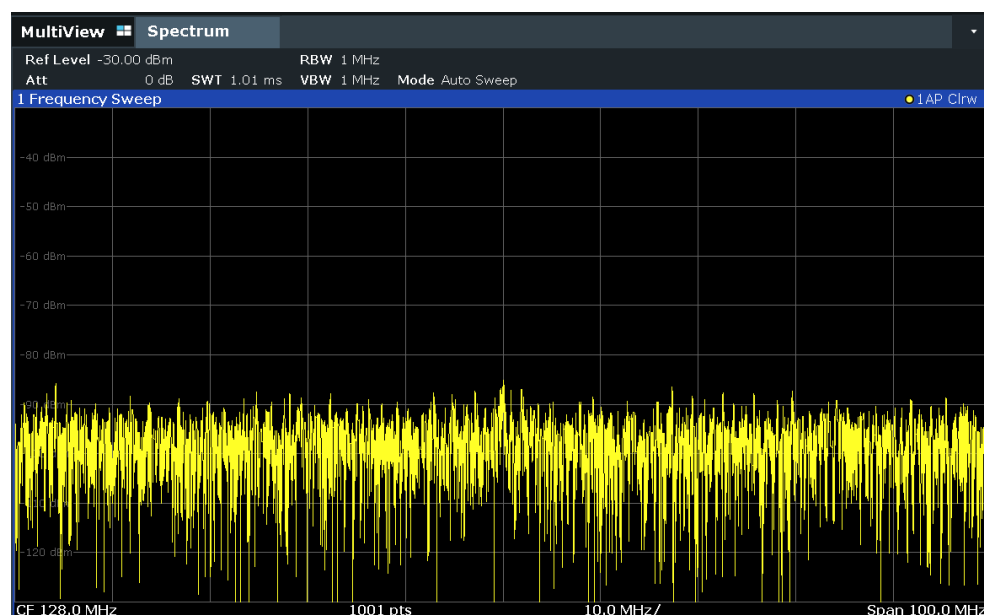


Figure 3-1: Sine wave signal with low S/N ratio

6. To suppress noise spikes, average the trace. In the "Traces" configuration dialog, set the "Trace Mode" to "Average" (see ["Trace Mode"](#) on page 367).

The traces of consecutive sweeps are averaged. To perform averaging, the R&S ESW automatically switches on the sample detector. The RF signal, therefore, can be more clearly distinguished from noise.

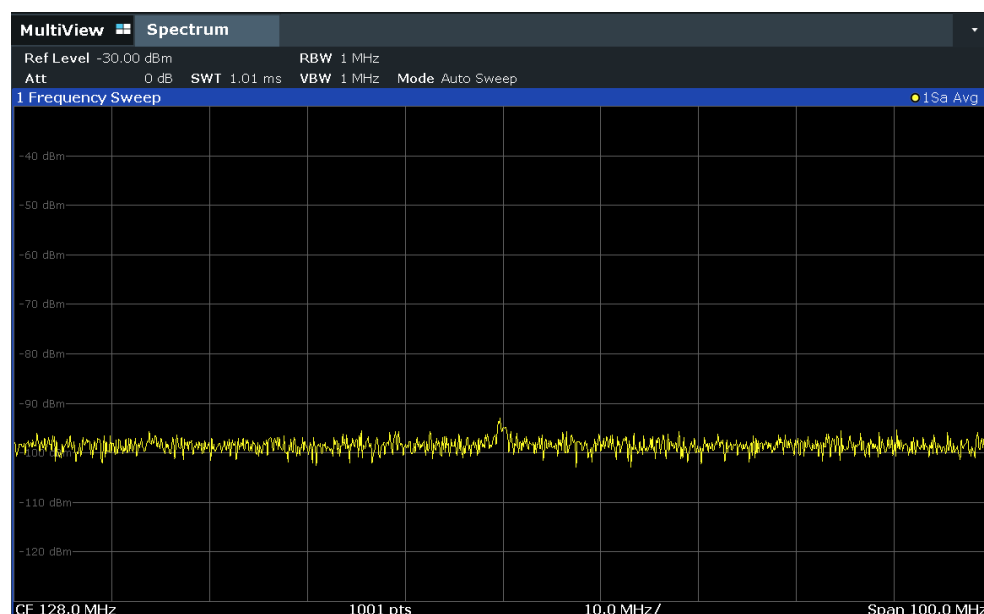
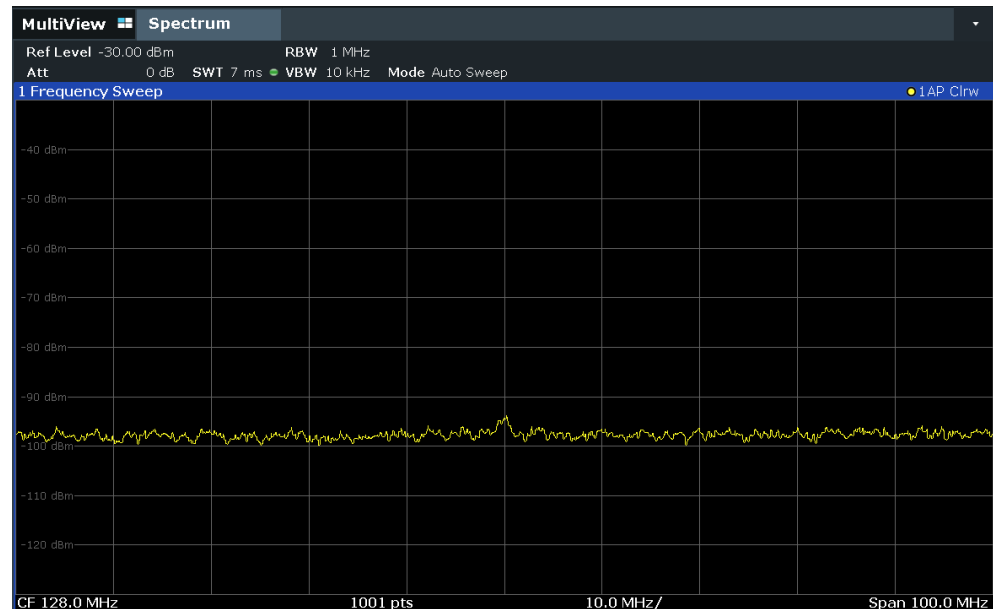


Figure 3-2: RF sine wave signal with low S/N ratio with an averaged trace

7. Instead of trace averaging, you can select a video filter that is narrower than the resolution bandwidth. Set the trace mode back to "Clear/ Write", then set the VBW to 10 kHz manually in the "Bandwidth" configuration dialog.

The RF signal can be distinguished from noise more clearly.



**Figure 3-3: RF sine wave signal with low S/N ratio with a smaller video bandwidth**

8. By reducing the resolution bandwidth by a factor of 10, the noise is reduced by 10 dB. Set the RBW to 100 kHz.

The displayed noise is reduced by approximately 10 dB. The signal, therefore, emerges from noise by about 10 dB. Compared to the previous setting, the video bandwidth has remained the same, i.e. it has increased relative to the smaller resolution bandwidth. The averaging effect of the video bandwidth is therefore reduced. The trace will be noisier.

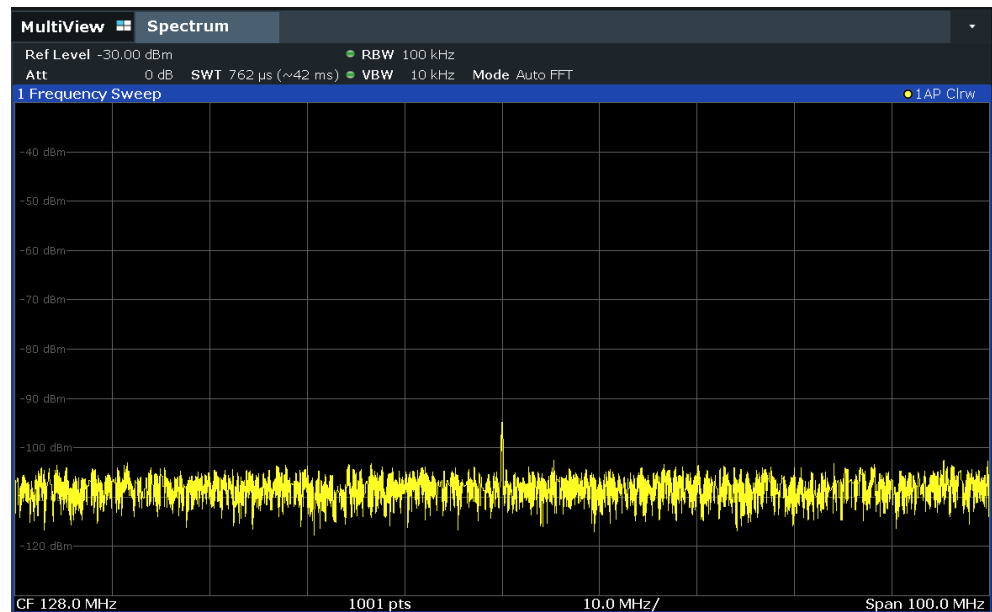


Figure 3-4: Reference signal at a smaller resolution bandwidth

### 3.1.5 Measurement examples - measuring signal spectra with multiple signals

- [Separating signals by selecting the resolution bandwidth](#)..... 28
- [Measuring the modulation depth of an AM-modulated carrier in the frequency domain](#)..... 31
- [Measuring AM-modulated signals](#)..... 32

#### 3.1.5.1 Separating signals by selecting the resolution bandwidth

A basic feature of a Signal and Spectrum Analyzer is the ability to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component (see also [Chapter 4.6.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 298).

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

In this measurement example we will analyze two signals with a level of -30 dBm each and a frequency spacing of 30 kHz.



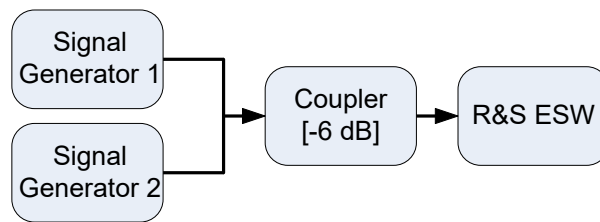


Figure 3-5: Test setup

Table 3-2: Signal generator settings (e.g. R&amp;S SMW)

|                    | Level   | Frequency  |
|--------------------|---------|------------|
| Signal generator 1 | -30 dBm | 128,00 MHz |
| Signal generator 2 | -30 dBm | 128,03 MHz |

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *128.015 MHz*.
4. Set the frequency span to *300 kHz*.
5. Set the resolution bandwidth to *30 kHz* and the video bandwidth to *1 kHz*.

**Note:** Larger video bandwidths. The video bandwidth is set to 1 kHz in order to make the level drop in the center of the two signals clearly visible. At larger video bandwidths, the video voltage that results from envelope detection is not sufficiently suppressed. This produces additional voltages, which are visible in the trace, in the transition area between the two signals.

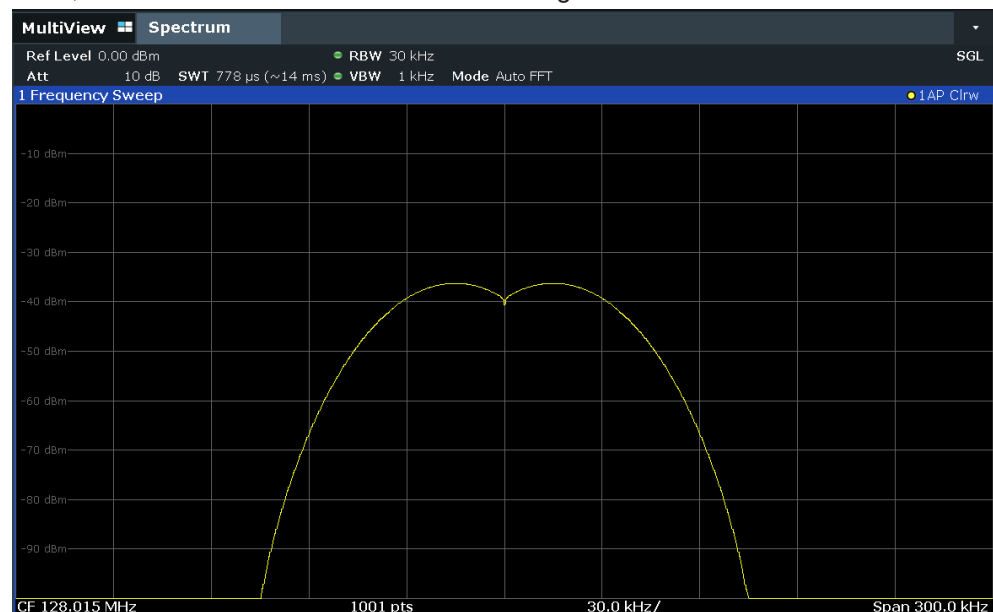


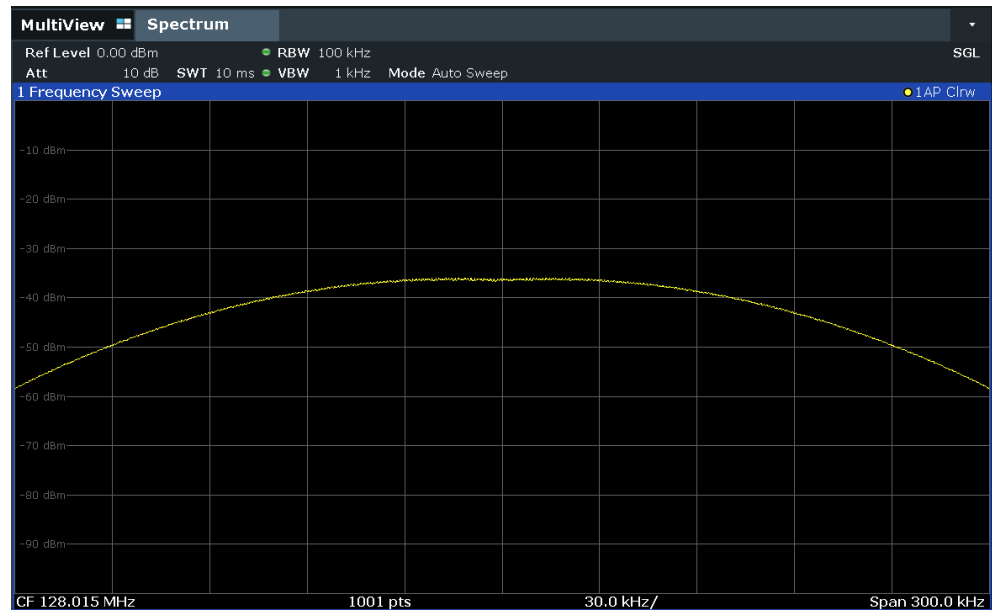
Figure 3-6: Measurement of two equally-leveled RF sinusoidal signals with the resolution bandwidth which corresponds to the frequency spacing of the signals

### Matching generator and R&S ESW frequencies

The level drop is located exactly in the center of the display only if the generator frequencies match the frequency display of the R&S ESW exactly. To achieve exact matching, the frequencies of the generators and the R&S ESW must be synchronized.

6. Set the resolution bandwidth to *100 kHz*.

It is no longer possible to clearly distinguish the two generator signals.



**Figure 3-7: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth which is larger than their frequency spacing**

7. Set the resolution bandwidth to *1 kHz*.

The two generator signals are shown with high resolution. However, the sweep time becomes longer. At smaller bandwidths, the noise display decreases simultaneously (10 dB decrease in noise floor for a decrease in bandwidth by a factor of 10).

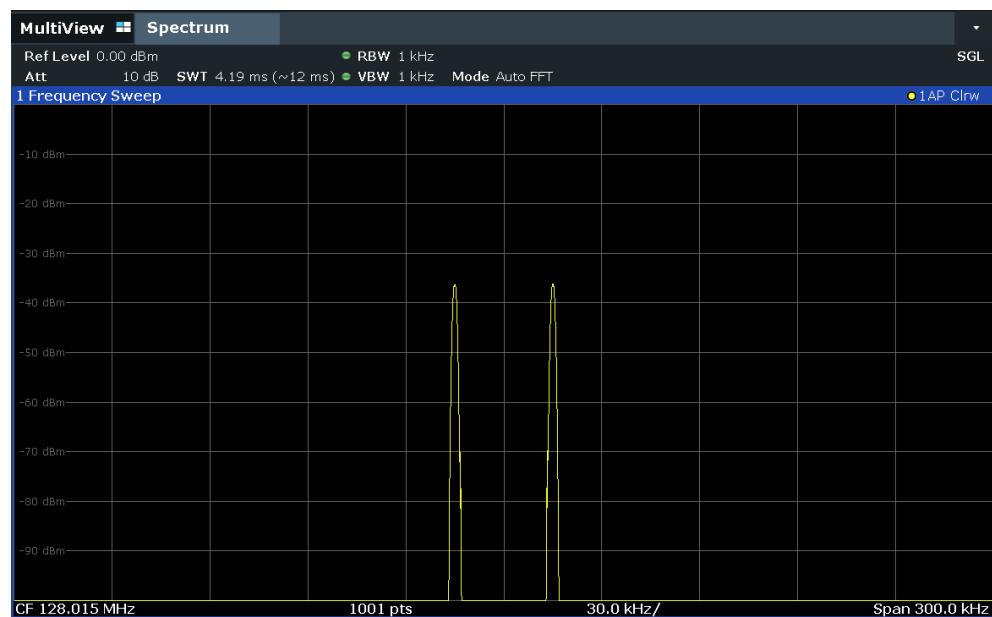


Figure 3-8: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth (1 kHz) which is significantly smaller than their frequency spacing

### 3.1.5.2 Measuring the modulation depth of an AM-modulated carrier in the frequency domain

In the frequency range display, the AM side bands can be resolved with a narrow bandwidth and measured separately. The modulation depth of a carrier modulated with a sinusoidal signal can then be measured. Since the dynamic range of a signal analyzer is very large, extremely small modulation depths can also be measured precisely. For this purpose, the R&S ESW provides measurement routines that output the modulation depth numerically in percent directly.

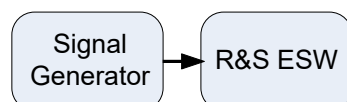


Figure 3-9: Test setup

Table 3-3: Signal generator settings (e.g. R&S SMW)

|            |                    |
|------------|--------------------|
| Frequency  | 128 MHz            |
| Level      | -30 dBm            |
| Modulation | 50 % AM, 10 kHz AF |

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to 128 MHz.
4. Set the frequency span to 50 kHz.

5. Select [MEAS] > "AM Modulation Depth" to activate the modulation depth measurement.

The R&S ESW automatically sets a marker to the carrier signal in the center of the diagram and one delta marker each to the upper and lower AM sidebands. The R&S ESW calculates the AM modulation depth from the level differences of the delta markers to the main marker and outputs the numeric value in the marker information.

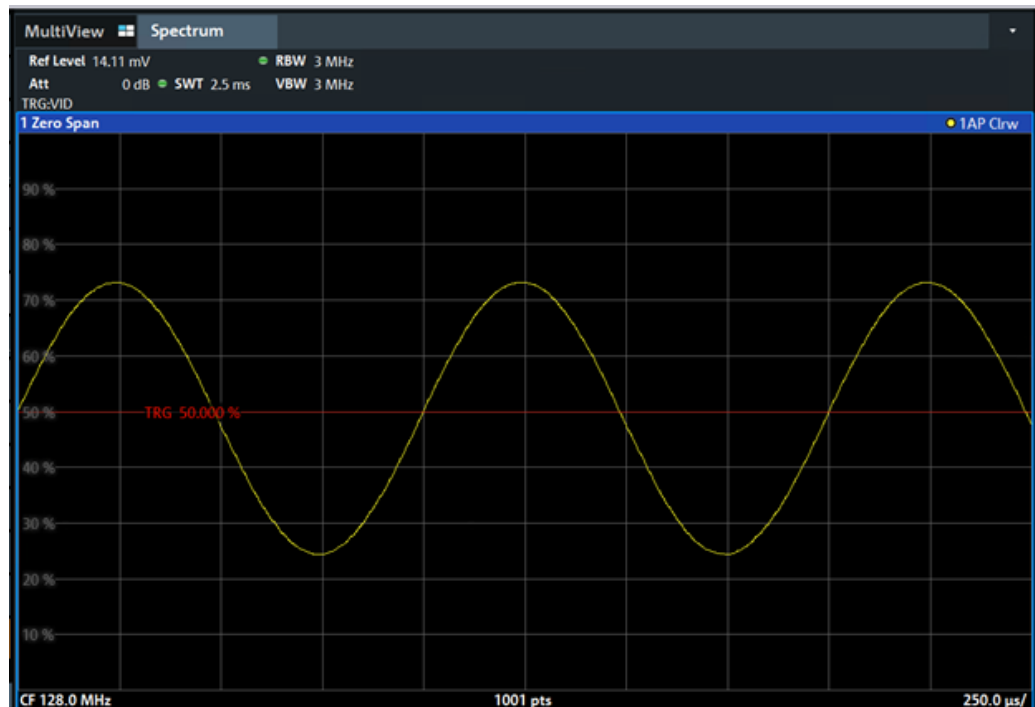


Figure 3-10: Measurement of the AM modulation depth

The modulation depth is displayed as "MDepth". The frequency of the AF signal can be obtained from the frequency display of the delta marker.

### 3.1.5.3 Measuring AM-modulated signals

The R&S ESW rectifies the RF input signal (that is, removes the negative parts) and displays it as a magnitude spectrum. The rectification also demodulates AM-modulated signals. The AF voltage can be displayed in zero span if the modulation sidebands fall within the resolution bandwidth.

#### Displaying the AF of an AM-modulated signal (Zero Span)

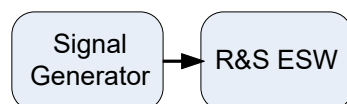


Figure 3-11: Test setup

**Table 3-4: Signal generator settings (e.g. R&S SMW)**

|            |                   |
|------------|-------------------|
| Frequency  | 128 MHz           |
| Level      | -30 dBm           |
| Modulation | 50 % AM, 1 kHz AF |

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *128 MHz*.
4. Set the frequency span to *0 Hz* or select "Zero Span".
5. Set the sweep time to *2.5 ms*.
6. Set the RBW to *3 MHz*.
7. Set the reference level to *-24 dBm* and the display range to linear ([AMPT] > "Scale Config" > "Scaling": "Linear Percent").
8. Set the scaling unit to Volt ([AMPT] > "Amplitude Config" > "Unit": "V").
9. Define triggering in response to the AF signal using the video trigger to produce a static image.
  - a) Press [TRIG].
  - b) Select "Video".
  - c) Set the "Trg/Gate Level" to *50%*.

The trigger level is displayed as a horizontal line across the entire measurement diagram. The R&S ESW displays the 1 kHz AF signal as a static image in zero span.

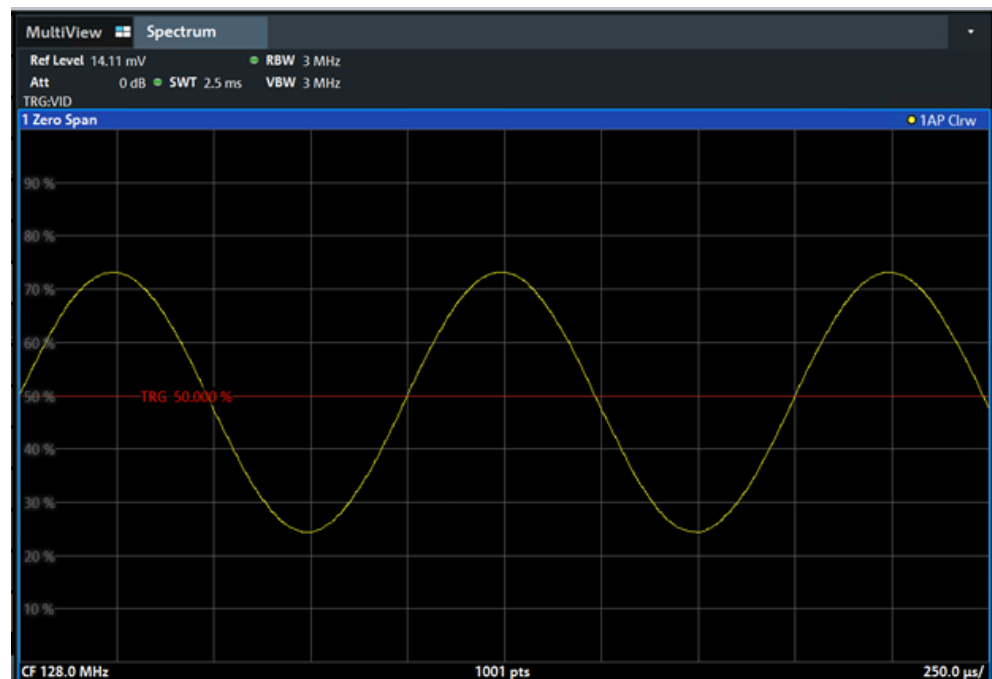


Figure 3-12: Measurement of the AF signal of a carrier that is AM-modulated with 1 kHz

10. Activate the internal AM demodulator to output the audio signal.

- a) Press [MKR FUNC].
- b) Select "Marker Demodulation".

The R&S ESW automatically switches on the AM audio demodulator. A 1 kHz tone can be heard over headset (via the headphone connector). If necessary, use the volume control to turn up the volume.

### 3.1.6 Measurement examples in zero span

For radio transmission systems that use the TDMA method (for example, GSM), transmission quality is determined not only by spectral characteristics but also by characteristics in zero span. A timeslot is assigned to each user since several users share the same frequency. Smooth operation is ensured only if all users adhere exactly to their assigned timeslots.

Both the power during the send phase as well as the timing and duration of the TDMA burst, and rise and fall times of the burst, are important.

- [Measuring the power characteristic of burst signals](#)..... 34
- [Measuring the signal-to-noise ratio of burst signals](#).....38

#### 3.1.6.1 Measuring the power characteristic of burst signals

To measure power in zero span, the R&S ESW offers easy-to-use functions that measure the power over a predefined time.

### Measuring the power of a GSM burst during the activation phase

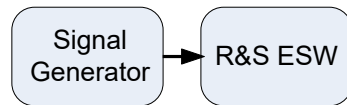


Figure 3-13: Test setup

Table 3-5: Signal generator settings (e.g. R&S SMW)

|            |                             |
|------------|-----------------------------|
| Frequency  | 890 MHz                     |
| Level      | 0 dBm                       |
| Modulation | GSM, one timeslot activated |

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *890 MHz* ([FREQ]).
4. Set the frequency span to *0 Hz* ([SPAN] > "Zero Span").
5. Set the reference level to *10 dBm* (= level of the signal generator +10 dB) (AMPT).
6. Set the attenuation to *20 dB* ([AMPT] > "RF Atten Manual").
7. Set the resolution bandwidth to *1 MHz* ([BW] > "Res BW").
8. Set the sweep time to *1 ms* ([SWEEP] > Sweep Time Manual).

The R&S ESW shows the GSM burst continuously across the display.

9. Using the video trigger, set triggering on the rising edge of the burst.
  - a) Press [TRIG].
  - b) Set the "Trg Source" to "Video".
  - c) Set the "Trg/Gate Level" to 70%.

The R&S ESW shows a static image with the GSM burst at the start of the trace.

The trigger level is displayed as a horizontal line labeled with the absolute level for the trigger threshold in the measurement diagram.

10. Activate power measurement within the activation phase of the burst in zero span.
  - a) Press [MEAS].
  - b) Select "Time Domain Power".
  - c) Select "Time Dom Power Config".
  - d) Set the "Limits" state to "On".
  - e) Select the "Left Limit" input field.
  - f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
  - g) Select the "Right Limit" input field.

- h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.

The R&S ESW displays the average (mean) power during the activation phase of the burst.

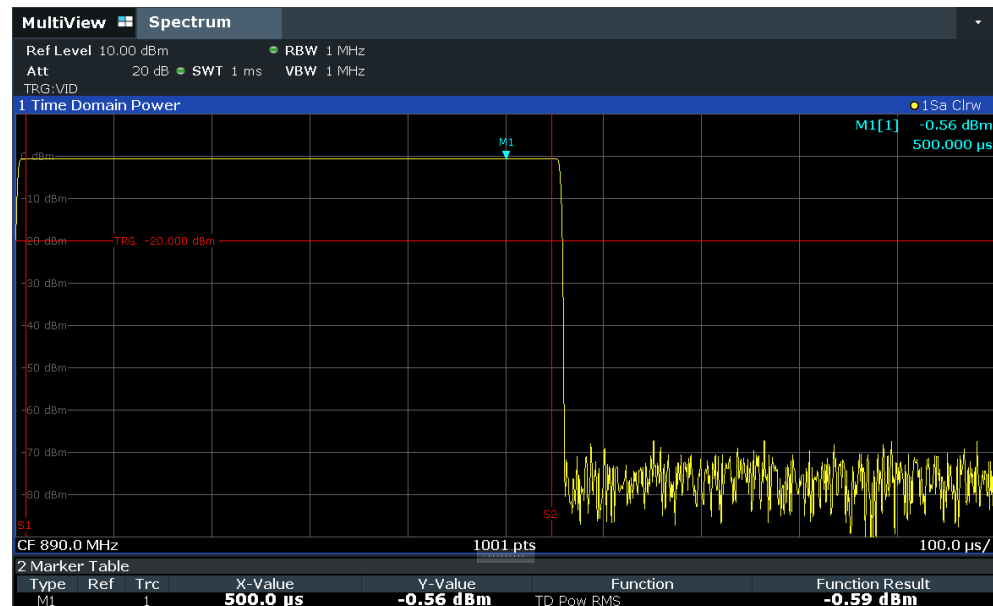


Figure 3-14: Measurement of the average power during the burst of a GSM signal

### Measuring the edges of a GSM burst with high time resolution

Due to the high time resolution of the R&S ESW at the 0 Hz display range, the edges of TDMA bursts can be measured precisely. The edges can be shifted to the display area using the trigger offset.

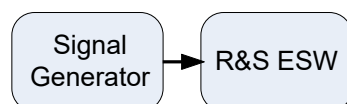


Figure 3-15: Test setup

Table 3-6: Signal generator settings (e.g. R&S SMW)

|            |                             |
|------------|-----------------------------|
| Frequency  | 890 MHz                     |
| Level      | 0 dBm                       |
| Modulation | GSM, one timeslot activated |

The measurement is based on the example ["Measuring the power of a GSM burst during the activation phase"](#) on page 35.

1. Switch off the power measurement.
  - a) Press [MEAS].
  - b) Select "Zero Span".



2. Increase the time resolution by setting the sweep time to  $100\ \mu\text{s}$  ([SWEEP] > Sweep Time Manual).
  3. Shift the rising edge of the GSM burst to the center of the display by defining a trigger offset.
    - a) Press [TRIG].
    - b) Select "Trigger Offset".
    - c) By turning the rotary knob counterclockwise, reduce the trigger offset until the burst edge is displayed in the center of the display, or enter  $-50\ \mu\text{s}$ .
- The R&S ESW displays the rising edge of the GSM burst.

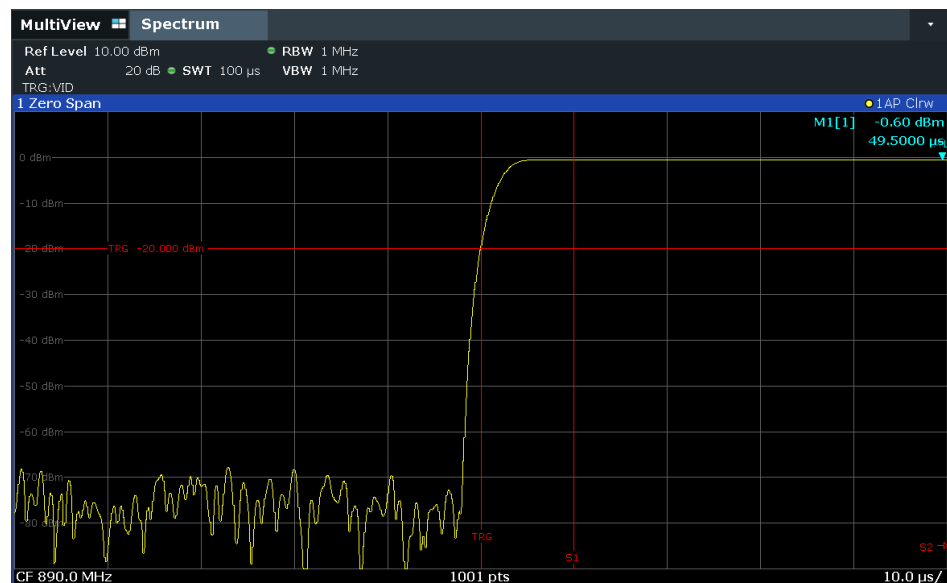


Figure 3-16: Rising edge of the GSM burst displayed with high time resolution

4. Move the falling edge of the burst to the center of the display. To do so, switch the trigger "Slope" to "Falling" ([TRIG] > "Trigger/ Gate Config").
- The R&S ESW displays the falling edge of the GSM burst.

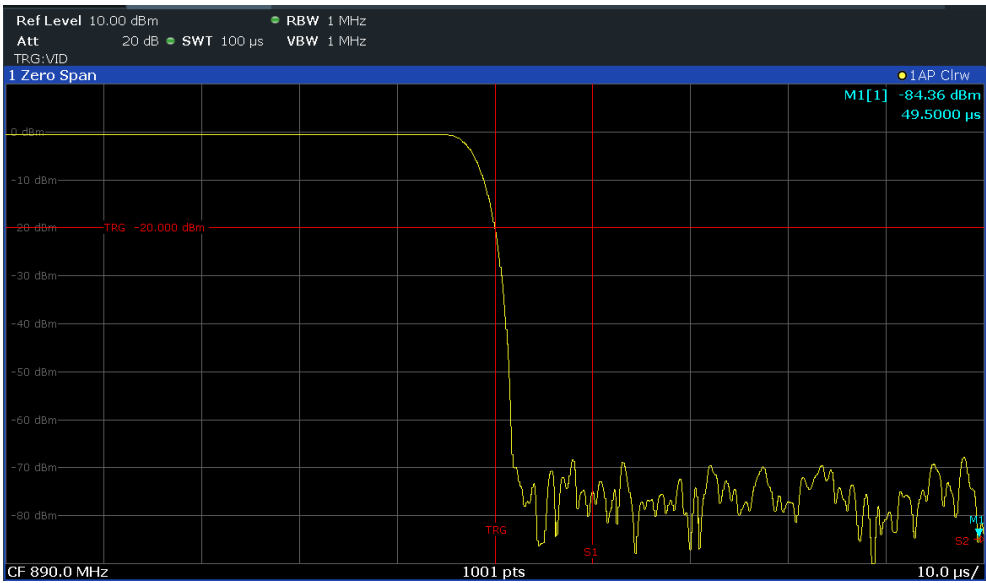


Figure 3-17: Falling edge of the GSM burst displayed with high time resolution

### 3.1.6.2 Measuring the signal-to-noise ratio of burst signals

When TDMA transmission methods are used, the signal-to-noise ratio or the dynamic range for deactivation can be measured by comparing the power values during the activation phase and the deactivation phase of the transmission burst. Therefore, the R&S ESW provides a measurement for absolute and relative power in zero span. In the following example, the measurement is performed using a GSM burst.

#### Signal-to-Noise Ratio of a GSM Signal

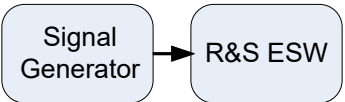


Figure 3-18: Test setup

Table 3-7: Signal generator settings (e.g. R&S SMW)

|            |                                   |
|------------|-----------------------------------|
| Frequency  | 890 MHz                           |
| Level      | 0 dBm                             |
| Modulation | GSM, one time slot is switched on |

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to 890 MHz.
4. Set the frequency span to 0 Hz.
5. Set the resolution bandwidth to 1 MHz.

6. Set the reference level to 0 dBm (= level of the signal generator).
7. Set the sweep time to 2 ms ([SWEEP] > Sweep Time Manual).

The R&S ESW shows the GSM burst continuously across the display.

8. Use the trigger source "Video" and the trigger slope "Rising" to trigger on the rising edge of the burst and shift the start of the burst to the center of the display (see [step 3](#) in "Measuring the edges of a GSM burst with high time resolution" on page 36).
9. Activate power measurement within the activation phase of the burst in zero span.
  - a) Press [MEAS].
  - b) Select "Time Domain Power".
  - c) Select "Time Dom Power Config".
  - d) Set the "Limits" state to "On".
  - e) Select the "Left Limit" input field.
  - f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
  - g) Select the "Right Limit" input field.
  - h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.
  - i) Note down the power result for the burst, indicated by the "TD Pow RMS" result in the marker table.
10. Measure the power during the deactivation phase of the burst by switching the trigger slope to "Falling" ([TRIG] > "Trigger/ Gate Config").

The R&S ESW initiates triggering in response to the falling edge of the burst. This shifts the burst to the left-hand side of the measurement diagram. The power is measured in the deactivation phase.

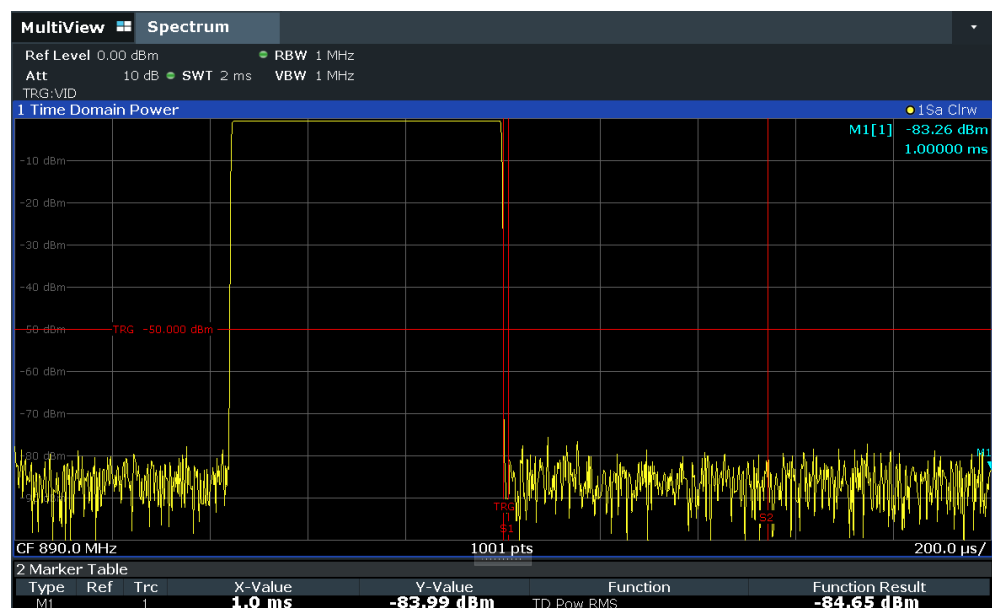


Figure 3-19: Measurement of the signal-to-noise ratio of a GSM burst signal in zero span

11. Note down the power result for the measured noise, indicated by the "TD Pow RMS" result in the marker table.

Subtract the measured noise power from the burst power to obtain the signal-to-noise ratio of the burst signal.

## 3.2 Channel power and adjacent-channel power (ACLR) measurement

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

|  |    |
|--|----|
| • <a href="#">About channel power measurements</a> .....                   | 40 |
| • <a href="#">Channel power results</a> .....                              | 41 |
| • <a href="#">Channel power basics</a> .....                               | 43 |
| • <a href="#">Channel power configuration</a> .....                        | 56 |
| • <a href="#">MSR ACLR configuration</a> .....                             | 64 |
| • <a href="#">How to perform channel power measurements</a> .....          | 79 |
| • <a href="#">Measurement examples</a> .....                               | 84 |
| • <a href="#">Optimizing and troubleshooting the measurement</a> .....     | 87 |
| • <a href="#">Reference: predefined CP/ACLR standards</a> .....            | 88 |
| • <a href="#">Reference: predefined ACLR user standard XML files</a> ..... | 89 |

### 3.2.1 About channel power measurements

Measuring channel power and adjacent channel power is one of the most important tasks during signal analysis with the necessary test routines in the field of digital transmission. Theoretically, a power meter could be used to measure channel power at highest accuracy. However, its low selectivity means that it is not suitable for measuring adjacent channel power as an absolute value or relative to the transmit channel power. Only a selective power meter can measure the power in the adjacent channels.

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

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

## Channel power and adjacent-channel power (ACLR) measurement

The R&S ESW software allows you to perform ACLR measurements on input containing multiple signals for different communication standards. A measurement standard is provided that allows you to define multiple discontinuous transmit channels at specified frequencies, independent from the selected center frequency. The ACLR measurement determines the power levels of the individual transmit, adjacent, and gap channels, as well as the total power for each sub block of transmit channels.

A detailed measurement example is provided in [Chapter 3.2.7, "Measurement examples"](#), on page 84.

### 3.2.2 Channel power results

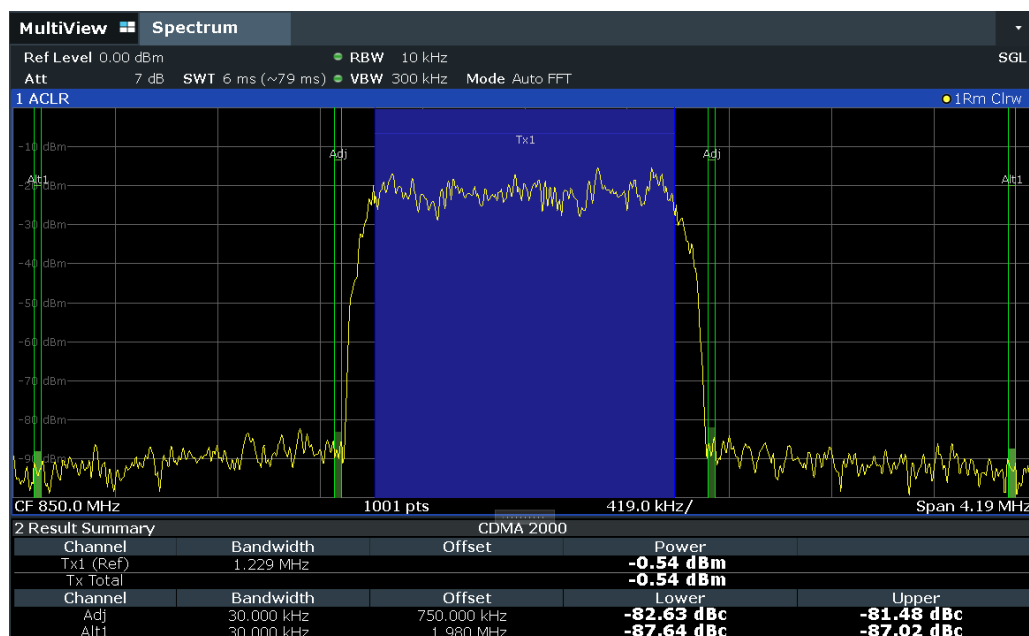
For channel or adjacent-channel power measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel ("Adj", "Alt %1", "Tx %1", etc., or a user-defined name) is indicated above the bar (separated by a line which has no further meaning).

For "Fast ACLR" measurements, which are performed in the time domain, the power versus time is shown for each channel.



#### Multi-standard radio (MSR) channel power results

The channel power results for MSR signals are described in [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.



Results are provided for the TX channel and the number of defined adjacent channels *above and below* the TX channel. If more than one TX channel is defined, you must specify the channel to which the relative adjacent-channel power values refer. By default, it is the TX channel with the maximum power.

## Channel power and adjacent-channel power (ACLR) measurement

Table 3-8: Measurements performed depending on the number of adjacent channels

| Number of adj. chan. | Measurement results   |
|----------------------|---|
| 0                    | Channel powers  |
| 1                    | <ul style="list-style-type: none"> <li>Channel powers</li> <li>Power of the upper and lower adjacent channel</li> </ul>   |
| 2                    | <ul style="list-style-type: none"> <li>Channel powers</li> <li>Power of the upper and lower adjacent channel</li> <li>Power of the next higher and lower channel (alternate channel 1)</li> </ul>   |
| 3                    | <ul style="list-style-type: none"> <li>Channel powers</li> <li>Power of the upper and lower adjacent channel</li> <li>Power of the next higher and lower channel (alternate channel 1)</li> <li>Power of the second next higher and lower adjacent channel (alternate channel 2)</li> </ul> |
| ...                  | ...   |
| 12                   | <ul style="list-style-type: none"> <li>Channel powers</li> <li>Power of the upper and lower adjacent channel</li> <li>Power of all the higher and lower channels (alternate channels 1 to 11)</li> </ul>  |



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

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

For each channel, the following values are displayed:

| Label                  | Description   |
|------------------------|---|
| Channel                | Channel name as specified in the "Channel Settings" (see <a href="#">"Channel Names"</a> on page 64).   |
| Bandwidth              | Configured channel bandwidth (see <a href="#">"Channel Bandwidth"</a> on page 62)   |
| Offset                 | Offset of the channel to the TX channel (configured channel spacing, see <a href="#">"Channel Bandwidth"</a> on page 62)  |
| Power<br>(Lower/Upper) | The measured power values for the TX and lower and upper adjacent channels. The powers of the transmission channels are output in dBm or dBm/Hz, or in dBc, relative to the specified reference TX channel. |

### Retrieving Results via Remote Control

All or specific channel power measurement results can be retrieved using the `CALC:MARK:FUNC:POW:RES?` command from a remote computer (see [CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESULT?](#) on page 473). Alternatively, the results can be output as channel power density, i.e. in reference to the measurement bandwidth.

Furthermore, the measured power values of the displayed trace can be retrieved as usual using the `TRAC:DATA?` commands (see [TRACE<n>\[:DATA\]](#) on page 690). In

this case, the measured power value for each sweep point (by default 1001) is returned.

For a full list of remote commands for ACLR measurements, see [Chapter 6.7.3.9, "Measurement results"](#), on page 508.

### 3.2.3 Channel power basics

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

- [Measurement methods](#)..... 43
- [Measurement repeatability](#).....45
- [Recommended common measurement parameters](#).....46
- [Measurement on multi-standard radio \(MSR\) signals](#).....50

#### 3.2.3.1 Measurement methods

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

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

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

- **IBW method** (Integration **B**and**W**idth method)
- **Fast ACLR** (Zero-span method ), i.e. using a channel filter

#### IBW method

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

## Channel power and adjacent-channel power (ACLR) measurement

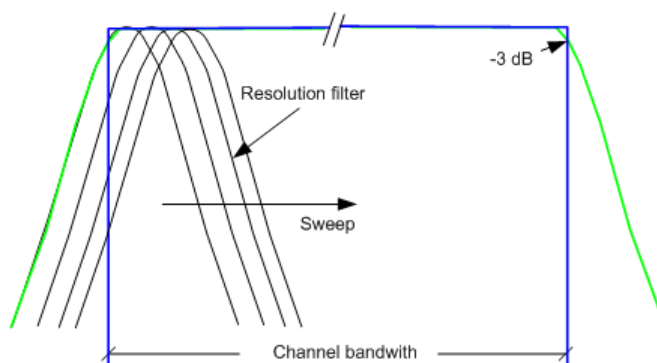


Figure 3-20: Approximating the channel filter by sweeping with a small resolution bandwidth

The following steps are performed:

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

$$P_i = 10^{(L_i/10)}$$
 Where  $P_i$  = power of the trace pixel  $i$   
 $L_i$  = displayed level of trace point  $i$
2. The powers of all trace points within the channel are summed up and the sum is divided by the number of trace points in the channel.
3. The result is multiplied by the quotient of the selected channel bandwidth and the noise bandwidth of the resolution filter (RBW).

Since the power calculation is performed by integrating the trace within the channel bandwidth, this method is called the IBW method (Integration **B**andwidth method).

### Fast ACLR

The integrated bandwidth method (IBW) calculates channel power and ACLR from the trace data obtained during a continuous sweep over the selected span. Most parts of this sweep are not part of the channel itself or the defined adjacent channels. Therefore, most of the samples taken during the sweep time cannot be used for channel power or ACLR calculation.

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

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



## Channel power and adjacent-channel power (ACLR) measurement

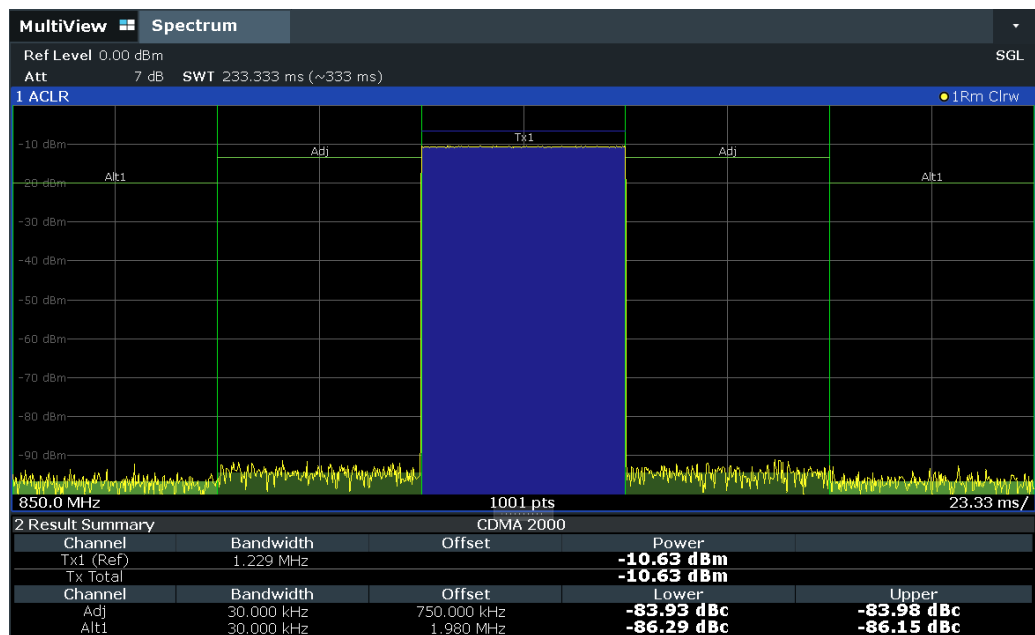


Figure 3-21: Measuring the channel power and adjacent channel power ratio for CDMA2000 signals with zero span (Fast ACLR)

### 3.2.3.2 Measurement repeatability

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

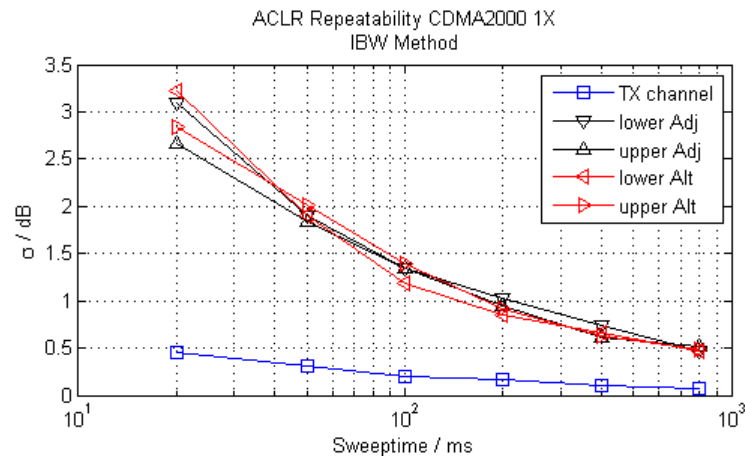
Assume a measurement with five channels (1 channel plus 2 lower and 2 upper adjacent channels) and a sweep time of 100 ms. This measurement requires a measurement time per channel of 20 ms. To calculate the power in one channel, the analyzer considers the following number of effective samples:

$$\text{<sweep time in channel> * <selected resolution bandwidth>}$$

For example, for a sweep time of 100 ms the analyzer considers  $(30 \text{ kHz} / 4.19 \text{ MHz}) * 100 \text{ ms} * 10 \text{ kHz} \approx 7$  samples. Whereas in Fast ACLR mode, it considers  $(100 \text{ ms} / 5) * 30 \text{ kHz} \approx 600$  samples. If you compare these numbers, you understand the increase of repeatability with a 95 % confidence level (2σ). It rises from  $\pm 2.8 \text{ dB}$  in normal mode to  $\pm 0.34 \text{ dB}$  in Fast ACLR mode for a sweep time of 100 ms.

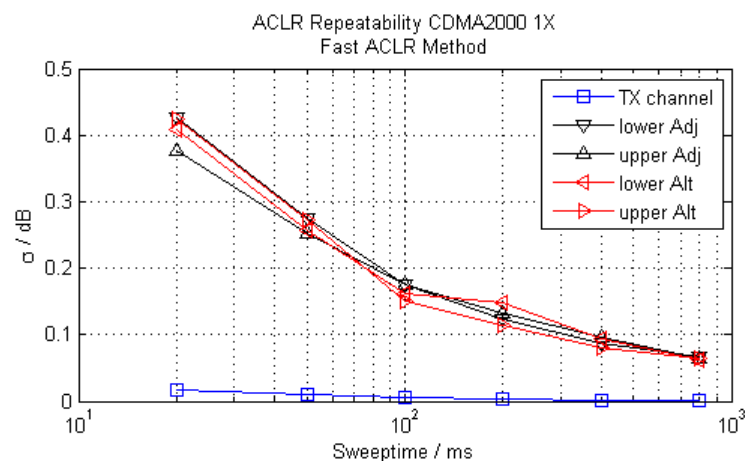
For the same repeatability, the integration method requires a sweep time of 8.5 s. The Figure 3-22 shows the standard deviation of the results as a function of the sweep time.

## Channel power and adjacent-channel power (ACLR) measurement



**Figure 3-22: Repeatability of adjacent channel power measurement on CDMA2000 standard signals if the integration bandwidth method is used**

The [Figure 3-23](#) shows the repeatability of power measurements in the transmit channel and of relative power measurements in the adjacent channels as a function of sweep time. The standard deviation of measurement results is calculated from 100 consecutive measurements. Consider the scaling when you compare power values.



**Figure 3-23: Repeatability of adjacent channel power measurements on CDMA2000 signals in the fast ACLR mode**

### 3.2.3.3 Recommended common measurement parameters

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



All instrument settings for the selected channel setup (channel bandwidth, channel spacing) can be optimized automatically using the "Adjust Settings" function (see ["Optimized Settings \(Adjust Settings\)"](#) on page 60).

The easiest way to configure a measurement is using the configuration "Overview", see [Chapter 4.2, "Configuration overview"](#), on page 221.

|                                   |    |
|-----------------------------------|----|
| • Sweep Time.....                 | 47 |
| • Frequency span.....             | 48 |
| • Resolution bandwidth (RBW)..... | 48 |
| • Video bandwidth (VBW).....      | 49 |
| • Detector.....                   | 49 |
| • Trace averaging.....            | 50 |
| • Reference level.....            | 50 |

### Sweep Time

The Sweep Time is selected depending on the desired reproducibility of results. Reproducibility increases with Sweep Time since power measurement is then performed over a longer time period. As a general approach, approximately 500 non-correlated measured values are required for a reproducibility of 0.5 dB. (That means: 95 % of the measurements are within 0.5 dB of the true measured value). Approximately 5000 measured values are required for a reproducibility of 0.1 dB (99 %). These values are valid for white noise. The measured values are considered as non-correlated if their time interval corresponds to the reciprocal of the measured bandwidth.

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

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

If the RMS detector is used, the selection of Sweep Times can affect the repeatability of the measurement results. Repeatability is increased at longer Sweep Times.

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

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

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

$$N_{\text{decorr}} = \text{SWT} * \text{RBW}$$

( $N_{\text{decorr}}$  means uncorrelated samples)

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

## Channel power and adjacent-channel power (ACLR) measurement

The Sweep Time can be defined using the softkey in the "Ch Power" menu or in the "Sweep" configuration dialog box (see ["Sweep Time"](#) on page 61).

### Frequency span

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

If the frequency span is large in comparison to the channel bandwidth (or the adjacent-channel bandwidths) being analyzed, only a few points on the trace are available per channel. The calculated waveform for the used channel filter is less accurate, which has a negative effect on the measurement accuracy. It is therefore strongly recommended that you consider the described formulas when you select the frequency span.

The frequency span for the defined channel settings can be optimized. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 60). You can set the frequency span manually in the "Frequency" configuration dialog box.

(See [Chapter 4.4.4, "How to define the frequency range"](#), on page 288.)

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

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

For adjacent-channel power measurements, the "Adjust Settings" function sets the frequency span as a function of the following parameters:

- Number of transmission channels
- Transmission channel spacing
- Adjacent-channel spacing
- Bandwidth of one of adjacent-channels ADJ, ALT1 or ALT2, whichever is furthest away from the transmission channels

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

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

### Resolution bandwidth (RBW)

It is important to suppress spectral components outside the channel to be measured, especially of the adjacent channels. At the same time, you expect an acceptable measurement speed. To fulfill both these requirements, the appropriate resolution bandwidth is essential. As a general approach, set the resolution bandwidth to values between 1 % and 4 % of the channel bandwidth.

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

## Channel power and adjacent-channel power (ACLR) measurement

You can optimize the resolution bandwidth for the defined channel settings. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 60). You can set the RBW manually in the "Bandwidth" configuration dialog box, see ["RBW"](#) on page 211.

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

$$\text{"RBW"} \leq 1/40 \text{ of "Channel Bandwidth"}$$

The maximum resolution bandwidth (concerning the requirement  $\text{RBW} \leq 1/40$ ) resulting from the available RBW steps (1, 3) is selected.

### Video bandwidth (VBW)

For a correct power measurement, the video signal must not be limited in bandwidth. A restricted bandwidth of the logarithmic video signal causes signal averaging and thus results in a too low indication of the power (-2.51 dB at very low video bandwidths). Thus, select the video bandwidth at least three times the resolution bandwidth:

$$\text{VBW} \geq 3 * \text{RBW}$$

For FFT sweeps, instead of increasing the VBW, you can also select the trace average mode "Power" to ensure correct power measurements (see ["Average Mode"](#) on page 369). Note that in power measurements this setting affects the VBW regardless of whether or not a trace is actually averaged.

The video bandwidth for the defined channel settings can be optimized. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 60). You can set the VBW manually in the "Bandwidth" configuration dialog box, see ["VBW"](#) on page 305.

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

### Detector

The RMS detector correctly indicates the power irrespective of the characteristics of the signal to be measured.

In principle, the sample detector is also possible. However, due to the limited number of measurement points used to calculate the power in the channel, the sample detector yields less stable results.

You can set the RMS detector for the defined channel settings automatically. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 60).

You can set the detector manually in the "Traces" configuration dialog box, see ["Detector"](#) on page 368.

### Trace averaging

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

The "Adjust Settings" function switches off trace averaging. You can deactivate the trace averaging manually in the "Traces" configuration dialog box, see ["Average Mode"](#) on page 369.

### Reference level

To achieve an optimum dynamic range, set the reference level so that the signal is as close to the reference level as possible without forcing an overload message. However, if the signal-to-noise ratio becomes too small, the dynamic range is also limited. The measurement bandwidth for channel power measurements is significantly smaller than the signal bandwidth. Thus, the signal path can be overloaded although the trace is still significantly below the reference level.



Selecting a predefined standard or automatically adjusting settings does not affect the reference level. The reference level can be set automatically using the "Auto Level" function in the [Auto Set] menu, or manually in the "Amplitude" menu.

#### 3.2.3.4 Measurement on multi-standard radio (MSR) signals

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

### Signal structure

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

## Channel power and adjacent-channel power (ACLR) measurement

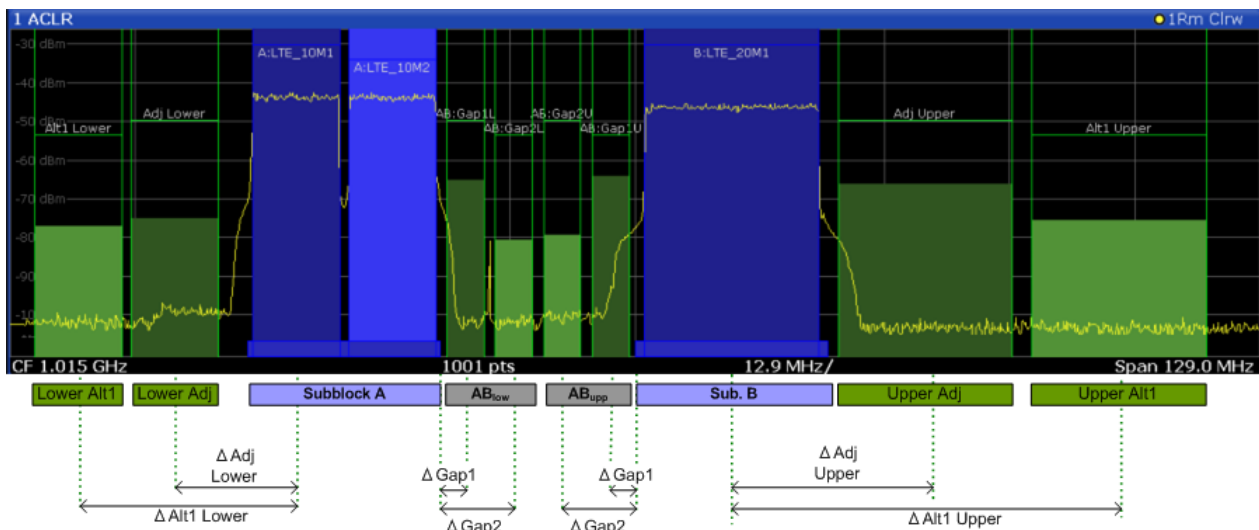


Figure 3-24: MSR signal structure

## Asymmetrical gap channels

Gap channels between sub blocks can now also be asymmetrical, that is: channels in the lower and upper gaps are not identical. For example, in Figure 3-25, the gap between sub blocks A and B contains one lower channel (AB:Gap1L), but two upper channels (AB:Gap1U, AB:Gap2U). Furthermore, the gaps between different sub blocks need not be identical. For example, the gap between sub blocks A and B contains 3 gap channels, while the gap between sub blocks B and C contains only two gap channels (BC:Gap1L, BC:Gap2L, which are not identical to the lower gap channels in gap AB).

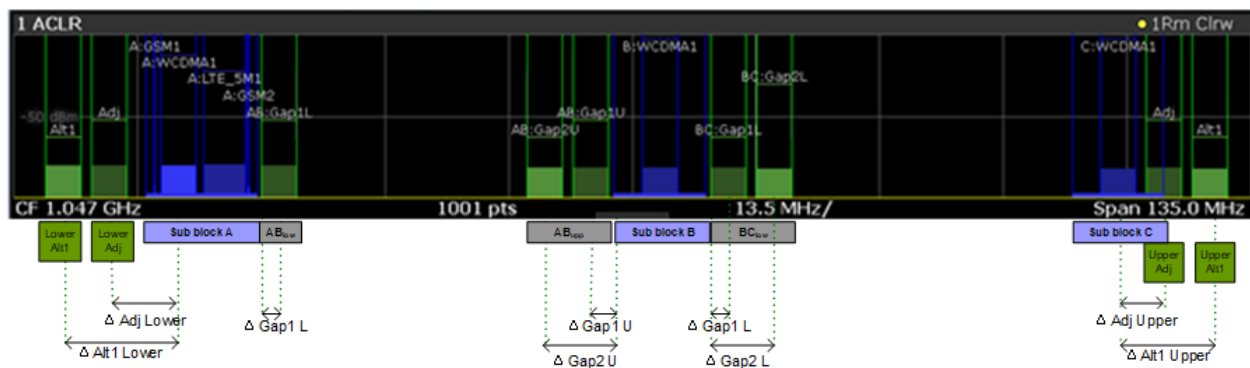


Figure 3-25: Asymmetrical MSR signal structure

## Sub block and channel definition

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

## Channel power and adjacent-channel power (ACLR) measurement

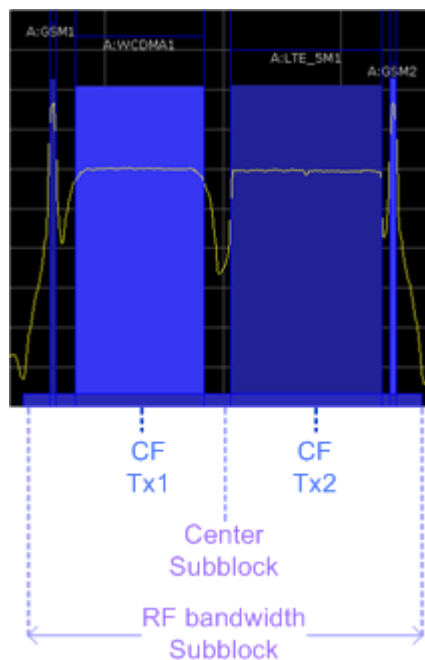


Figure 3-26: Sub block definition

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

#### Gap channels and CACLR

If two or more sub blocks are defined, the power in the gaps between the sub blocks must also be measured. Gap channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding sub blocks.

If the upper and lower gap channels are symmetrical, only two gap channels must be configured. The required spacing can be determined according to the following formula (indicated for lower channels):

$$\text{Spacing} = [\text{CF of gap channel}] - [\text{left sub block CF}] + ([\text{RF bandwidth of left sub block}] / 2)$$



## Channel power and adjacent-channel power (ACLR) measurement

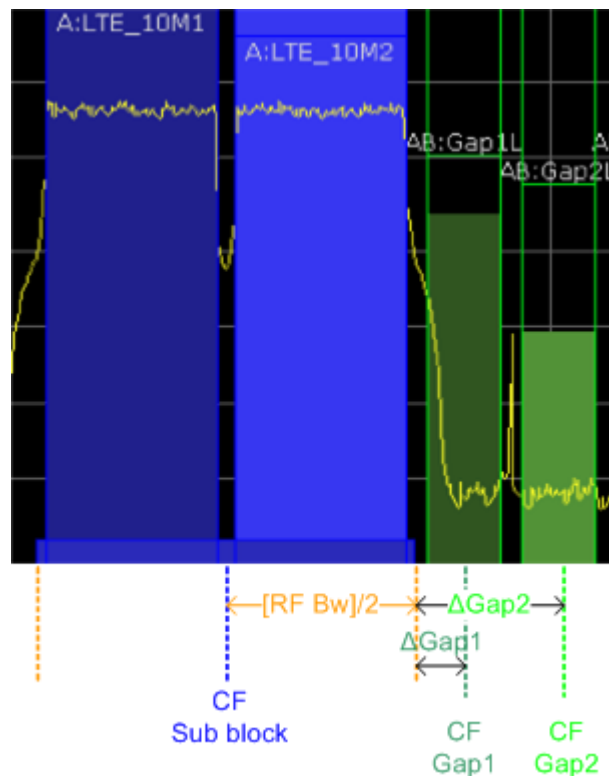


Figure 3-27: Gap channel definition for lower gap

If the gap channels are not symmetrical, you must configure up to four channels individually. The formula indicated above applies for the lower channels. For the upper channels, the spacing is defined as:

$$\text{Spacing} = [\text{right sub block CF}] - [\text{CF of gap channel}] - ([\text{RF bandwidth of right sub block}] / 2)$$

According to the MSR standard, the **Cumulative Adjacent Channel Leakage Ratio (CACLR)** power must be determined for the gap channels. The CACLR power is measured in the two gap channels for the upper and lower gap. The power in the gap channels is then set in relation to the power of the two closest transmission channels to either side of the gap. The CACLR power for the gap channels is indicated in the Result Summary.

In addition, the ACLR power for the individual gap channels is indicated in the Result Summary. The ACLR power of the lower gap channels refers to the TX channel to the left of the gap. The ACLR power of the upper gap channels refers to the TX channel to the right of the gap. A separate relative limit value can be defined for the ACLR power.

### Adjacent channels

Adjacent channels are defined as in common ACLR measurements using bandwidths and spacings, relative to the uppermost or lowermost transmit channels in the sub blocks (see also [Figure 3-24](#)):

- The spacing of the lower adjacent channels refers to the CF of the first TX channel in the first sub block.

## Channel power and adjacent-channel power (ACLR) measurement

- The spacing of the upper adjacent channels refers to the CF of the last TX channel in the last sub block.



The upper and lower adjacent channels can also be defined asymmetrically (see ["Symmetrical Adjacent Setup"](#) on page 69). This is particularly useful if the lowest TX channel and highest TX channel use different standards and thus require different bandwidths for adjacent channel power measurement.

### Channel display for MSR signals

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

TX channel names correspond to the specified technology (for LTE including the bandwidth), followed by a consecutive number. (If the channel is too narrow to display the channel name, "..." is displayed instead.) The assigned sub block is indicated with the channel name, e.g. "B: LTE\_5M1" for the first TX channel in sub block B that uses the LTE 5 MHz bandwidth technology.

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

Gap channels are indicated using the following syntax:

- The names of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B),
- The channel name ("Gap1" or "Gap2")
- "L" (for lower) or "U" (for upper)

For example: "ABGap1L" indicates the first lower gap channel between sub blocks A and B.

Both the lower and upper gap channels are displayed.



For symmetrical configuration, gap channels can be hidden if they do not reach a minimum size.

For asymmetrical configuration, you can define the number of upper or lower gap channels to be displayed.

In both cases, you can deactivate all gap channels. This enhances the result display, as fewer lines and bars are displayed. If gap channels are deactivated, the power results are not calculated and thus are not shown in the Result Summary table.

Furthermore, channel names for all TX, adjacent, and alternate channels are user-definable (not gap channels).

### Channel power results

The Result Summary for MSR signal measurements is similar to the table for common signals (see [Chapter 3.2.2, "Channel power results"](#), on page 41). However, the TX channel results are grouped by sub blocks, and sub block totals are provided instead

## Channel power and adjacent-channel power (ACLR) measurement

of a total TX channel power. Instead of the individual channel frequency offsets, the absolute center frequencies are indicated for the transmit channels.

The CACLR and ACLR power results for each gap channel are appended at the end of the table. The CACLR results are calculated as the power in the gap channel divided by the power sum of the two closest transmission channels to either side of it.

| 2 Result Summary   |             | USER(MSR_ACLR_Example) |             |             |  |
|--------------------|-------------|------------------------|-------------|-------------|--|
| Channel            | Bandwidth   | Frequency              | Power       |             |  |
| A:GSM1             | 200.000 kHz | 994.900 MHz            | -92.97 dBm  |             |  |
| A:WCDMA1           | 3.840 MHz   | 997.500 MHz            | -80.45 dBm  |             |  |
| A:LTE_SM1 (Ref)    | 4.515 MHz   | 1.002 GHz              | -79.65 dBm  |             |  |
| A:GSM2             | 200.000 kHz | 1.005 GHz              | -93.46 dBm  |             |  |
| Sub Block A Total  |             |                        | -76.82 dBm  |             |  |
| Channel            | Bandwidth   | Frequency              | Power       |             |  |
| B:WCDMA1           | 3.840 MHz   | 1.050 GHz              | -81.98 dBm  |             |  |
| Sub Block B Total  |             |                        | -81.98 dBm  |             |  |
| Channel            | Bandwidth   | Frequency              | Power       |             |  |
| C:WCDMA1           | 3.840 MHz   | 1.100 GHz              | -82.10 dBm  |             |  |
| Sub Block C Total  |             |                        | -82.10 dBm  |             |  |
| Adj Channels       | Bandwidth   | Offset                 | ACLR Lower  | ACLR Upper  |  |
| Adj                | 3.840 MHz   | 5.000 MHz              | -0.74 dBc   | -2.33 dBc   |  |
| Alt1               | 3.840 MHz   | 10.000 MHz             | -0.83 dBc   | -2.44 dBc   |  |
| Gap Channels ACLR  | Bandwidth   | Offset                 | ACLR Lower  | ACLR Upper  |  |
| AB:Gap1            | 3.840 MHz   | 2.500 MHz              | 13.19 dBc   | 0.04 dBc    |  |
| AB:Gap2            | 3.840 MHz   | 7.500 MHz              | 13.29 dBc   | 0.05 dBc    |  |
| BC:Gap1            | 3.840 MHz   | 2.500 MHz              | -0.02 dBc   | -0.02 dBc   |  |
| BC:Gap2            | 3.840 MHz   | 7.500 MHz              | -0.11 dBc   | 0.08 dBc    |  |
| Gap Channels CACLR | Bandwidth   | Offset                 | CACLR Lower | CACLR Upper |  |
| AB:Gap1            | 3.840 MHz   | 2.500 MHz              | 1.41 dBc    | -0.26 dBc   |  |
| AB:Gap2            | 3.840 MHz   | 7.500 MHz              | 1.52 dBc    | -0.25 dBc   |  |
| BC:Gap1            | 3.840 MHz   | 2.500 MHz              | -2.97 dBc   | -3.10 dBc   |  |
| BC:Gap2            | 3.840 MHz   | 7.500 MHz              | -3.06 dBc   | -2.99 dBc   |  |

Figure 3-28: Result summary for symmetrical channel definition

| 2 Result Summary  |             | USER(MSR_ACLR_Example) |            |             |  |
|-------------------|-------------|------------------------|------------|-------------|--|
| Channel           | Bandwidth   | Frequency              | Power      |             |  |
| A:GSM1            | 200.000 kHz | 994.900 MHz            | -92.92 dBm |             |  |
| A:WCDMA1          | 3.840 MHz   | 997.500 MHz            | -80.41 dBm |             |  |
| A:LTE_SM1 (Ref)   | 4.515 MHz   | 1.002 GHz              | -79.61 dBm |             |  |
| A:GSM2            | 200.000 kHz | 1.005 GHz              | -93.37 dBm |             |  |
| Sub Block A Total |             |                        | -76.78 dBm |             |  |
| Channel           | Bandwidth   | Frequency              | Power      |             |  |
| B:WCDMA1          | 3.840 MHz   | 1.050 GHz              | -82.01 dBm |             |  |
| Sub Block B Total |             |                        | -82.01 dBm |             |  |
| Channel           | Bandwidth   | Frequency              | Power      |             |  |
| C:WCDMA1          | 3.840 MHz   | 1.100 GHz              | -82.10 dBm |             |  |
| Sub Block C Total |             |                        | -82.10 dBm |             |  |
| Adj Channels      | Bandwidth   | Offset                 | ACLR Lower | ACLR Upper  |  |
| Adj               | 3.840 MHz   | 5.000 MHz              | -0.77 dBc  | -2.35 dBc   |  |
| Alt1              | 3.840 MHz   | 10.000 MHz             | -0.89 dBc  | -2.42 dBc   |  |
| Gap Channels      | Bandwidth   | Offset                 | ACLR Power | CACLR Power |  |
| AB:Gap1L          | 3.840 MHz   | 2.500 MHz              | 13.08 dBc  | 1.41 dBc    |  |
| AB:Gap1U          | 3.840 MHz   | 2.500 MHz              | 0.09 dBc   | -0.22 dBc   |  |
| AB:Gap2U          | 3.840 MHz   | 7.500 MHz              | 0.09 dBc   | -0.22 dBc   |  |
| BC:Gap1L          | 3.840 MHz   | 2.500 MHz              | 0.01 dBc   | -2.95 dBc   |  |
| BC:Gap2L          | 3.840 MHz   | 7.500 MHz              | -0.03 dBc  | -3.00 dBc   |  |

Figure 3-29: Result summary for asymmetrical channel definition

#### Remote command:

CALCulate:MARKer:FUNCTION:POWER<sb>:RESult? GACLR or  
 CALCulate:MARKer:FUNCTION:POWER<sb>:RESult? MACM, see  
[CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?](#) on page 473


#### Restrictions and dependencies

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

3.2.4 Channel power configuration

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Config"

Both Channel Power (CP) and Adjacent-Channel Power (ACLR) measurements are available.



If the "Multi-Standard Radio" standard is selected (see ["Standard"](#) on page 57), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box. See [Chapter 3.2.5, "MSR ACLR configuration"](#), on page 64 for a description of these settings.

ACLR Setup

General Settings

Channel Settings

Standard

None

Manage User Standards

Channel Count

Tx 1

Adj 0

Reference Channel

Max Power Tx Channel

ACLR Mode

Abs

Rel

Abs

Power Unit

Fast ACLR

On

Off

Power Mode

CLRW

Max Hold

Selected Trace

1

Set CP Reference

Adjust Settings

The remote commands required to perform these tasks are described in [Chapter 6.7.3, "Channel power and ACLR"](#), on page 477.

- [General CP/ACLR measurement settings](#)..... 56
- [Channel setup](#)..... 61

3.2.4.1 General CP/ACLR measurement settings

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

|  |    |
|--|----|
| <a href="#">Standard</a> .....               | 57 |
| L <a href="#">Predefined Standards</a> ..... | 57 |
| L <a href="#">User Standards</a> .....       | 57 |

## Channel power and adjacent-channel power (ACLR) measurement

|  |    |
|--|----|
| Number of channels: Tx, Adj.....   | 58 |
| Reference Channel.....   | 59 |
| Fast ACLR.....   | 59 |
| Selected Trace.....  | 59 |
| Absolute and Relative Values (ACLR Mode).....                                    | 59 |
| Channel power level and density (Power Unit).....                                | 60 |
| Power Mode.....  | 60 |
| Setting a fixed reference for Channel Power measurements (Set CP Reference)..... | 60 |
| Optimized Settings (Adjust Settings).....  | 60 |
| Sweep Time.....  | 61 |

**Standard**

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

**Note:** If the "Multi-Standard Radio" standard is selected, the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box (see [Chapter 3.2.5, "MSR ACLR configuration"](#), on page 64).

If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see [Chapter 3.2.4, "Channel power configuration"](#), on page 56).

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

**Predefined Standards ← Standard**

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

The predefined standards contain the following settings:

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

For details on the available standards, see [Chapter 3.2.9, "Reference: predefined CP/ACLR standards"](#), on page 88.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet` on page 477

**User Standards ← Standard**

**Access:** "CP / ACLR Config" > "General Settings" tab > "Manage User Standards"

In addition to the predefined standards, you can save your own standards with your specific measurement settings in an XML file so you can use them again later. User-defined standards are stored on the instrument in the

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\acp\_std directory.

## Channel power and adjacent-channel power (ACLR) measurement

A sample file is provided for an MSR ACLR measurement (MSR\_ACLRExample.xml). It sets up the measurement for the MSR signal generator waveform described in the file C:\R\_S\Instr\User\waveform\MSRA\_GSM\_WCDMA\_LTE\_GSM.wv.

Note that ACLR user standards are not supported for Fast ACLR measurements.

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

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

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

Save the current measurement settings as a user-defined standard, load a stored measurement configuration, or delete an existing configuration file.

For details see [Chapter 3.2.6.4, "How to manage user-defined configurations"](#), on page 83.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

Remote command:

To query all available standards:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:STANdard:CATalog?`

on page 478

To load a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:PRESet` on page 477

To save a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:STANdard:SAVE`

on page 478

To delete a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:STANdard:DELeTe`

on page 478

### Number of channels: Tx, Adj

Up to 18 carrier channels and up to 12 adjacent channels can be defined.

Results are provided for the Tx channel and the number of defined adjacent channels *above and below* the Tx channel. If more than one Tx channel is defined, the carrier channel to which the relative adjacent-channel power values should be referenced must be defined (see ["Reference Channel"](#) on page 59).

## Channel power and adjacent-channel power (ACLR) measurement

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

For more information on how the number of channels affects the measured powers, see [Chapter 3.2.2, "Channel power results"](#), on page 41.

Remote command:

Number of Tx channels:

[\[SENSe:\] POWER:ACHannel:TXChannel:COUNT](#) on page 482

Number of Adjacent channels:

[\[SENSe:\] POWER:ACHannel:ACPairs](#) on page 479

### Reference Channel

The measured power values in the adjacent channels can be displayed relative to the transmission channel. If more than one Tx channel is defined, define which one is used as a reference channel.

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

Remote command:

[\[SENSe:\] POWER:ACHannel:REference:TXChannel:MANual](#) on page 486

[\[SENSe:\] POWER:ACHannel:REference:TXChannel:AUTO](#) on page 485

### Fast ACLR

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

Remote command:

[\[SENSe:\] POWER:HSPeet](#) on page 493

### Selected Trace

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

Remote command:

[\[SENSe:\] POWER:TRACe](#) on page 476

### Absolute and Relative Values (ACLR Mode)

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

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



## Channel power and adjacent-channel power (ACLR) measurement

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

Remote command:

[SENSe:]POWER:ACHannel:MODE on page 510

### Channel power level and density (Power Unit)

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

**Note:** The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:

"channel power density = channel power – log<sub>10</sub>(channel bandwidth)"

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

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESULT:PHZ on page 509

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESULT:UNIT on page 510

### Power Mode

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

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE on page 472

### Setting a fixed reference for Channel Power measurements (Set CP Reference)

If only one TX channel and no adjacent channels are defined, the currently measured channel power can be used as a fixed reference value for subsequent channel power measurements.

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

**Note:** In adjacent-channel power measurement, the power is always referenced to a transmission channel (see ["Reference Channel"](#) on page 59), thus, this function is not available.

Remote command:

[SENSe:]POWER:ACHannel:REFERENCE:AUTO ONCE on page 485

### Optimized Settings (Adjust Settings)

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



## Channel power and adjacent-channel power (ACLR) measurement

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

The following settings are optimized by "Adjust Settings":

- "Frequency span" on page 48
- "Resolution bandwidth (RBW)" on page 48
- "Video bandwidth (VBW)" on page 49
- "Detector" on page 49
- "Trace averaging" on page 50

**Note:** The reference level is not affected by this function. To adjust the reference level automatically, use the [Setting the Reference Level Automatically \(Auto Level\)](#) function in the [Auto Set] menu.

Remote command:

[SENSe:] POWER:ACHannel:PRESet on page 475

### Sweep Time

With the RMS detector, a longer Sweep Time increases the stability of the measurement results. For recommendations on setting this parameter, see ["Sweep Time"](#) on page 47.

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

Remote command:

[SENSe:] SWEEp:TIME on page 672

### 3.2.4.2 Channel setup

The "Channel Settings" tab in the "ACLR Setup" dialog box provides all the channel settings to configure the channel power or ACLR measurement. You can define the channel settings for all channels, independent of the defined number of *used* TX or adjacent channels (see ["Number of channels: Tx, Adj"](#) on page 58).

For details on setting up channels, see [Chapter 3.2.6.2, "How to set up the channels"](#), on page 80.



In addition to the specific channel settings, the general settings ["Standard"](#) on page 57 and ["Number of channels: Tx, Adj"](#) on page 58 are also available in this tab.

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

|   |    |
|---|----|
| <a href="#">Channel Bandwidth</a> ..... | 62 |
| <a href="#">Channel Spacings</a> .....  | 62 |
| <a href="#">Limit Check</a> .....       | 63 |
| <a href="#">Weighting Filters</a> ..... | 64 |
| <a href="#">Channel Names</a> .....     | 64 |

## Channel Bandwidth

**ACLR Setup**

**General Settings** | **Channel Settings**

Standard: EUTRA/LTE Square  
 Manage User Standards

Channel Count:  
 Tx: 1  
 Adj: 2

**Bandwidths** | **Spacing** | **Limits** | **Weighting Filters** | **Names**

**Tx Channels**

| Channel | Bandwidth |
|---------|-----------|
| Tx 1    | 9.015 MHz |
| Tx 2    | 9.015 MHz |
| Tx 3    | 9.015 MHz |
| Tx 4    | 9.015 MHz |
| Tx 5    | 9.015 MHz |
| Tx 6    | 9.015 MHz |
| Tx 7    | 9.015 MHz |
| Tx 8    | 9.015 MHz |

**Adjacent Channels**

| Channel | Bandwidth |
|---------|-----------|
| Adj     | 9.015 MHz |
| Alt 1   | 9.015 MHz |
| Alt 2   | 9.015 MHz |
| Alt 3   | 9.015 MHz |
| Alt 4   | 9.015 MHz |
| Alt 5   | 9.015 MHz |
| Alt 6   | 9.015 MHz |
| Alt 7   | 9.015 MHz |

The Tx channel bandwidth is normally defined by the transmission standard.

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

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

The value entered for any Tx channel is automatically also defined for all subsequent Tx channels. Thus, only enter one value if all Tx channels have the same bandwidth.

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

Remote command:

[SENSe:]POWER:ACHannel:BANDwidth[:CHANnel<ch>] on page 480

[SENSe:]POWER:ACHannel:BANDwidth:ACHannel on page 479

[SENSe:]POWER:ACHannel:BANDwidth:ALternate<ch> on page 479

## Channel Spacings

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

## Channel power and adjacent-channel power (ACLR) measurement

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

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

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

|       |  |
|-------|--|
| Tx1-2 | Spacing between the first and the second carrier |
| Tx2-3 | Spacing between the second and the third carrier |
| ...   | ...  |

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

For details, see [Chapter 3.2.6.2, "How to set up the channels"](#), on page 80

Remote command:

[SENSe:]POWER:ACHannel:SPACing:CHANnel<ch> on page 482

[SENSe:]POWER:ACHannel:SPACing[:ACHannel] on page 482

[SENSe:]POWER:ACHannel:SPACing:ALternate<ch> on page 481

### Limit Check

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

| 2 Result Summary   |            |                        | W-CDMA 3GPP DL |               |            |           |
|--------------------|------------|------------------------|----------------|---------------|------------|-----------|
| Tx Power 30.54 dBm |            | Tx Bandwidth 3.840 MHz |                | RBW 1.000 MHz |            |           |
| Range Low          | Range Up   | RBW                    | Frequency      | Power Abs     | Power Rel  | ΔLimit    |
| -12.750 MHz        | -8.000 MHz | 1.000 MHz              | 2.09053 GHz    | -40.68 dBm    | -71.22 dB  | -17.18 dB |
| -8.000 MHz         | -4.000 MHz | 1.000 MHz              | 2.09268 GHz    | -40.13 dBm    | -70.67 dB  | -20.63 dB |
| -4.000 MHz         | -3.515 MHz | 30.000 kHz             | 2.09647 GHz    | -52.60 dBm    | -83.14 dB  | -20.10 dB |
| -3.515 MHz         | -2.715 MHz | 30.000 kHz             | 2.09652 GHz    | -54.30 dBm    | -84.84 dB  | -22.38 dB |
| -2.715 MHz         | -2.515 MHz | 30.000 kHz             | 2.09728 GHz    | -51.51 dBm    | -82.05 dB  | -31.01 dB |
| -2.515 MHz         | 2.715 MHz  | 30.000 kHz             | 2.10270 GHz    | -54.13 dBm    | -84.67 dB  | -33.63 dB |
| 2.715 MHz          | 3.515 MHz  | 30.000 kHz             | 2.10299 GHz*   | -57.29 dBm*   | -87.83 dB* | 7.27 dB*  |
| 3.515 MHz          | 4.000 MHz  | 30.000 kHz             | 2.10355 GHz    | -51.94 dBm    | -82.48 dB  | -19.44 dB |
| 4.000 MHz          | 8.000 MHz  | 1.000 MHz              | 2.10725 GHz    | -40.01 dBm    | -70.55 dB  | -20.51 dB |
| 8.000 MHz          | 12.750 MHz | 1.000 MHz              | 2.10911 GHz    | -40.28 dBm    | -70.82 dB  | -16.78 dB |

The results of the power limit checks are also indicated in the STATus:QUESTionable:ACPLimit status registry.

Remote command:

CALCulate<n>:LIMit<li>:ACPower[:STATe] on page 492

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute:STATe on page 487

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute on page 487

## Channel power and adjacent-channel power (ACLR) measurement

[CALCulate<n>:LIMIT<li>:ACPower:ACHannel\[:RELative\]:STATE](#)

on page 488

[CALCulate<n>:LIMIT<li>:ACPower:ACHannel\[:RELative\]](#) on page 488

[CALCulate<n>:LIMIT<li>:ACPower:ALternate<ch>:ABSolute:STATE](#)

on page 490

[CALCulate<n>:LIMIT<li>:ACPower:ALternate<ch>:ABSolute](#) on page 489

[CALCulate<n>:LIMIT<li>:ACPower:ALternate<ch>\[:RELative\]:STATE](#)

on page 491

[CALCulate<n>:LIMIT<li>:ACPower:ALternate<ch>\[:RELative\]](#)

on page 490

[CALCulate<n>:LIMIT<li>:ACPower:ACHannel:RESult?](#) on page 489

### Weighting Filters

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

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

Remote command:

Activating/Deactivating:

[\[SENSe:\] POWER:ACHannel:FILTer\[:STATE\]:CHANnel<ch>](#) on page 485

[\[SENSe:\] POWER:ACHannel:FILTer\[:STATE\]:ACHannel](#) on page 484

[\[SENSe:\] POWER:ACHannel:FILTer\[:STATE\]:ALternate<ch>](#) on page 484

Alpha value:

[\[SENSe:\] POWER:ACHannel:FILTer:ALPHa:CHANnel<ch>](#) on page 484

[\[SENSe:\] POWER:ACHannel:FILTer:ALPHa:ACHannel](#) on page 483

[\[SENSe:\] POWER:ACHannel:FILTer:ALPHa:ALternate<ch>](#) on page 483

### Channel Names

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

Remote command:

[\[SENSe:\] POWER:ACHannel:NAME:ACHannel](#) on page 480

[\[SENSe:\] POWER:ACHannel:NAME:ALternate<ch>](#) on page 481

[\[SENSe:\] POWER:ACHannel:NAME:CHANnel<ch>](#) on page 481

## 3.2.5 MSR ACLR configuration

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Config"

ACLR measurements can also be performed on input containing multiple signals for different communication standards. A new measurement standard is provided that allows you to define multiple discontinuous transmit channels at specified frequencies, independent from the selected center frequency. If the "Multi-Standard Radio" standard

## Channel power and adjacent-channel power (ACLR) measurement

is selected (see ["Standard"](#) on page 57), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box.

For more information, see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

The remote commands required to perform these tasks are described in [Chapter 6.7.3, "Channel power and ACLR"](#), on page 477.

- [General MSR ACLR measurement settings](#)..... 65
- [MSR sub block and TX channel definition](#)..... 69
- [MSR adjacent channel setup](#)..... 72
- [MSR gap channel setup](#)..... 75
- [MSR channel names](#)..... 78

### 3.2.5.1 General MSR ACLR measurement settings

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Config" > "MSR General Settings" tab

|  |    |
|--|----|
| <a href="#">Standard</a> .....                                     | 66 |
| L <a href="#">Predefined Standards</a> .....                       | 66 |
| L <a href="#">User Standards</a> .....                             | 66 |
| <a href="#">Number of Sub Blocks</a> .....                         | 67 |
| <a href="#">Reference Channel</a> .....                            | 67 |
| <a href="#">Selected Trace</a> .....                               | 68 |
| <a href="#">Absolute and Relative Values (ACLR Mode)</a> .....     | 68 |
| <a href="#">Channel power level and density (Power Unit)</a> ..... | 68 |
| <a href="#">Power Mode</a> .....                                   | 68 |
| <a href="#">Optimized Settings (Adjust Settings)</a> .....         | 69 |
| <a href="#">Symmetrical Adjacent Setup</a> .....                   | 69 |
| <a href="#">Limit Checking</a> .....                               | 69 |

## Channel power and adjacent-channel power (ACLR) measurement

**Standard**

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

**Note:** If the "Multi-Standard Radio" standard is selected, the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box (see [Chapter 3.2.5, "MSR ACLR configuration"](#), on page 64).

If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see [Chapter 3.2.4, "Channel power configuration"](#), on page 56).

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

**Predefined Standards ← Standard**

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

The predefined standards contain the following settings:

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

For details on the available standards, see [Chapter 3.2.9, "Reference: predefined CP/ACLR standards"](#), on page 88.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:PRESet` on page 477

**User Standards ← Standard**

**Access:** "CP / ACLR Config" > "General Settings" tab > "Manage User Standards"

In addition to the predefined standards, you can save your own standards with your specific measurement settings in an XML file so you can use them again later. User-defined standards are stored on the instrument in the

`C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\acp_std directory.`

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

Note that ACLR user standards are not supported for Fast ACLR measurements.

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

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

- Number of adjacent channels

## Channel power and adjacent-channel power (ACLR) measurement

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

Save the current measurement settings as a user-defined standard, load a stored measurement configuration, or delete an existing configuration file.

For details see [Chapter 3.2.6.4, "How to manage user-defined configurations"](#), on page 83.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

Remote command:

To query all available standards:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:STANDARD:CATALOG?`

on page 478

To load a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:PRESet` on page 477

To save a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:STANDARD:SAVE`

on page 478

To delete a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:STANDARD:DELETE`

on page 478

### Number of Sub Blocks

Defines the number of sub blocks, i.e. groups of transmission channels in an MSR signal.

For more information, see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

Remote command:

`[SENSe:] POWER:ACHannel:SBCount` on page 503

### Reference Channel

The measured power values in the adjacent channels can be displayed relative to the transmission channel. If more than one Tx channel is defined, define which one is used as a reference channel.

|                      |  |
|----------------------|--|
| Tx Channel 1         | Transmission channel 1 is used.<br>(Not available for MSR ACLR)                |
| Min Power Tx Channel | The transmission channel with the lowest power is used as a reference channel. |

## Channel power and adjacent-channel power (ACLR) measurement

|                          |  |
|--------------------------|--|
| Max Power Tx Channel     | The transmission channel with the highest power is used as a reference channel (Default).  |
| Lowest & Highest Channel | The outer left-hand transmission channel is the reference channel for the lower adjacent channels, the outer right-hand transmission channel that for the upper adjacent channels. |

Remote command:

[SENSe:] POWER:ACHannel:REference:TXChannel:MANual on page 486

[SENSe:] POWER:ACHannel:REference:TXChannel:AUTO on page 485

### Selected Trace

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

Remote command:

[SENSe:] POWER:TRACe on page 476

### Absolute and Relative Values (ACLR Mode)

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

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

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

Remote command:

[SENSe:] POWER:ACHannel:MODE on page 510

### Channel power level and density (Power Unit)

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

**Note:** The channel power density in dBm/Hz corresponds to the power inside a bandwidth of 1 Hz and is calculated as follows:

"channel power density = channel power – log<sub>10</sub>(channel bandwidth)"

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

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESULT:PHZ on page 509

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESULT:UNIT on page 510

### Power Mode

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



## Channel power and adjacent-channel power (ACLR) measurement

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:MODE` on page 472

### Optimized Settings (Adjust Settings)

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

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

The following settings are optimized by "Adjust Settings":

- "Frequency span" on page 48
- "Resolution bandwidth (RBW)" on page 48
- "Video bandwidth (VBW)" on page 49
- "Detector" on page 49
- "Trace averaging" on page 50

**Note:** The reference level is not affected by this function. To adjust the reference level automatically, use the [Setting the Reference Level Automatically \(Auto Level\)](#) function in the [Auto Set] menu.

Remote command:

`[SENSe:] POWer:ACHannel:PRESet` on page 475

### Symmetrical Adjacent Setup

If enabled, the upper and lower adjacent and alternate channels are defined symmetrically. This is the default behavior.

If disabled, the upper and lower channels can be configured differently. This is particularly useful if the lowest TX channel and highest TX channel use different standards and thus require different bandwidths for adjacent channel power measurement.

Remote command:

`[SENSe:] POWer:ACHannel:SSEtup` on page 507

### Limit Checking

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

The results of the power limit checks are also indicated in the `STATus:QUESTionable:ACPLimit` status registry.

Remote command:

`CALCulate<n>:LIMit<li>:ACPower[:STATe]` on page 492

#### 3.2.5.2 MSR sub block and TX channel definition

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Config" > "Tx Channels" tab

The "Tx Channels" tab provides all the channel settings to configure sub blocks and TX channels in MSR ACLR measurements.

## Channel power and adjacent-channel power (ACLR) measurement

**MSR ACLR Setup**

**MSR General Settings** | **Tx Channels** | **Adjacent Channels** | **Gap Channels** | **Names**

**Sub Block A** Sub Block Definition

Center 985.0 MHz RF Bandwidth 20.0 MHz Tx Count 2

**Sub Block B** Tx Channels

|      | Center    | Technology | Bandwidth | Weighting Filter |
|------|-----------|------------|-----------|------------------|
| Tx 1 | 980.0 MHz | LTE_10_00  | 9.015 MHz | 220.0 m          |
| Tx 2 | 990.0 MHz | LTE_10_00  | 9.015 MHz | 220.0 m          |
| Tx 3 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |
| Tx 4 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |
| Tx 5 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |
| Tx 6 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |
| Tx 7 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |
| Tx 8 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |
| Tx 9 | 1.96 GHz  | WCDMA      | 3.84 MHz  | 220.0 m          |

For details on MSR signals, see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

For details on setting up channels, see [Chapter 3.2.6.3, "How to configure an MSR ACLR measurement"](#), on page 81.

The TX channel settings for the individual sub blocks are configured in individual sub-tabs of the "Tx Channel Settings" tab.

|   |    |
|---|----|
| Sub Block Definition.....               | 70 |
| L Sub Block / Center Freq.....          | 71 |
| L RF Bandwidth.....                     | 71 |
| L Number of Tx Channels (Tx Count)..... | 71 |
| Tx Channel Definition.....              | 71 |
| L Tx Center Frequency.....              | 71 |
| L Technology Used for Transmission..... | 71 |
| L Tx Channel Bandwidth.....             | 72 |
| L Weighting Filters.....                | 72 |

### Sub Block Definition

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

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

## Channel power and adjacent-channel power (ACLR) measurement

**Sub Block / Center Freq ← Sub Block Definition**

Defines the center of an MSR sub block. Note that the position of the sub block also affects the position of the adjacent gap channels.

Remote command:

[SENSe:] POWER:ACHannel:SBlock<sb>:FREQuency:CENTer on page 504

**RF Bandwidth ← Sub Block Definition**

Defines the bandwidth of the individual MSR sub block. Note that sub block ranges also affect the position of the adjacent gap channels.

Remote command:

[SENSe:] POWER:ACHannel:SBlock<sb>:RFBWidth on page 505

**Number of Tx Channels (Tx Count) ← Sub Block Definition**

Defines the number of transmit channels the specific sub block contains. The maximum is 18 TX channels.

Remote command:

[SENSe:] POWER:ACHannel:SBlock<sb>:TXCHannel:COUNt on page 506

**Tx Channel Definition**

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

The TX channel settings for the individual sub blocks are configured in individual sub-tabs of the "Tx Channel Settings" tab.

For details on configuring MSR TX channels, see [Chapter 3.2.6.3, "How to configure an MSR ACLR measurement"](#), on page 81.

Remote command:

[SENSe:] POWER:ACHannel:SBlock<sb>:NAME[:CHANnel<ch>] on page 504

**Tx Center Frequency ← Tx Channel Definition**

Defines the (absolute) center frequency of an MSR TX channel. Each TX channel is defined independently of the others; automatic spacing as in common ACLR measurements is not performed.

Note that the position of the adjacent channels is also affected by:

- The position of the first TX channel in the first sub block
- The position of last TX channel in the last sub block

Remote command:

[SENSe:] POWER:ACHannel:SBlock<sb>:CENTer[:CHANnel<ch>] on page 503

**Technology Used for Transmission ← Tx Channel Definition**

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

|          |   |
|----------|---|
| "GSM"    | Transmission according to GSM standard    |
| "W-CDMA" | Transmission according to W-CDMA standard |

## Channel power and adjacent-channel power (ACLR) measurement

"LTE\_xxx"

Transmission according to LTE standard for different channel bandwidths

"USER"

User-defined transmission; no automatic preconfiguration possible

Remote command:

```
[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]
```

on page 505

### **Tx Channel Bandwidth ← Tx Channel Definition**

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

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

Remote command:

```
[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth[:CHANnel<ch>]
```

on page 503

### **Weighting Filters ← Tx Channel Definition**

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

Remote command:

Activating/Deactivating:

```
[SENSe:]POWer:ACHannel:FILTer[:STATe]:SBLock<sb>:CHANnel<ch>
```

on page 501

Alpha value:

```
[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLock<sb>:CHANnel<ch>
```

on page 500

### **3.2.5.3 MSR adjacent channel setup**

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Config" > "Adjacent Channels" tab

The "Adjacent Channels" tab provides all the channel settings to configure adjacent and gap channels in MSR ACLR measurements.



For symmetrical channel definition (see "[Symmetrical Adjacent Setup](#)" on page 69), the dialog box is reduced as the upper and lower channels are identical.

MSR ACLR Setup

MSR General Settings

Tx Channels

Adjacent Channels

Gap Channels

Names

Settings

Adj Count

2

Adj Channels

|             | Spacing  | Bandwidth | Weighting Filter                    | Relative Limit | Absolute Limit                                |         |
|-------------|----------|-----------|-------------------------------------|----------------|---|---------|
| Adjacent    |          |           |                                     |                |   |         |
| Lower       | 5.0 MHz  | 3.84 MHz  | <input checked="" type="checkbox"/> | 220.0 m        | <input checked="" type="checkbox"/> -44.2 dBc | 0.0 dBm |
| Upper       | 5.0 MHz  | 3.84 MHz  | <input checked="" type="checkbox"/> | 220.0 m        | <input checked="" type="checkbox"/> -44.2 dBc | 0.0 dBm |
| Alternate 1 |          |           |                                     |                |   |         |
| Lower       | 10.0 MHz | 3.84 MHz  | <input checked="" type="checkbox"/> | 220.0 m        | <input checked="" type="checkbox"/> -49.2 dBc | 0.0 dBm |
| Upper       | 10.0 MHz | 3.84 MHz  | <input checked="" type="checkbox"/> | 220.0 m        | <input checked="" type="checkbox"/> -49.2 dBc | 0.0 dBm |
| Alternate 2 |          |           |                                     |                |   |         |
| Lower       | 15.0 MHz | 3.84 MHz  | <input checked="" type="checkbox"/> | 220.0 m        | <input type="checkbox"/> 0.0 dBc              | 0.0 dBm |
| Upper       | 15.0 MHz | 3.84 MHz  | <input checked="" type="checkbox"/> | 220.0 m        | <input type="checkbox"/> 0.0 dBc              | 0.0 dBm |

Figure 3-30: Asymmetrical adjacent channel definition

For details on setting up channels, see [Chapter 3.2.6.3, "How to configure an MSR ACLR measurement"](#), on page 81.

|   |    |
|---|----|
| Number of Adjacent Channels (Adj Count) | 73 |
| Adjacent Channel Definition             | 73 |
| L Adjacent Channel Spacings             | 74 |
| L Adjacent Channel Bandwidths           | 74 |
| L Weighting Filters                     | 74 |
| L Limit Checking                        | 75 |

**Number of Adjacent Channels (Adj Count)**  
Defines the number of adjacent channels *above and below* the TX channel block in an MSR signal. You must define the carrier channel to which the relative adjacent-channel power values refer (see ["Reference Channel"](#) on page 59).

Remote command:  
[\[SENSe:\] POWER:ACHannel:ACPairs](#) on page 479

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

## Channel power and adjacent-channel power (ACLR) measurement

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

- The lower adjacent channels are defined in relation to the CF of the first TX channel in the first sub block.
- The upper adjacent channels are defined in relation to the CF of the last TX channel in the last sub block.

Adjacent channels are named "Adj" and "Alt1" to "Alt11" by default; the names can be changed manually (see [Chapter 3.2.5.5, "MSR channel names"](#), on page 78).

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

**Adjacent Channel Spacings ← Adjacent Channel Definition**

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

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

- The spacing of the lower adjacent channels refers to the CF of the first TX channel in the first sub block.
- The spacing of the upper adjacent channels refers to the CF of the last TX channel in the last sub block.

For details, see [Chapter 3.2.6.3, "How to configure an MSR ACLR measurement"](#), on page 81

Remote command:

[SENSe:] POWER:ACHannel:SPACing[:ACHannel] on page 482

[SENSe:] POWER:ACHannel:SPACing:ALternate<ch> on page 481

[SENSe:] POWER:ACHannel:SPACing:UACHannel on page 507

[SENSe:] POWER:ACHannel:SPACing:UALternate<ch> on page 507

**Adjacent Channel Bandwidths ← Adjacent Channel Definition**

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

Remote command:

[SENSe:] POWER:ACHannel:BANDwidth:ACHannel on page 479

[SENSe:] POWER:ACHannel:BANDwidth:ALternate<ch> on page 479

[SENSe:] POWER:ACHannel:BANDwidth:UACHannel on page 499

[SENSe:] POWER:ACHannel:BANDwidth:UALternate<ch> on page 499

**Weighting Filters ← Adjacent Channel Definition**

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

Remote command:

Activating/Deactivating:

[SENSe:] POWER:ACHannel:FILTer[:STATe]:ACHannel on page 484

[SENSe:] POWER:ACHannel:FILTer[:STATe]:ALternate<ch> on page 484

[SENSe:] POWER:ACHannel:FILTer[:STATe]:UACHannel on page 501

[SENSe:] POWER:ACHannel:FILTer[:STATe]:UALternate<ch> on page 502

## Channel power and adjacent-channel power (ACLR) measurement

Alpha value:

[SENSe:] POWER:ACHannel:FILTer:ALPHa:ACHannel on page 483

[SENSe:] POWER:ACHannel:FILTer:ALPHa:ALternate<ch> on page 483

[SENSe:] POWER:ACHannel:FILTer:ALPHa:UACHannel on page 500

[SENSe:] POWER:ACHannel:FILTer:ALPHa:UALternate<ch> on page 500

### Limit Checking ← Adjacent Channel Definition

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

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

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

Remote command:

CALCulate<n>:LIMit<li>:ACPower[:STATe] on page 492

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute:STATe on page 487

CALCulate<n>:LIMit<li>:ACPower:ACHannel:ABSolute on page 487

CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative]:STATe

on page 488

CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative] on page 488

CALCulate<n>:LIMit<li>:ACPower:ALternate<ch>:ABSolute:STATe

on page 490

CALCulate<n>:LIMit<li>:ACPower:ALternate<ch>:ABSolute on page 489

CALCulate<n>:LIMit<li>:ACPower:ALternate<ch>[:RELative]:STATe

on page 491

CALCulate<n>:LIMit<li>:ACPower:ALternate<ch>[:RELative]

on page 490

CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult? on page 489

### 3.2.5.4 MSR gap channel setup

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Config" > "Gap Channels" tab

The "Gap Channels" tab provides all the channel settings to configure gap channels in MSR ACLR measurements.

## Channel power and adjacent-channel power (ACLR) measurement

| MSR General Settings                                      | Tx Channels   | Adjacent Channels | Gap Channels                        | Names          |                          |                |       |                          |           |
|---|---|-------------------|-------------------------------------|----------------|--------------------------|----------------|-------|--------------------------|-----------|
| Gap Activation  |   |                   |                                     |                |                          |                |       |                          |           |
| Activate Gaps   | <input checked="" type="button" value="On"/> <input type="button" value="Off"/> |                   |                                     |                |                          |                |       |                          |           |
| Minimum gap size to show Gap 1                            | 5.0 MHz   |                   |                                     |                |                          |                |       |                          |           |
| Minimum gap size to show Gap 2                            | 10.0 MHz  |                   |                                     |                |                          |                |       |                          |           |
| Gap Channels Configuration (for measuring ACLR and CACLR) |   |                   |                                     |                |                          |                |       |                          |           |
|   | Spacing   | Bandwidth         | Weighting Filter                    | Absolute Limit |                          | Relative Limit |       |                          |           |
| Gap 1   | 2.5 MHz   | 3.84 MHz          | <input checked="" type="checkbox"/> | 0.22           | <input type="checkbox"/> | 0.0 dBm        | ACLR  | <input type="checkbox"/> | -44.2 dBc |
|   |   |                   |                                     |                |                          |                | CACLR | <input type="checkbox"/> | -44.2 dBc |
| Gap 2   | 7.5 MHz   | 3.84 MHz          | <input checked="" type="checkbox"/> | 0.22           | <input type="checkbox"/> | 0.0 dBm        | ACLR  | <input type="checkbox"/> | -44.2 dBc |
|   |   |                   |                                     |                |                          |                | CACLR | <input type="checkbox"/> | -44.2 dBc |

For details on MSR signals, see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

For details on setting up channels, see [Chapter 3.2.6.3, "How to configure an MSR ACLR measurement"](#), on page 81.

|   |    |
|---|----|
| Activate Gaps.....  | 76 |
| Gap Channel Definition.....   | 76 |
| L Minimum gap size to show Gap 1/ Minimum gap size to show Gap 2..... | 77 |
| L Gap Channel Spacing.....  | 77 |
| L Gap Channel Bandwidths.....   | 78 |
| L Weighting Filters.....  | 78 |
| L Limit Checking.....   | 78 |

### Activate Gaps

If enabled, the gap channels are displayed and channel power results are calculated and displayed in the Result Summary.

Remote command:

[\[SENSe:\] POWER:ACHannel:AGChannels](#) on page 498

### Gap Channel Definition

Between two sub blocks in an MSR signal, two gaps are defined: a *lower gap* and an *upper gap*. Each gap in turn can contain two channels, the *gap channels*.

Gap channels are indicated using the following syntax:

- The names of the surrounding sub blocks (e.g. "AB" for the gap between sub blocks A and B)
- The channel name ("Gap1" or "Gap2")
- "L" (for lower) or "U" (for upper)



### Minimum gap size to show Gap 1/ Minimum gap size to show Gap 2 ← Gap Channel Definition

If the gap between the sub blocks does not exceed the specified bandwidth, the gap channels are not displayed in the diagram. The gap channel results are not calculated in the result summary.

Remote command:

`[SENSe:] POWER:ACHannel:GAP<gap>[:AUTO]:MSIZE` on page 502

### Gap Channel Spacing ← Gap Channel Definition

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

Gap channels are defined using bandwidths and spacings, relative to the outer edges of the surrounding sub blocks.

The required spacing can be determined according to the following formula (indicated for lower channels):

$$\text{Spacing} = [\text{CF of gap channel}] - [\text{left sub block CF}] + ([\text{RF bandwidth of left sub block}] / 2)$$

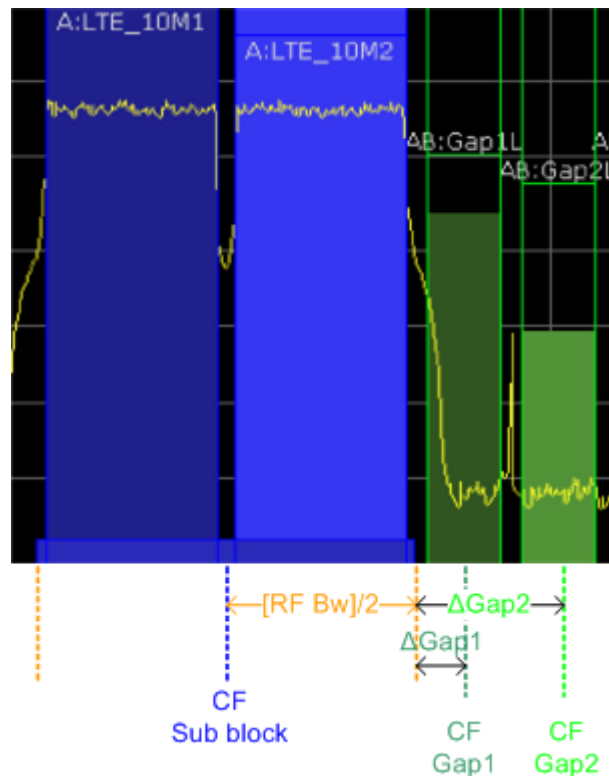


Figure 3-31: Gap channel definition for lower gap

For details, see [Chapter 3.2.6.3, "How to configure an MSR ACLR measurement"](#), on page 81.

Remote command:

`[SENSe:] POWER:ACHannel:SPACing:GAP<gap>[:AUTO]` on page 506

## Channel power and adjacent-channel power (ACLR) measurement

**Gap Channel Bandwidths ← Gap Channel Definition**

The gap channel bandwidth is normally predefined by the transmission technology standard. The correct bandwidth is set automatically for the selected technology. The bandwidth for each channel is indicated by a colored bar in the display (if the gap is not too narrow, see ["Channel display for MSR signals"](#) on page 54).

Remote command:

`[SENSe:] POWER:ACHannel:BANDwidth:GAP<gap>[:AUTO]` on page 498

**Weighting Filters ← Gap Channel Definition**

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

Remote command:

`[SENSe:] POWER:ACHannel:FILTer[:STATE]:GAP<gap>[:AUTO]` on page 501

`[SENSe:] POWER:ACHannel:FILTer:ALPHa:GAP<gap>[:AUTO]` on page 499

**Limit Checking ← Gap Channel Definition**

During an ACLR measurement, the power values can be checked whether they exceed user-defined or standard-defined limits. A relative or absolute limit can be defined, or both, for each individual gap channel. Both limit types are considered, regardless whether the measured levels are absolute or relative values. The check of both limit values can be activated independently. Furthermore, relative limits can be defined and activated individually for ACLR or CACLR power levels.

If any active limit value is exceeded, the measured value is displayed in red and marked by a preceding asterisk in the result table.

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

Remote command:

[Chapter 6.7.3.5, "Limit check"](#), on page 486

**3.2.5.5 MSR channel names**

**Access:** "Overview" > "Select Measurement" > "Channel Power ACLR" > "CP / ACLR Standard" > "Standard": "Multi-Standard Radio" > "CP / ACLR Config" > "Names" tab

Channel names for all TX, adjacent, and alternate channels are user-definable.

In the "Names" tab, you can define a customized name for each channel in each sub block. Note that the names are not checked for uniqueness.

**MSR ACLR Setup**

**MSR General Settings** | **Tx Channels** | **Adjacent Channels** | **Gap Channels** | **Names**

**Tx Channels**

| Tx    | SB A       | SB B |
|-------|------------|------|
| Tx 1  | A:LTE_10M1 |      |
| Tx 2  | A:LTE_10M2 |      |
| Tx 3  | A:WCDMA1   |      |
| Tx 4  | A:WCDMA2   |      |
| Tx 5  | A:WCDMA3   |      |
| Tx 6  | A:WCDMA4   |      |
| Tx 7  | A:WCDMA5   |      |
| Tx 8  | A:WCDMA6   |      |
| Tx 9  | A:WCDMA7   |      |
| Tx 10 | A:WCDMA8   |      |
| Tx 11 | A:WCDMA9   |      |
| Tx 12 | A:WCDMA10  |      |

**Adjacent Channels**

**Adjacent**

Lower: Adj Lower

Upper: Adj Upper

**Alternate 1**

Lower: Alt1 Lower

Upper: Alt1 Upper

**Alternate 2**

Lower: Alt2 Lower

Upper: Alt2 Upper

**Alternate 3**

Lower: Alt3 Lower

Upper: Alt3 Upper

**Alternate 4**

Figure 3-32: Channel name definition for asymmetric adjacent channels

#### Remote command:

[SENSe:] POWER:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>] on page 504

[SENSe:] POWER:ACHannel:NAME:ACHannel on page 480

[SENSe:] POWER:ACHannel:NAME:ALternate<ch> on page 481

[SENSe:] POWER:ACHannel:NAME:UACHannel on page 502

[SENSe:] POWER:ACHannel:NAME:UALternate<ch> on page 503

### 3.2.6 How to perform channel power measurements

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



For remote operation, see [Chapter 6.7.3.10, "Programming examples for channel power measurements"](#), on page 510.

## Channel power and adjacent-channel power (ACLR) measurement

- [How to perform a standard channel power measurement](#)..... 80
- [How to set up the channels](#).....80
- [How to configure an MSR ACLR measurement](#).....81
- [How to manage user-defined configurations](#).....83
- [How to compare the TX channel power in successive measurements](#).....84

**3.2.6.1 How to perform a standard channel power measurement**

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

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".  
The measurement is started immediately with the default settings.
3. Select "CP / ACLR Standard".
4. Select a standard from the list.  
The measurement is restarted with the predefined settings for the selected standard.
5. If necessary, edit the settings for your specific measurement as described in [Chapter 3.2.6.2, "How to set up the channels"](#), on page 80, or load a user-defined configuration (see ["To load a user-defined configuration"](#) on page 83).

**3.2.6.2 How to set up the channels**

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

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

Channel setup consists of the following settings:

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



Changes to an existing standard can be stored as a user-defined standard, see [Chapter 3.2.6.4, "How to manage user-defined configurations"](#), on page 83.

- To configure the channels in the "Ch Power" dialog box, select "Ch Power" > "CP / ACLR Config" > "Channel Settings" tab.



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

### To define channel spacings

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

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

### Example: Defining channel spacing

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

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

Starting from the default setting, set the spacing of the fifth adjacent channel ("ALT4") to 150 kHz. For all higher adjacent channels, the spacing is multiplied by factor 1.5: 180 kHz ("ALT5"), 210 kHz ("ALT6"), 240 kHz ("ALT7"), ...

### 3.2.6.3 How to configure an MSR ACLR measurement

You configure ACLR measurements on MSR signals in a special configuration dialog box on the R&S ESW.

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".  
The measurement is started immediately with the default settings.
3. Select "CP / ACLR Standard".
4. Select the "Multi-Standard Radio" standard from the list.

## Channel power and adjacent-channel power (ACLR) measurement

5. Select "CP / ACLR Config" to configure general MSR settings, including the number of sub blocks (up to 5).  
To configure asymmetric adjacent channels, deactivate the "Symmetrical" option in the general MSR settings.
6. Select the "Tx Channels" tab to configure the sub blocks and transmission channels.  
For each sub block:
  - a) Define the (center frequency) position and bandwidth of the sub block, as well as the number of transmission channels it contains.
  - b) For each transmission channel in the sub block:
    - Define the center frequency.
    - Select the technology used for transmission.
    - Check the bandwidth.
    - If necessary, define the use of a weighting filter for the channel.
7. Select the "Adjacent Channels" tab to configure the adjacent channels.
8. Define the number of adjacent channels and the settings for each channel:
  - The spacing, defined as the distance of the center frequency from the center frequency of the first transmission channel in the first sub block.  
For asymmetrical channels, define the upper adjacent channel spacing as the distance from the center frequency of the last transmission channel in the last sub block.
  - The bandwidth
  - If necessary, a weighting filter
  - Optionally, define *and activate* relative or absolute limits, or both, against which the power levels of the channel are to be checked.
9. Select the "Gap Channels" tab to configure the gap channels.
10. Define the following settings for the two (upper or lower) gap channels. Since the upper and lower channels are identical, it is only necessary to configure two channels.
  - The spacing, defined as the distance of the center frequency from the outer edge of the sub block to the left or right of the gap. You can determine the required spacing as follows:  

$$\text{Spacing} = [\text{CF of the gap channel}] - [\text{left sub block center}] + ([\text{RF bandwidth of left sub block}] / 2)$$
  - The bandwidth
  - If necessary, a weighting filter
  - Optionally, define *and activate* relative or absolute limits, or both, against which the power levels of the channel are to be checked.
11. If power limits are defined and activated, activate global limit checking for the measurement on the "MSR General Settings" tab.

12. Optionally, store the settings for the MSR ACLR measurement as a user-defined standard as described in ["To store a user-defined configuration"](#) on page 83. Otherwise the configuration is lost when you select a different measurement standard.

#### 3.2.6.4 How to manage user-defined configurations

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

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



##### Compatibility to R&S FSP

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

##### To store a user-defined configuration

1. In the "Ch Power" menu, select "CP / ACLR Config" to display the "ACLR Setup" dialog box.
2. Configure the measurement as required (see also [Chapter 3.2.6.2, "How to set up the channels"](#), on page 80).
3. In the "General Settings" tab, select "Manage User Standards" to display the "Manage" dialog box.
4. Define a filename and storage location for the user standard.  
By default, the XML file is stored in  
`C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\acp_std\.`  
However, you can define any other storage location.
5. Select "Save".

##### To load a user-defined configuration

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

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

### 3.2.6.5 How to compare the TX channel power in successive measurements

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

1. Configure a measurement with only one TX channel and no adjacent channels (see also [Chapter 3.2.6.2, "How to set up the channels"](#), on page 80).

2. In the "ACLR Setup" dialog box, select "Set CP Reference".

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

3. Start a new measurement.

The resulting power is indicated relative to the fixed reference power.

4. Repeat this for any number of measurements.

5. To start a new measurement without the fixed reference, temporarily define a second channel or preset the instrument.

## 3.2.7 Measurement examples

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

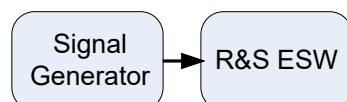


A programming example demonstrating an ACLR measurement in a remote environment is provided in [Chapter 6.7.3.10, "Programming examples for channel power measurements"](#), on page 510.

- [Measurement example 1 – ACPR measurement on a CDMA2000 signal](#)..... 84
- [Measurement example 3 – measuring the intrinsic noise of the R&S ESW with the channel power function](#)..... 86

### 3.2.7.1 Measurement example 1 – ACPR measurement on a CDMA2000 signal

**Test setup:**





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

|             |          |
|-------------|----------|
| Frequency:  | 850 MHz  |
| Level:      | 0 dBm    |
| Modulation: | CDMA2000 |

**Procedure:**

1. Preset the R&S ESW.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *850 MHz*.
4. Set the span to *4 MHz*.
5. Set the reference level to *+10 dBm*.
6. Press [MEAS] or select "Select Measurement" in the "Overview".
7. Select the "Channel Power ACLR" measurement function.
8. Set the "CDMA2000" standard for adjacent channel power measurement in the "ACLR Setup" dialog box.

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

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

9. Set the optimal reference level and RF attenuation for the applied signal level using the "Auto Level" function in the [Auto Set] menu.

The R&S ESW sets the optimal RF attenuation and the reference level based on the transmission channel power to obtain the maximum dynamic range.

The [Figure 3-33](#) shows the result of the measurement.

## Channel power and adjacent-channel power (ACLR) measurement

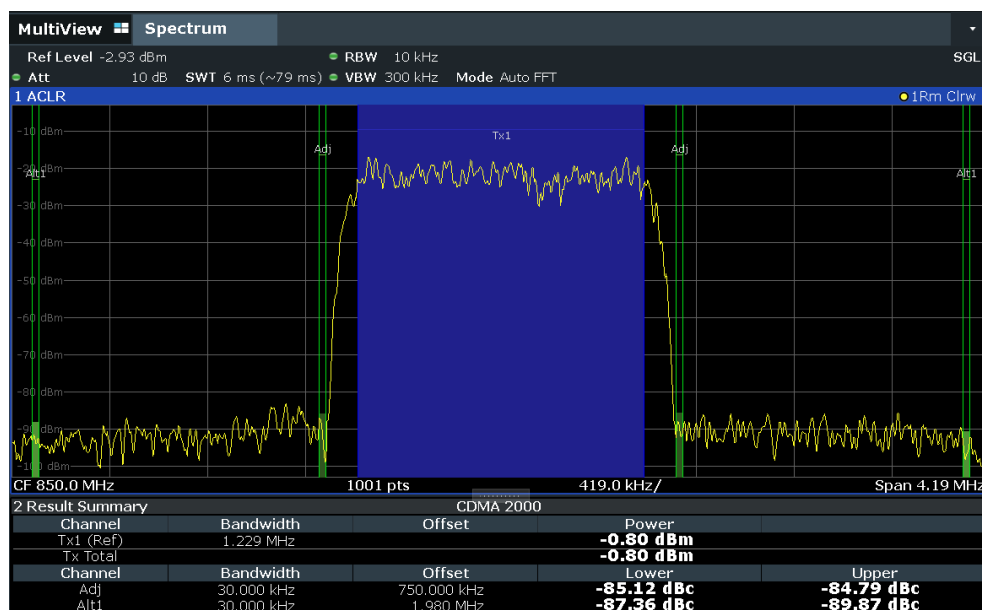


Figure 3-33: Adjacent channel power measurement on a CDMA2000 signal

### 3.2.7.2 Measurement example 3 – measuring the intrinsic noise of the R&S ESW with the channel power function

Noise in any bandwidth can be measured with the channel power measurement functions. Thus the noise power in a communication channel can be determined, for example.

If the noise spectrum within the channel bandwidth is flat, the noise marker can be used to determine the noise power in the channel by considering the channel bandwidth. However, in the following cases, the channel power measurement method must be used to obtain correct measurement results:

- If phase noise and noise that normally increases towards the carrier is dominant in the channel to be measured
- If there are discrete spurious signals in the channel

#### Test setup:

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

#### Procedure:

1. Preset the R&S ESW.
2. Set the center frequency to 1 GHz and the span to 1 MHz.
3. To obtain maximum sensitivity, set RF attenuation to 0 dB and the reference level to -40 dBm.

## Channel power and adjacent-channel power (ACLR) measurement

4. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
5. In the "ACLR Setup" dialog box, set up a single TX channel with the channel bandwidth 1.23 MHz.
6. Select "Adjust Settings".  
The settings for the frequency span, the bandwidth (RBW and VBW) and the detector are automatically set to the optimum values required for the measurement.
7. Stabilize the measurement result by increasing the Sweep Time.  
Set the Sweep Time to 1 s.

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

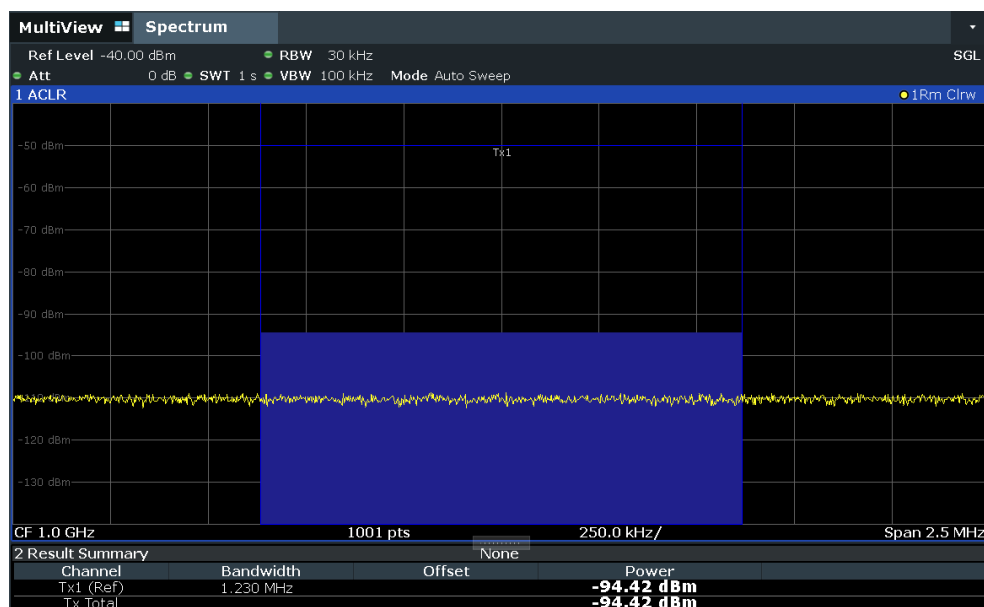


Figure 3-34: Measurement of the R&S ESW's intrinsic noise power in a 1.23 MHz channel bandwidth.

### 3.2.8 Optimizing and troubleshooting the measurement

If the results do not meet your expectations, or if you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Only activate as many **adjacent channels** as necessary to minimize the required span and thus the required measurement time for the measurement.
- Increase the **RBW** to minimize the measurement time; however, consider the requirements of the standard if you need to measure according to standard! The automatic settings are always according to standard.
- Take advantage of the **speed optimization mode** in the "Sweep" settings if you do not require the larger dynamic range (see "Optimization" on page 308).

## Channel power and adjacent-channel power (ACLR) measurement

- Reduce the **Sweep Time** and thus the amount of data to be captured and calculated; however, consider the requirements regarding the standard deviation.
- To improve the **stability of the measured results**, increase the Sweep Time, which also leads to more averaging steps.
- Instead of **trace averaging**, use an RMS detector with a higher Sweep Time to obtain better average power results in less time.
- To determine a **channel power level** quickly, use the **Time domain power measurement** (TDP) rather than a Channel Power measurement. The TDP measurement is a zero span measurement where the sweep time determines the measurement time. Due to the FFT measurement, duplicate averaging is performed, providing very stable results very quickly.  
Note, however, that for TDP measurements, channel filters are not available and a fixed RBW is used. Thus, the measurement may not be according to standard for some test cases.

### 3.2.9 Reference: predefined CP/ACLR standards

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

You can select a predefined standard via "CP / ACLR Standard" in the "Ch Power" menu or the selection list in the "General Settings" tab of the "ACLR Setup" dialog box (see ["Standard"](#) on page 57).

**Table 3-9: Predefined CP / ACLR standards with remote command parameters**

| Standard             | Remote parameter |
|----------------------|------------------|
| None                 | NONE             |
| Multi-Standard Radio | MSR              |
| EUTRA/LTE Square     | EUTRa            |
| EUTRA/LTE Square/RRC | REUTra           |
| 5G NR DL FR1 20MHz   | F1D20nr5g        |
| 5G NR DL FR1 100MHz  | F1D100nr5g       |
| 5G NR UL FR1 20MHz   | F1U20nr5g        |
| 5G NR UL FR1 100MHz  | F1U100nr5g       |
| 5G NR DL FR2 100MHz  | F2D100nr5g       |
| 5G NR DL FR2 200MHz  | F2D200nr5g       |
| 5G NR UL FR2 100MHz  | F2U100nr5g       |
| 5G NR UL FR2 200MHz  | F2U200nr5g       |
| W-CDMA 3GPP FWD      | FW3Gppcdma       |
| W-CDMA 3GPP REV      | RW3Gppcdma       |
| CDMA IS95A FWD       | F8CDma           |
| CDMA IS95A REV       | R8CDma           |

## Channel power and adjacent-channel power (ACLR) measurement

| Standard                 | Remote parameter |
|--------------------------|------------------|
| CDMA IS95C Class 0 FWD*) | FIS95c0          |
| CDMA IS95C Class 0 REV*) | RIS95c0          |
| CDMA J-STD008 FWD        | F19Cdma          |
| CDMA J-STD008 REV        | R19Cdma          |
| CDMA IS95C Class 1 FWD*) | FIS95c1          |
| CDMA IS95C Class 1 REV*) | RIS95c1          |
| CDMA2000                 | S2CDma           |
| TD-SCDMA FWD             | FTCDma           |
| TD-SCDMA REV             | TRCDma           |
| WLAN 802.11A             | AWLAN            |
| WLAN 802.11B             | BWLAN            |
| WIMAX                    | WIMax            |
| WIBRO                    | WIBRo            |
| GSM                      | GSM              |
| RFID 14443               | RFID14443        |
| TETRA                    | TETRa            |
| PDC                      | PDC              |
| PHS                      | PHS              |
| CDPD                     | CDPD             |
| APCO-25 P2               | PAPCo25          |
| User Standard            | USER             |
| Customized Standard      | <string>         |



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

### 3.2.10 Reference: predefined ACLR user standard XML files

In addition to the predefined standards, some user standards with specific measurement settings for common ACLR measurements are provided in XML files on the instrument in the

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\acp\_std directory.

Furthermore, the following XML files are provided:

**5G NR\DL**

- 5G NR\DL\5G NR\_DL\_FR1\_20MHz
- 5G NR\DL\5G NR\_DL\_FR1\_100MHz
- 5G NR\DL\5G NR\_DL\_FR2\_100MHz
- 5G NR\DL\5G NR\_DL\_FR2\_200MHz

**5G NR\UL**

- 5G NR\UL\5G NR\_UL\_FR1\_20MHz
- 5G NR\UL\5G NR\_UL\_FR1\_100MHz
- 5G NR\UL\5G NR\_UL\_FR2\_100MHz
- 5G NR\UL\5G NR\_UL\_FR2\_200MHz

**LTE\DL**

- LTE\DL\LTE\_DL\_5MHZ.XML
- LTE\DL\LTE\_DL\_10MHZ.XML
- LTE\DL\LTE\_DL\_15MHZ.XML
- LTE\DL\LTE\_DL\_20MHZ.XML

**LTE\UL**

- LTE\UL\LTE\_UL\_5MHZ.XML
- LTE\UL\LTE\_UL\_10MHZ.XML
- LTE\UL\LTE\_UL\_15MHZ.XML
- LTE\UL\LTE\_UL\_20MHZ.XML

**WLAN**

- WLAN\802\_11ac\802\_11ac\_20MHZ.XML
- WLAN\802\_11ac\802\_11ac\_40MHZ.XML
- WLAN\802\_11ac\802\_11ac\_80MHZ.XML
- WLAN\802\_11ac\802\_11ac\_160MHZ.XML



To load a stored measurement configuration, in the "General Settings" tab of the "ACLR Setup" dialog box, select "Manage User Standards" to display the "Manage" dialog box. Select the user standard file, then "Load".

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

For details, see [Chapter 3.2.6.4, "How to manage user-defined configurations"](#), on page 83.

### 3.3 Carrier-to-noise measurements

Measures the carrier-to-noise ratio. C/No measurements normalize the ratio to a 1 Hz bandwidth.

|   |    |
|---|----|
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| • <a href="#">Carrier-to-noise results</a> .....                    | 91 |
| • <a href="#">Carrier-to-noise configuration</a> .....              | 92 |
| • <a href="#">How to determine the carrier-to-noise ratio</a> ..... | 94 |

### 3.3.1 About the measurement

The largest signal in the frequency span is the carrier. When you activate the C/N or C/N<sub>0</sub> function, the R&S ESW searches the (unmodulated) carrier using a peak detector. The carrier is marked using a fixed reference marker ("FXD").

To determine the noise power, the R&S ESW analyzes a channel with a defined bandwidth at the defined center frequency. The R&S ESW integrates the power within this channel to obtain the noise power level. If the carrier is within this channel, you have to switch off the carrier to determine the correct noise power level. To determine the noise power, the R&S ESW requires an RMS detector. To switch detectors, you must adjust the settings between the two measurements (see ["Adjust Settings"](#) on page 93).

The R&S ESW subtracts the noise power of the channel from the maximum carrier signal level. For a C/N<sub>0</sub> measurement, the R&S ESW normalizes the result to a 1 Hz bandwidth.



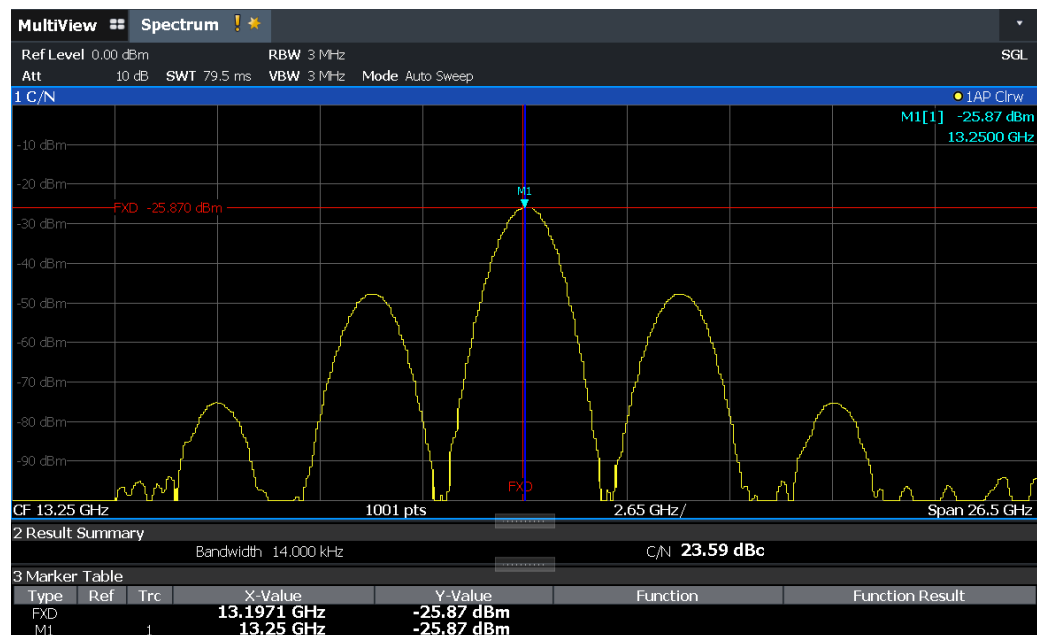
The carrier-to-noise measurements are only available in the frequency domain (span >0).

#### Frequency Span

To measure the carrier-to-noise ratio correctly, set the frequency span to approximately twice the channel bandwidth. The "Adjust Settings" function automatically uses that value.

### 3.3.2 Carrier-to-noise results

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



#### Remote command:

CALC:MARK:FUNC:POW:RES? CN

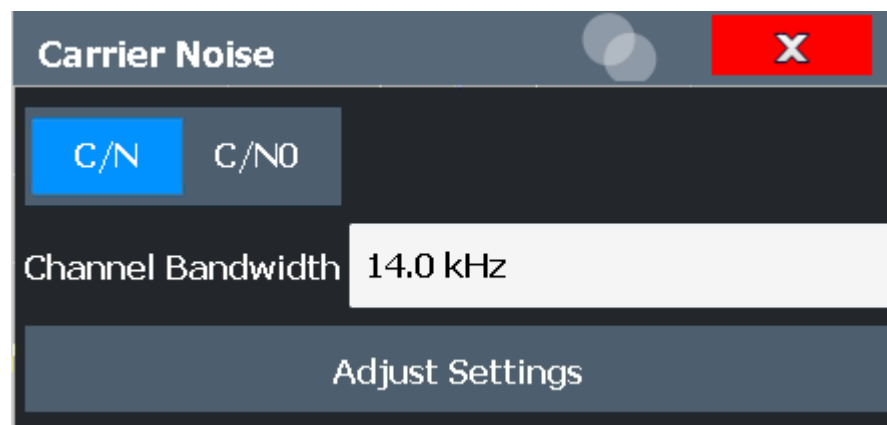
CALC:MARK:FUNC:POW:RES? CN0

See [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 473.

### 3.3.3 Carrier-to-noise configuration

**Access:** "Overview" > "Select Measurement" > "C/N"/"C/N0" > "Carrier Noise Config"

Both a carrier-to-noise ratio (C/N) and a carrier-to-noise ratio in relation to the bandwidth (C/N<sub>0</sub>) measurement are available.



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





The easiest way to configure a measurement is using the configuration "Overview", see [Chapter 4.2, "Configuration overview"](#), on page 221.

The remote commands required to perform these tasks are described in [Chapter 6.7.4, "Carrier-to-noise ratio"](#), on page 518.

|                        |    |
|------------------------|----|
| C/N.....               | 93 |
| C/NO.....              | 93 |
| Channel Bandwidth..... | 93 |
| Adjust Settings.....   | 93 |

### C/N

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

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use "Marker To Trace" in the "Marker" menu (see ["Assigning the Marker to a Trace"](#) on page 208).

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:SElect` on page 474  
`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?` on page 473  
`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>[:STATe]` on page 475

### C/NO

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

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use "Marker To Trace" in the "Marker" menu (see ["Assigning the Marker to a Trace"](#) on page 208).

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:SElect` on page 474  
`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?` on page 473  
`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>[:STATe]` on page 475

### Channel Bandwidth

Defines the channel bandwidth.

The default setting is 14 kHz.

Remote command:

`[SENSe:] POWER:ACHannel:BANDwidth[:CHANnel<ch>]` on page 480

### Adjust Settings

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

$2 * \text{channel bandwidth}$

The adjustment is performed once. If necessary, you can change the setting later.

Remote command:

`[SENSe:] POWER:ACHannel:PRESet` on page 475

### 3.3.4 How to determine the carrier-to-noise ratio

The following step-by-step instructions demonstrate how to determine the carrier-to-noise ratio.



For remote operation, see [Chapter 6.7.17, "Programming example: carrier-to-noise ratio"](#), on page 616.

1. Select [MEAS].
2. To configure the measurement without reference to the bandwidth, select "C/N".  
To configure the measurement with reference to the bandwidth, select "C/N<sub>0</sub>".
3. To change the channel bandwidth to be analyzed, select "Channel Bandwidth".
4. Select [RUN SINGLE].  
The fixed reference marker for the (unmodulated) carrier is indicated in the diagram.
5. If the carrier signal is located within the analyzed channel bandwidth, switch off the carrier signal so that only the noise is displayed in the channel.
6. To optimize the settings for the selected channel configuration and use the RMS detector, select "Adjust Settings".
7. Select [RUN SINGLE] to perform a second measurement.  
The carrier-to-noise ratio is displayed after the measurement has been completed.

## 3.4 Occupied bandwidth measurement (OBW)

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

- [About the measurement](#).....94
- [OBW results](#).....96
- [OBW configuration](#).....97
- [How to determine the occupied bandwidth](#).....99
- [Measurement example](#).....100

### 3.4.1 About the measurement

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

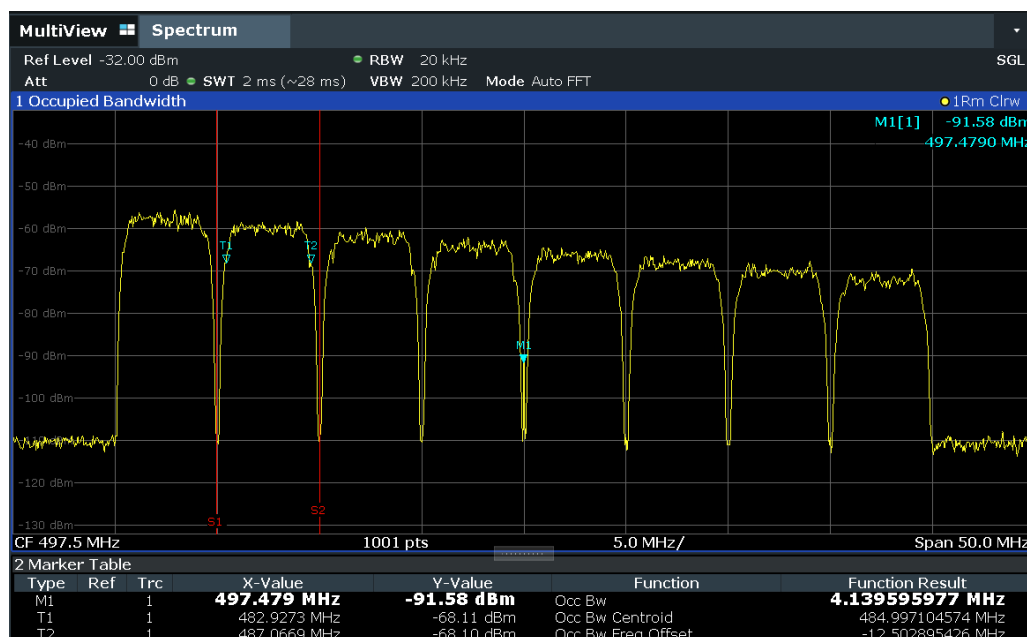
## Occupied bandwidth measurement (OBW)

## Measurement principle

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

**OBW within defined search limits - multicarrier OBW measurement in one sweep**

The occupied bandwidth of the signal can also be determined within defined search limits instead of for the entire signal. Thus, only a single sweep is required to determine the OBW for a multicarrier signal. To do so, search limits are defined for an individual carrier and the OBW measurement is restricted to the frequency range contained within those limits. Then the search limits are adapted for the next carrier and the OBW is automatically recalculated for the new range.



For step-by-step instructions, see ["How to determine the OBW for a multicarrier signal using search limits"](#) on page 99.

## Prerequisites

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

- Only the signal to be measured is displayed in the window, or search limits are defined to include only one (carrier) signal. An additional signal would falsify the measurement.

## Occupied bandwidth measurement (OBW)

- $RBW \ll$  occupied bandwidth (approx. 1/20 of occupied bandwidth, for voice communication type: 300 Hz or 1 kHz)
- $VBW \geq 3 \times RBW$
- RMS detector
- $Span \geq 2$  to  $3 \times$  occupied bandwidth

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

### 3.4.2 OBW results

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

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



The OBW calculation is repeated if you change the [search limits](#), without performing a new sweep. Thus, the OBW for a multicarrier signal can be determined using only one sweep.

#### Centroid frequency

The centroid frequency is defined as the point in the center of the occupied bandwidth, calculated using the temporary OBW markers T1 and T2. This frequency is indicated as a function result ("Occ Bw Centroid") in the marker table.

#### Frequency offset

The offset of the calculated centroid frequency to the defined center frequency of the R&S ESW is indicated as a function result ("Occ Bw Freq Offset") in the marker table.

#### Remote command:

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

`CALC:MARK:FUNC:POW:SEL OBW`, see [CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:SElect](#) on page 474

[CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>\[:STATe\]](#) on page 475

`CALC:MARK:FUNC:POW:RES? OBW`, see [CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?](#) on page 473

CALC:MARK:FUNC:POW:RES? COBW, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 473

3.4.3 OBW configuration

Access: "Overview" > "Select Measurement" > "OBW" > "OBW Config"

Occupied Bandwidth

OBW Settings

% Power Bandwidth

99.0 %

Channel Bandwidth

14.0 kHz

Adjust Settings

Search Limits

Left Limit

☐

0.0 Hz

Right Limit

☐

26.5 GHz

Search Limits Off

This measurement is not available in zero span.



Configuring search limits for OBW measurement

The OBW measurement uses the same search limits as defined for marker search (see [search limits](#)). However, only the left and right limits are considered.

The remote commands required to perform these tasks are described in [Chapter 6.7.5, "Occupied bandwidth"](#), on page 519.

|  |    |
|--|----|
| <a href="#">% Power Bandwidth</a> .....            | 97 |
| <a href="#">Channel Bandwidth</a> .....            | 98 |
| <a href="#">Adjust Settings</a> .....              | 98 |
| <a href="#">Search Limits (Left / Right)</a> ..... | 98 |
| <a href="#">Search Limits Off</a> .....            | 98 |

% Power Bandwidth

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

Remote command:

[SENSe:] POWER: BANDwidth on page 520

### Channel Bandwidth

Defines the channel bandwidth for the transmission channel in single-carrier measurements. This bandwidth is used to optimize the test parameters (for details see ["Adjust Settings"](#) on page 98). The default setting is 14 kHz.

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

For multicarrier measurements, this setting is irrelevant.

Remote command:

[SENSe:] POWER: ACHannel: BANDwidth[:CHANnel<ch>] on page 480

### Adjust Settings

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

This function is only useful for single carrier measurements.

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

- Frequency span:  $3 \times$  channel bandwidth
- RBW  $\leq 1/40$  of channel bandwidth
- VBW  $\geq 3 \times$  RBW
- Detector: RMS

The reference level is not affected by "Adjust Settings". For an optimum dynamic range, select the reference level such that the signal maximum is close to the reference level.

(See ["Setting the Reference Level Automatically \(Auto Level\)"](#) on page 293).

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

Remote command:

[SENSe:] POWER: ACHannel: PRESet on page 475

### Search Limits (Left / Right)

If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches, see ["Peak search limits"](#) on page 424.

Remote command:

CALCulate<n>: MARKer<m>: X: SLIMits[:STATe] on page 726

CALCulate<n>: MARKer<m>: X: SLIMits: LEFT on page 725

CALCulate<n>: MARKer<m>: X: SLIMits: RIGHT on page 725

### Search Limits Off

Deactivates the search range limits.

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 726

`CALCulate<n>:THReshold:STATe` on page 727

### 3.4.4 How to determine the occupied bandwidth

The following step-by-step instructions demonstrate how to determine the occupied bandwidth.



For remote operation, see [Chapter 6.7.5.2, "Programming example: OBW measurement"](#), on page 520.

#### How to determine the OBW for a single signal

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select the "OBW" measurement function.  
The measurement is started immediately with the default settings.
3. Select "OBW Config".  
The "Occupied Bandwidth" configuration dialog box is displayed.
4. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
5. If necessary, change the channel bandwidth for the transmission channel.
6. To optimize the settings for the selected channel configuration, select "Adjust Settings".
7. Start a sweep.

The result is displayed as OBW in the marker results.

#### How to determine the OBW for a multicarrier signal using search limits

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select the "OBW" measurement function.
3. Select "OBW Config".
4. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
5. Define search limits so the search area contains only the first carrier signal:
  - a) Enter values for the left or right limits, or both.
  - b) Enable the use of the required limits.
6. Start a sweep.

The result for the first carrier is displayed as OBW in the marker results.

7. Change the search limits so the search area contains the next carrier signal as described in [step 5](#).  
The OBW is recalculated and the result for the next carrier is displayed. A new sweep is not necessary!
8. Continue in this way until all carriers have been measured.

### 3.4.5 Measurement example

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



A programming example demonstrating an OBW measurement in a remote environment is provided in [Chapter 6.7.5.2, "Programming example: OBW measurement"](#), on page 520.

1. Preset the R&S ESW.
2. Enter the Spectrum application via [MODE].
3. Set the "Center Frequency" to *800 MHz*.
4. Set the "Reference Level" to *-10 dBm*.
5. Press [MEAS] or select "Select Measurement" in the "Overview".
6. Select the "OBW" measurement function.
7. Select "OBW Config".
8. Set the "% Power Bandwidth" to *99 %*.
9. Set the "Channel Bandwidth" to *21 kHz* as specified by the PDC standard.
10. Optimize the settings for the selected channel configuration by selecting "Adjust Settings".
11. Adjust the reference level to the measured total power by selecting "Auto Level" in the [Auto set] menu.
12. The PDC standard requires the peak detector for OBW measurement. In the "Traces" configuration dialog, set the trace detector to "PositivePeak".
13. Start a sweep.

The result is displayed as OBW in the marker results.

## 3.5 Spectrum emission mask (SEM) measurement

Spectrum Emission Mask (SEM) measurements monitor compliance with a spectral mask.



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| • <a href="#">Typical applications</a> .....                                | 101 |
| • <a href="#">SEM results</a> .....   | 101 |
| • <a href="#">SEM basics</a> .....  | 104 |
| • <a href="#">SEM configuration</a> .....                                   | 115 |
| • <a href="#">How to perform a spectrum emission mask measurement</a> ..... | 132 |
| • <a href="#">Measurement example: Multi-SEM measurement</a> .....          | 137 |
| • <a href="#">Reference: SEM file descriptions</a> .....                    | 138 |

### 3.5.1 About the measurement

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

In the basic Spectrum application, spectrum emissions can be measured for multiple sub blocks of channels, where the sub blocks can include gaps or overlap, and define separate masks. Radio signals using multiple standards can also be analyzed.

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

To improve the performance of the R&S ESW for spectrum emission mask measurements, a "Fast SEM" mode is available.

A special limit check for SEM measurements allows for monitoring compliance of the spectrum.

### 3.5.2 Typical applications

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

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

### 3.5.3 SEM results

As a result of the Spectrum Emission Mask measurement, the following results are displayed in a diagram (see also [Chapter 3.5.4.2, "Limit lines in SEM measurements"](#), on page 107):

- The measured signal levels

## Spectrum emission mask (SEM) measurement

- The result of the limit check (mask monitoring)
- The defined limit lines
- TX channel power "P"
- The used power class

**Multi-SEM measurements**

Multi-SEM measurements are SEM measurements with more than one sub block. In these measurements, each sub block has its own power class definitions. In this case, the power class is not indicated in the graphical result displays.

**Example:**

For example, in [Figure 3-35](#), " $31 < P < 39$ " is indicated as the used power class is defined from 31 to 39.

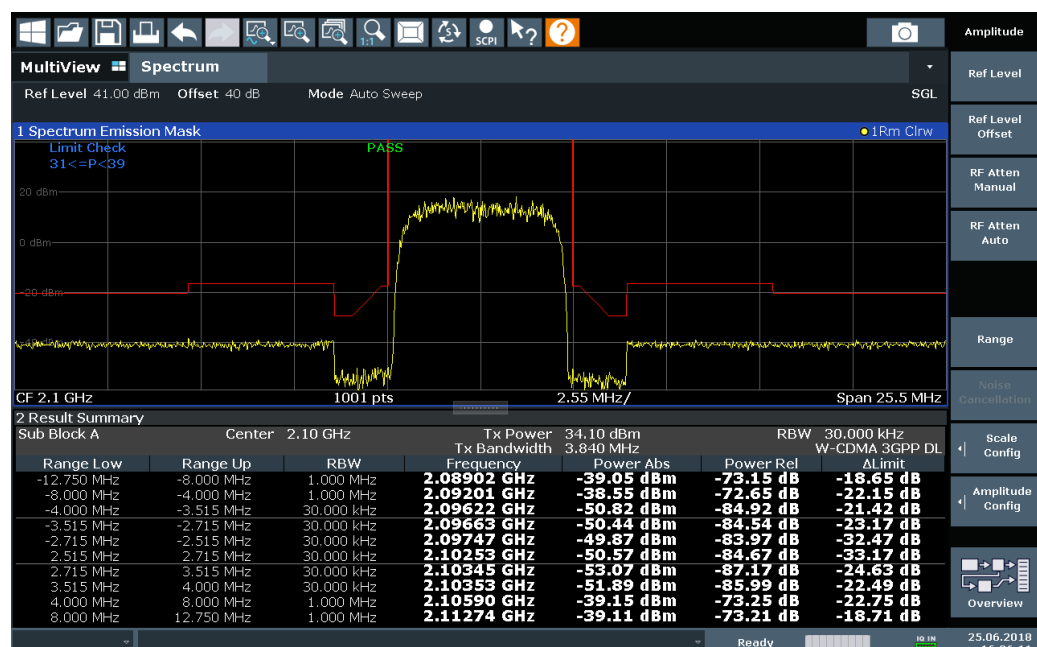


Figure 3-35: Spectrum Emission Mask result displays

In addition to the graphical results of the SEM measurement displayed in the diagram, a result summary is displayed to evaluate the limit check results (see also [Chapter 3.5.4.2, "Limit lines in SEM measurements"](#), on page 107).

The following information is provided in the result summary:

| Label                      | Description                              |
|----------------------------|--|
| <b>General information</b> |  |
| "Standard"                 | Loaded standard settings                 |
| "Tx Power"                 | Power of the reference range             |
| "Tx Bandwidth"             | Tx bandwidth used by the reference range |

## Spectrum emission mask (SEM) measurement

| Label                | Description   |
|----------------------|---|
| "RBW"                | RBW used by the reference range                               |
| <b>Range results</b> |   |
| "Range Low"          | Start of the frequency range the peak value was found in      |
| "Range Up"           | Frequency range end the peak value was found in               |
| "RBW"                | RBW of the range  |
| "Frequency"          | Frequency of the peak power level                             |
| "Power Abs"          | Absolute peak power level within the range                    |
| "Power Rel"          | Peak power level within the range, relative to the "Tx Power" |
| "ΔLimit"             | Deviation of the peak power level from the limit line         |

You can define in which detail the data is displayed in the result summary in the "List Evaluation" settings (see [Chapter 3.5.5.7, "List evaluation \(results configuration\)"](#), on page 130). By default, one peak per range is displayed. However, you can change the settings to display only peaks that exceed a threshold ("Margin").

Detected peaks are not only listed in the Result Summary, they are also indicated by colored squares in the diagram (optionally, see [Show Peaks](#) in the "List Evaluation" settings).

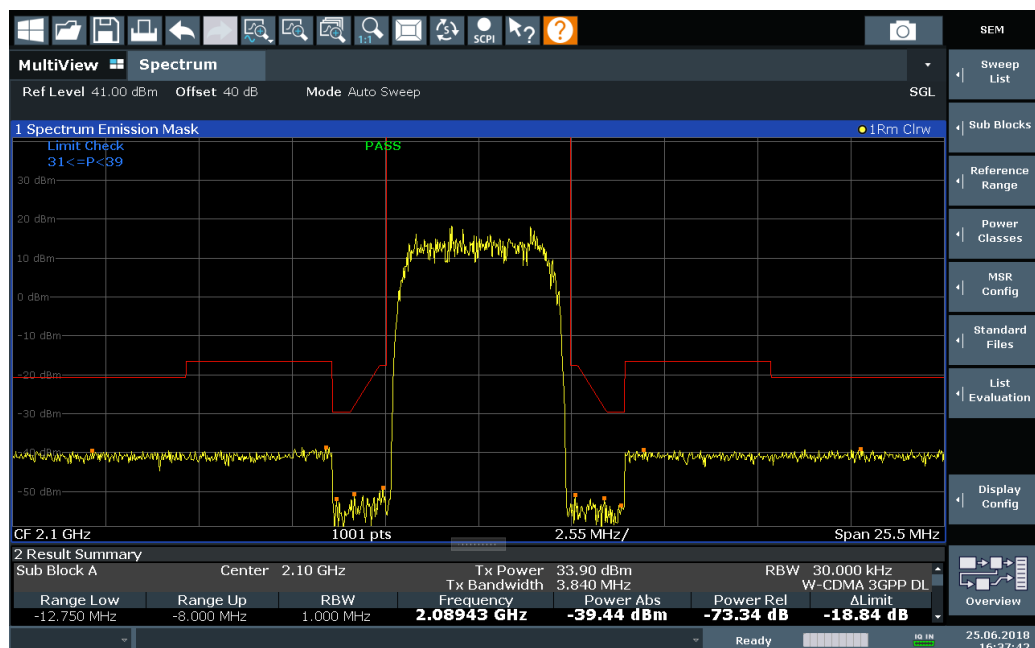


Figure 3-36: Detected peak display in SEM measurement

Furthermore, you can export the results of the result summary to a file which can be exported to another application for further analysis.

## Spectrum emission mask (SEM) measurement

## Results for SEM with multiple sub blocks

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see [Chapter 3.5.4.5, "SEM with multiple sub blocks \("Multi-SEM"\)"](#), on page 111 for details). Up to 3 sub blocks (with 2 gaps) can be defined. For each sub block and each gap, the results described above are provided individually in the result summary.

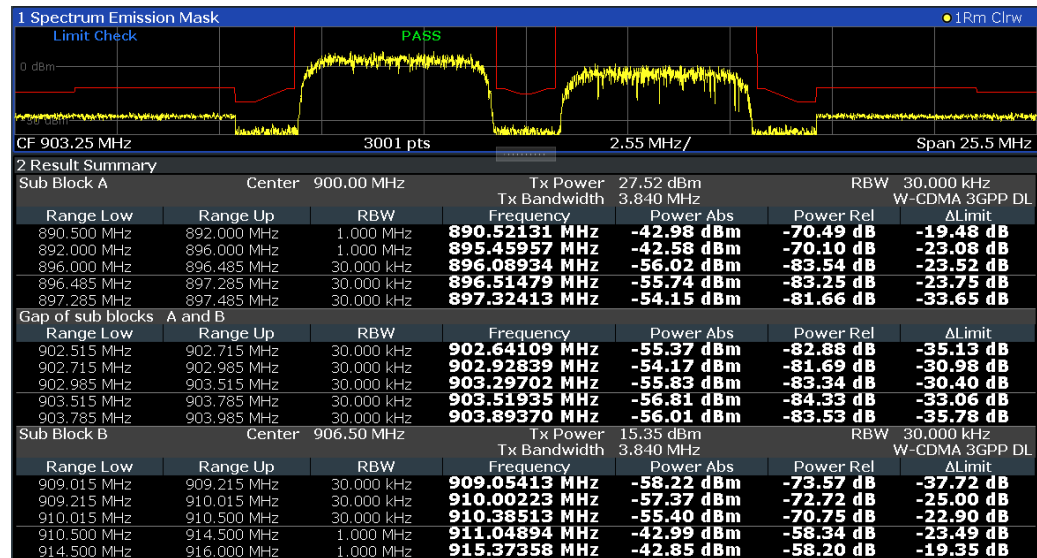


Figure 3-37: SEM results for multiple sub blocks

## Retrieving results via remote control

The measurement results of the spectrum emission mask *test* can be retrieved using the `CALC:LIM:FAIL?` command from a remote computer; see [CALCulate<n>:LIMit<li>:FAIL?](#) on page 777 for a detailed description.

The *power* result for the reference range can be queried using `CALC:MARK:FUNC:POW:RES? CPOW`;

The *peak* power for the reference range can be queried using `CALC:MARK:FUNC:POW:RES? PPOW`, see [CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESULT?](#) on page 473.

The measured *power trace* can be queried using `TRAC:DATA?` and `TRAC:DATA:X?`, see [TRACe<n>\[:DATA\]](#) on page 690 and [TRACe<n>\[:DATA\]:X?](#) on page 692:

The measured *peak power list* can be queried using `TRAC:DATA? LIST`, see [TRACe<n>\[:DATA\]](#) on page 690.

## 3.5.4 SEM basics

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

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| • <a href="#">Limit lines in SEM measurements</a> .....             | 107 |
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| • <a href="#">Multi-standard radio (MSR) SEM measurements</a> ..... | 111 |
| • <a href="#">SEM with multiple sub blocks ("Multi-SEM")</a> .....  | 111 |

### 3.5.4.1 Ranges and range settings

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

- Start and stop frequency
- RBW
- VBW
- Sweep Time
- "Sweep Points"
- Reference level
- Attenuator settings
- Preamplifier settings
- Transducer settings
- Limit values

Via the sweep list, you define the ranges and their settings. For details on settings, refer to [Chapter 3.5.5.1, "Sweep List"](#), on page 116.

For details on defining the limits (masks), see [Chapter 3.5.4.2, "Limit lines in SEM measurements"](#), on page 107.

#### Range definition

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

The changes of the sweep list are only kept until you load another parameter set (by pressing [PRESET] or by loading an XML file). If you want a parameter set to be available permanently, create an XML file for this configuration (for details refer to ["How to save a user-defined SEM settings file"](#) on page 135).

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

#### Reference range

The range containing the center frequency is defined as the reference range for all other ranges in the sweep list. All range limits are defined in relation to the reference range. The TX power used as a reference for all power level results in the result summary is also calculated for this reference range. You can define whether the power used for reference is the peak power level or the integrated power of the reference

range. In the Sweep List, the reference range is highlighted in blue and cannot be deleted.

### Rules

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but can have gaps).
- The maximum number of ranges is 30.
- The minimum number of ranges is 3.
- The reference range cannot be deleted.
- Center the reference range on the center frequency.
- The current "Tx Bandwidth" defines the minimum span of the reference range (see ["Channel Power Settings"](#) on page 123).
- Define frequency values for each range relative to the center frequency.



### Changing the frequency range of the measurement using external mixers

If you change the used frequency range of the measurement by activating or deactivating an external mixer, the R&S ESW automatically adapts the span to full span. Thus, the ranges for the SEM measurement can change, as well.

### Sweep points

You can define a minimum number of sweep points for each range. The total number of available sweep points is then distributed among the ranges in consideration of the minimum values. If the total number of sweep points is not enough to satisfy the minimum sweep point requirements in all ranges, the R&S ESW adjusts the global number of [Sweep Points](#) accordingly. By default, each range has a minimum of one sweep point.

This allows you to increase the resolution within a specific range for detailed analysis. You do not have to increase the overall number of sweep points and thus the measurement time for the SEM measurement.

### Symmetrical ranges

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

Symmetrical ranges fulfill the conditions required for "Fast SEM" mode (see [Chapter 3.5.4.3, "Fast SEM measurements"](#), on page 109).

## Spectrum emission mask (SEM) measurement

## Power classes

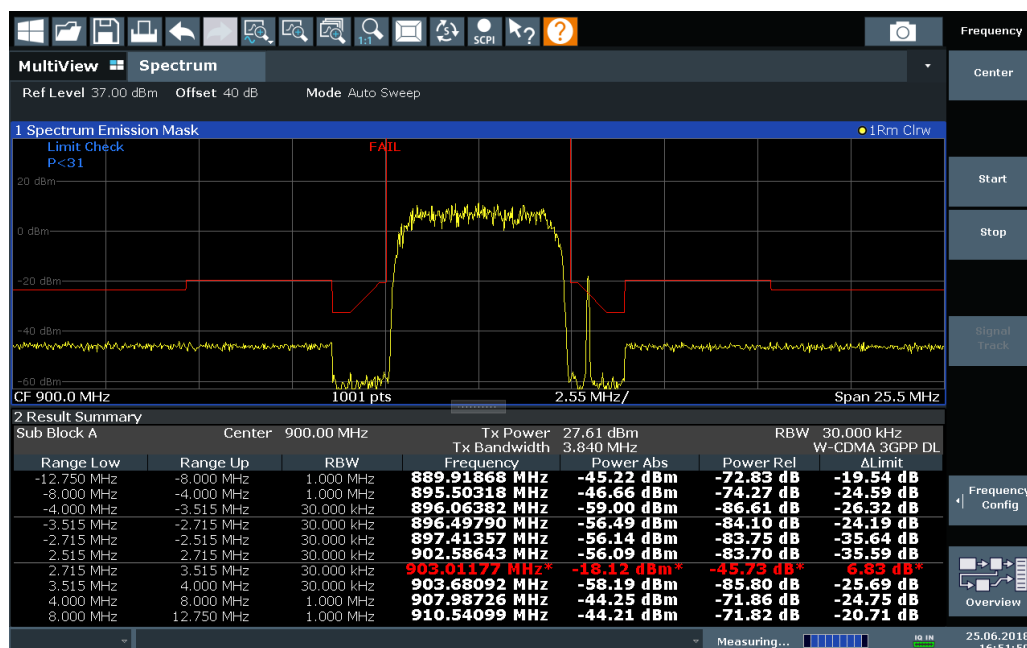
If the signal power level to be monitored varies and the limits vary accordingly, you can define power classes, which can then be assigned to the frequency ranges. Thus, the limits for the signal levels can be defined differently for varying input levels. For instance, for higher input levels a transmission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

## 3.5.4.2 Limit lines in SEM measurements

For the R&S ESW, the spectrum emission mask is defined using limit lines. Limit lines allow you to check the measured data (that is, the trace results) against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using the [Lines] function. For SEM measurements, however, special limit lines are available via the Sweep List, and it is strongly recommended that you use only these limit line definitions.

In the Sweep List, you can define a limit line for each power class that varies its level according to the specified frequency ranges. Special limit lines are automatically defined for each power class according to the current Sweep List settings every time the settings change. These limit lines are labeled "\_SEM\_LINE\_<xxx>\_ABS<0...3>" and "\_SEM\_LINE\_<xxx>\_REL<0...3>", where <xxx> is an index to distinguish limit lines between different channels.

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



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

**Table 3-10: Limit check types**

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

### Relative limit line functions

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

If the relative limit value function is used in combination with the "Abs and Rel" or "Abs or Rel" limit check types, an additional condition is considered for the limit check (see [Table 3-10](#)).

### Limit check results in the result summary

For each range, the peak measured value and the deviation of these values from the limit line are displayed in the result summary. If the limit check is passed for the range, the deviation represents the closest value to the limit line. If the limit check is passed for the range, the deviation represents the closest value to the limit line. If the limit check for the range fails, the deviation represents the maximum violation against the limit line. Furthermore, the absolute power levels and the relative deviation of the peaks from the TX channel power are displayed. Values that exceed the limit are indicated in red and by an asterisk (\*).



## Spectrum emission mask (SEM) measurement

| A2 Spectrum Emission Mask |            |                        |               | W-CDMA 3GPP (31,39)dBm DL |            |           |
|---------------------------|------------|------------------------|---------------|---------------------------|------------|-----------|
| Tx Power -28.10 dBm       |            | Tx Bandwidth 3.840 MHz |               | RBW 1.000 MHz             |            |           |
| Range Low                 | Range Up   | RBW                    | Frequency     | Power Abs                 | Power Rel  | ΔLimit    |
| -12.750 MHz               | -8.000 MHz | 1.000 MHz              | 13.24173 GHz* | -47.08 dBm*               | -18.98 dB* | 35.52 dB* |
| -8.000 MHz                | -4.000 MHz | 1.000 MHz              | 13.24364 GHz* | -25.01 dBm*               | 3.09 dB*   | 53.59 dB* |
| -4.000 MHz                | -3.515 MHz | 30.000 kHz             | 13.24619 GHz  | -100.18 dBm               | -72.08 dB  | -8.58 dB  |
| -3.515 MHz                | -2.715 MHz | 30.000 kHz             | 13.24668 GHz  | -105.92 dBm               | -77.83 dB  | -17.23 dB |



Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the Result Summary can be defined. (In the "List Evaluation" settings, see [Chapter 3.5.5.7, "List evaluation \(results configuration\)"](#), on page 130).

### 3.5.4.3 Fast SEM measurements

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

#### Prerequisites

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

- The frequency ranges are consecutive, without frequency gaps
- The following sweep settings are identical (for details see [Chapter 3.5.5.1, "Sweep List"](#), on page 116):
  - "Filter Type"
  - "RBW"
  - "VBW"
  - Sweep Time Mode
  - "Reference Level"
  - "RF Attenuation Mode"
  - "RF Attenuation"
  - "Preamplifier"

#### Activating Fast SEM mode

"Fast SEM" mode is activated in the sweep list (see [Chapter 3.5.5.1, "Sweep List"](#), on page 116) or using a remote command. Activating the mode for one range automatically activates it for all ranges in the sweep list.

#### Remote command:

[SENSe:]ESpectrum<sb>:HSPeet on page 525



### Fast SEM not supported for multiple sub blocks

For SEM with multiple sub blocks, fast SEM is not available. If more than one sub block is defined and a standard is loaded which contains an active fast SEM setting, this setting is disabled.

For more information on multi-SEM measurements, see [Chapter 3.5.4.5, "SEM with multiple sub blocks \("Multi-SEM"\)"](#), on page 111.

### Consequences

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



If "Symmetrical Setup" mode is active when "Fast SEM" mode is activated, not all sweep list settings can be configured symmetrically automatically (see also ["Symmetrical Setup"](#) on page 121).

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

### Example

| Spectrum Emission Mask |                  |                 |            |                        |              |                |
|------------------------|------------------|-----------------|------------|------------------------|--------------|----------------|
| Sweep List             | Sub Blocks       | Reference Range |            | Power Classes          | MSR Settings | Standard Files |
| Sub Block A            | Range Start      | Range 1         | Range 2    | Range 3                | Range 4      | Range 5        |
|                        | Range Stop       | -12.75 MHz      | -2.515 MHz | -2.51498 MHz           | 2.515 MHz    | 2.51502 MHz    |
|                        | Fast SEM         | On              | On         | On                     | On           | On             |
|                        | Filter Type      | Normal(3dB)     |            |                        | Normal(3dB)  |                |
|                        | RBW              | 30 kHz          | 1          |                        | 30 kHz       | 2              |
|                        | VBW              | 3 MHz           |            |                        | 3 MHz        |                |
|                        | Sweep Time       | 419 µs          |            |                        | 279 µs       |                |
|                        | Ref Level        | 0 dBm           |            |                        | 0 dBm        |                |
|                        | RF Att Mode      | Auto            |            |                        | Auto         |                |
|                        | RF Attenuation   | 10 dB           |            |                        | 10 dB        |                |
|                        | Transducer       | None            | None       | Baseband Input I to RF | None         | None           |
|                        | Multi Limit Calc | SUM             | SUM        | NONE                   | SUM          | SUM            |
|                        | Min Sweep Points | 1               | 1          | 1                      | 1            | 1              |
|                        |                  | Range Up        | RBW        | Frequency              | Power Abs    | Power Rel      |

Insert before Range  
 Insert after Range  
 Delete Range

99.72 dBm\*  
 95.91 dBm\*  
 96.67 dBm\*  
 93.47 dBm\*

-23.75 dB  
 -19.94 dB  
 -20.70 dB  
 -17.50 dB

Symmetrical Setup  
 On Off

Figure 3-38: Sweep list using Fast SEM mode

In [Figure 3-38](#), a sweep list is shown for which Fast SEM is activated. The formerly five separately defined ranges are combined to two sweep ranges internally.

#### 3.5.4.4 Multi-standard radio (MSR) SEM measurements

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

Refined settings allow the R&S ESW to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0, which distinguishes between base station configurations and power values.

#### 3.5.4.5 SEM with multiple sub blocks ("Multi-SEM")

In the Spectrum application application only, spectrum emissions can be measured for multiple sub blocks of channels (also referred to as a "Multi-SEM" measurement). Sub blocks are a set of multiple ranges around a defined center frequency (carrier). Multiple sub blocks can include gaps or overlap, and each sub block defines a separate mask. In the overlapping masks, multi-limit lines are calculated. Up to 3 sub blocks (with 2 gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines etc. can be defined individually.

##### Comparison to "traditional" SEM measurement

The default SEM measurement is simply a special case of "*Multi-SEM*" - consisting of one single block. Only if the number of sub blocks in the basic SEM configuration is larger than 1, multiple sub blocks are inserted in the configuration settings and result tables.

##### Particular features of configuring multiple sub blocks

The sub blocks are independent of the global start, stop, center and span frequencies for the complete SEM measurement. Thus, there can be gaps that can even include other carrier ranges, but are not configured for the SEM measurement.

For each sub block, you define:

- The center frequency of the reference range of the sub block; center frequencies must be defined in ascending order for sub blocks A,B,C
- The reference range; note that although individual ranges of different sub blocks can overlap, reference ranges for different sub blocks *cannot*; they must define distinct frequency ranges
- The sweep list, including the limit lines
- Optionally: a standard file or MSR settings to be used for measurement (if one is selected, the other is disabled)



### Fast SEM not supported for multiple sub blocks

For SEM with multiple sub blocks, fast SEM is not available. If more than one sub block is defined and a standard is loaded which contains an active fast SEM setting, this setting is disabled.

### Absolute vs relative frequencies

In the default configuration with only one sub block, frequencies are defined relative to the center frequency; this is the familiar configuration.

For setups with more than one sub block, frequencies are defined relative to the center frequency of the reference ranges for the individual sub blocks. However, in the result summary, frequencies are indicated as absolute values. Relative frequencies that refer to different reference ranges would be inconvenient and difficult to analyze.

### Limit check behavior for overlapping masks

Since spectrum emission masks are defined individually for each sub block, and sub blocks can overlap, the question arises what happens during the limit check in the overlapping regions? To answer this question, we must distinguish the following cases:

- For the reference range, no limit checking is performed, as the reference range contains the carrier
- For other ranges, only the limit lines defined for ranges between the carriers, that is the reference ranges to either side, are significant. In other words: if a limit line definition covers the frequency area of several carriers, only the limit lines for ranges between the corresponding reference range and the next closest reference range are significant.

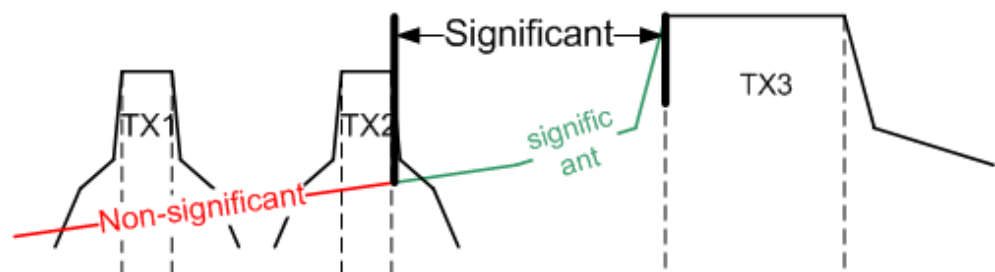


Figure 3-39: Behavior for overlapping masks

- For the ranges in which multiple limit lines are significant, a range-specific function determines the behavior of the limit check

### Limit calculation for individual ranges

For each range a function can be defined that determines the behavior of the limit check if there are multiple limit lines:

- **"NONE"**: In reference ranges no limit check is performed; Reference ranges always use the function "NONE". For other ranges, see the combinations for overlapping ranges below.
- **"SUM"**: sum of the two limit lines (calculated for linear powers) is used
- **"MAX"**: maximum of the two limit lines is used

This leads to the following **combinations for overlapping ranges**:

- **"MAX"+"MAX"**: maximum of the two limit lines is used
- **"MAX"+"SUM"**: maximum of the two limit lines is used
- **"SUM"+"SUM"**: sum of the two limit lines (calculated for linear powers) is used
- **"NONE"+"MAX"/"NONE"+"SUM"**: limit line (and parameters) of the "NONE" range are ignored
- **"NONE"+"NONE"**: depends on the position of the overlapping ranges in relation to the mid-frequency between the two neighboring sub blocks:
  - Overlap is completely *below* the mid-frequency: limits and parameters of the left sub block are used
  - Overlap is completely *above* the mid-frequency: limits and parameters of the right sub block are used
  - Overlap crosses the mid-frequency: new subranges are created: one to the left of the mid-frequency, one to the right of the mid-frequency. The left subrange uses the limits and parameters of the left sub block, the right subrange uses the limits and parameters of the right sub block.



#### Different RBWs in overlapping ranges

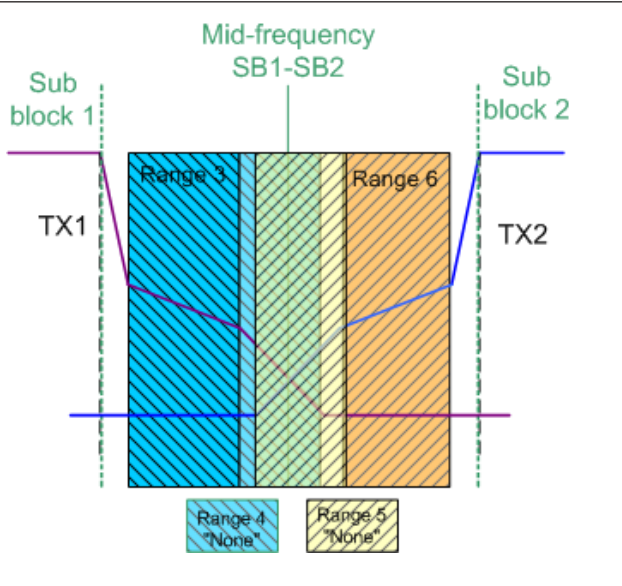
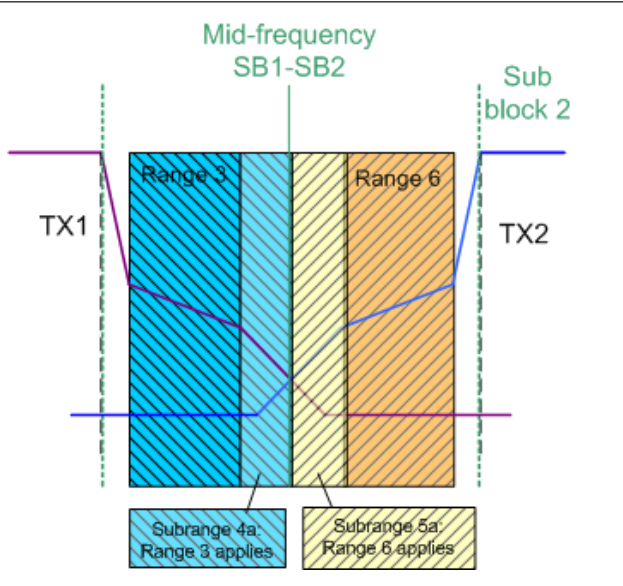
If different RBWs are defined for the overlapping ranges, the following parameters from the range with the smaller RBW are considered for both ranges:

- RBW
- VBW
- Attenuation
- Reference level
- Transducer
- Filter type
- (proportional) sweep time

In the range with the higher RBW, the following offset is applied to the limit line:

$$-10 \cdot \log(RBW_{large} / RBW_{small})$$

Table 3-11: Limit lines in overlapping ranges crossing the mid-frequency

|   |  |
|---|--|
|    |    |
| <p><b>Initial situation:</b> overlapping ranges</p> <p>Range 4 ("None") + Range 5 ("None") overlap and cross the mid-frequency between sub blocks 1 and 2</p> | <p><b>Result:</b> Subranges 4a and 5a are created left and right of the mid-frequency;</p> <p>For subrange 4a: limit line and parameters of range 4 apply</p> <p>For subrange 5a: limit line and parameters of range 5 apply</p> |

Global SEM limit check

For the complete SEM measurement, which can consist of multiple sub blocks, only one single limit check is performed. A single limit line is calculated according to the individual range limit lines and the defined functions for overlapping ranges. The measured values are then compared with this single limit line. If the limit is exceeded in any range, the result of the limit check is ." failed!"

## Spectrum emission mask (SEM) measurement

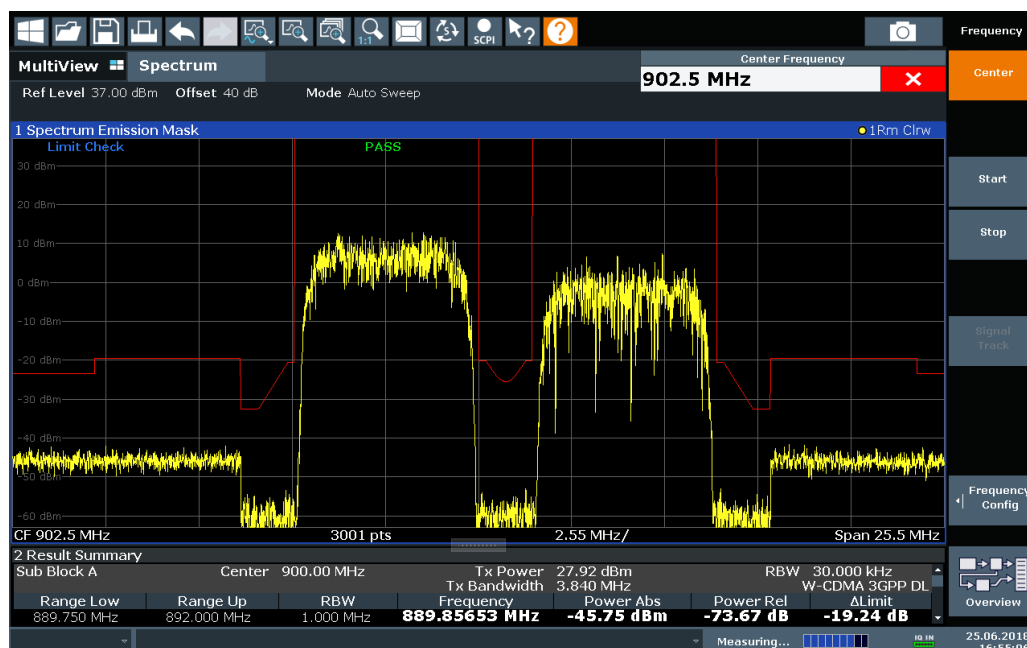


Figure 3-40: Summarized limit line for multiple sub blocks

### 3.5.5 SEM configuration

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask"

The SEM measurement is started immediately with the default settings.

The remote commands required to perform these tasks are described in [Chapter 6.7.6, "Spectrum emission mask \(SEM\)"](#), on page 521.



#### Global span settings

The span of the signal to be monitored is configured in the general span settings (see [Chapter 4.4.2, "Frequency and span settings"](#), on page 283). Only ranges within this global span are considered for the SEM measurement.



#### Multi-SEM configuration

In the Spectrum application application only, spectrum emissions can be measured for multiple sub blocks of channels (see [Chapter 3.5.4.5, "SEM with multiple sub blocks \("Multi-SEM"\)"](#), on page 111). Up to 3 sub blocks (with 2 gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines etc. can be defined in individual tabs. In addition, settings on the sub blocks themselves must be configured in the "Sub Block" tab of the "Spectrum Emission Mask" configuration dialog box (see [Chapter 3.5.5.2, "Multi-SEM \(sub block\) settings"](#), on page 121).

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

## Spectrum emission mask (SEM) measurement

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| • MSR settings.....                            | 125 |
| • Standard files.....                          | 128 |
| • List evaluation (results configuration)..... | 130 |

## 3.5.5.1 Sweep List

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > Sweep List

For SEM measurements, the input signal is split into several frequency ranges which are swept individually and for which different limitations apply. You configure the individual frequency ranges and mask limits in the Sweep List.



If you edit the sweep list, always follow the rules and consider the limitations described in [Chapter 3.5.4.1, "Ranges and range settings"](#), on page 105.

| Sub Block A       | Range 1     | Range 2     | Range 3     |
|-------------------|-------------|-------------|-------------|
| Range Start       | -12.75 MHz  | -2.515 MHz  | 2.515 MHz   |
| Range Stop        | -2.515 MHz  | 2.515 MHz   | 12.75 MHz   |
| Fast SEM          | Off         | Off         | Off         |
| Filter Type       | Normal(3dB) | Normal(3dB) | Normal(3dB) |
| RBW               | 30 kHz      | 30 kHz      | 30 kHz      |
| VBW               | 3 MHz       | 3 MHz       | 3 MHz       |
| Sweep Time Mode   | Auto        | Auto        | Auto        |
| Sweep Time        | 140 µs      | 140 µs      | 140 µs      |
| Ref Level         | 0 dBm       | 0 dBm       | 0 dBm       |
| RF Att Mode       | Auto        | Auto        | Auto        |
| RF Attenuation    | 10 dB       | 10 dB       | 10 dB       |
| Preamp            | Off         | Off         | Off         |
| Transducer        | None        | None        | None        |
| Multi Limit Calc  | SUM         | NONE        | SUM         |
| Min Sweep Points  | 1           | 1           | 1           |
| Limit Check 1     | Relative    | Relative    | Relative    |
| Rel Limit Start 1 | -50 dBc     | 300 dBc     | -50 dBc     |

|                               |     |
|-------------------------------|-----|
| Range Start / Range Stop..... | 117 |
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| Filter Type.....              | 117 |
| RBW.....                      | 118 |
| VBW.....                      | 118 |
| Sweep Time Mode.....          | 118 |
| Sweep Time.....               | 118 |



## Spectrum emission mask (SEM) measurement

|   |     |
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**Range Start / Range Stop**

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

To change the start/stop frequency of the first or last range, respectively, select the appropriate span in the [SPAN] configuration dialog. You can set a span that is smaller than the overall span of the ranges. In this case, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz. The first and last ranges are adapted to the given span as long as the minimum span of 20 Hz is not violated.

Define frequency values for each range relative to the center frequency. Center the reference range on the center frequency. The current "Tx Bandwidth" defines the minimum span of the reference range (see "[Channel Power Settings](#)" on page 123).

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:START on page 528

[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:STOP on page 528

**Fast SEM**

Activates "Fast SEM" mode for all ranges in the sweep list. For details, see [Chapter 3.5.4.3, "Fast SEM measurements"](#), on page 109.

**Note:** If you deactivate "Fast SEM" mode while "Symmetrical Setup" mode is on, "Symmetrical Setup" mode is automatically also deactivated.

If you activate "Fast SEM" mode while "Symmetrical Setup" mode is on, not all range settings can be configured symmetrically automatically.

Remote command:

[SENSe:]ESpectrum<sb>:HSPeet on page 525

**Filter Type**

Sets the filter type for this range.

For details on filter types, see [Chapter 4.6.1.6, "Which data may pass: filter types"](#), on page 301.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<ri>:FILTer:TYPE on page 527

**RBW**

Sets the resolution bandwidth for this range.

For details on the RBW, see [Chapter 4.6.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 298.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:BANdwidth:RESolution](#) on page 526

**VBW**

Sets the video bandwidth for this range.

For details on the VBW, see [Chapter 4.6.1.2, "Smoothing the trace using the video bandwidth"](#), on page 299.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:BANdwidth:VIDeo](#) on page 526

**Sweep Time Mode**

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode, see [Chapter 4.6.1.7, "How long the data is measured: Sweep Time"](#), on page 302

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO](#) on page 538

**Sweep Time**

Sets the sweep time value for the range.

For details on the sweep time, see [Chapter 4.6.1.7, "How long the data is measured: Sweep Time"](#), on page 302

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:SWEep:TIME](#) on page 537

**Ref Level**

Sets the reference level for the range.

For details on the reference level, see [Chapter 4.5.1.1, "Reference level"](#), on page 290.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:RLEVel](#) on page 537

**RF Att Mode**

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation, see ["Using the RF attenuator"](#) on page 224.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO](#) on page 529

**RF Attenuation**

Sets the attenuation value for the range.

For details on attenuation, see [Chapter 4.5.1.2, "Scaling"](#), on page 291.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation](#) on page 529

**Preamplifier**

Switches the preamplifier on or off.

If you have the optional low noise amplifier, you can also use that for the measurement (but not both at the same time).

For details on the preamplifier, see ["Preamplifier"](#) on page 294.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATe](#) on page 530

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:LNA:STATe](#) on page 530

**Transducer Factor**

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

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

For details on transducers, see the user manual of the R&S ESW.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:TRANsducer](#) on page 538

**Limit Check <n>**

Sets the type of limit check for the n-th power class in the range. Up to four limits are possible.

For details on limit checks, see [Chapter 3.5.4.2, "Limit lines in SEM measurements"](#), on page 107.

The limit state affects the availability of all limit settings.

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:LIMit<li>:STATe](#) on page 536

[CALCulate<n>:LIMit<li>:FAIL?](#) on page 777

**Abs Limit Start / Stop <n>**

Sets an absolute limit value for the n-th power class at the start or stop frequency of the range [dBm].

Remote command:

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:START](#)

on page 531

[\[SENSe:\]ESpectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STOP](#)

on page 532

**Rel Limit Start / Stop <n>**

Sets a relative limit value for the n-th power class at the start or stop frequency of the range [dBc].

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

## Spectrum emission mask (SEM) measurement

|                   |         |      |                         |                                      |                           |
|-------------------|---------|------|-------------------------|--------------------------------------|---------------------------|
| Rel Limit Start 1 | -50 dBc | f(x) | Function for Limitpoint | <input checked="" type="radio"/> Off | <input type="radio"/> Max |
| Rel Limit Stop 1  | -50 dBc | 30   |                         |                                      |                           |
|                   |         |      | Function                |                                      |                           |
|                   |         |      | Relative Level          | -50.0 dBc                            |                           |
|                   |         |      | Absolute Level          | -13.0 dBm                            |                           |

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

For more information, see ["Relative limit line functions"](#) on page 108.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:START`  
on page 532

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP`  
on page 534

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:START:`  
`FUNCTION` on page 533

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:FUNCTION`  
on page 535

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:START:ABS`  
on page 533

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS`  
on page 535

### Multi-Limit Calc <n>

Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details, see ["Limit calculation for individual ranges"](#) on page 112.

"NONE" (reference ranges only:) the limit of the reference range is used

"SUM" Sum of the two limit lines (calculated for linear powers) is used

"MAX" Maximum of the two limit lines is used

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:MLCalc` on page 523

### Min Sweep Points

Defines the minimum number of sweep points for the range.

If necessary to fulfill all minimum sweep point requirements in all ranges, the global [Sweep Points](#) setting is increased. By default, each range is supplied with a minimum of one sweep point.

For details, see ["Sweep points"](#) on page 106

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:POINTs:MINimum[:VALue]` on page 537

**Insert before Range / Insert after Range**

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

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INSert` on page 531

**Delete Range**

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

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:DELete` on page 527

**Symmetrical Setup**

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

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

**Note:** If "Fast SEM" mode is deactivated while "Symmetrical Setup" mode is on, "Sym Setup" mode is automatically also deactivated.

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

Remote command:

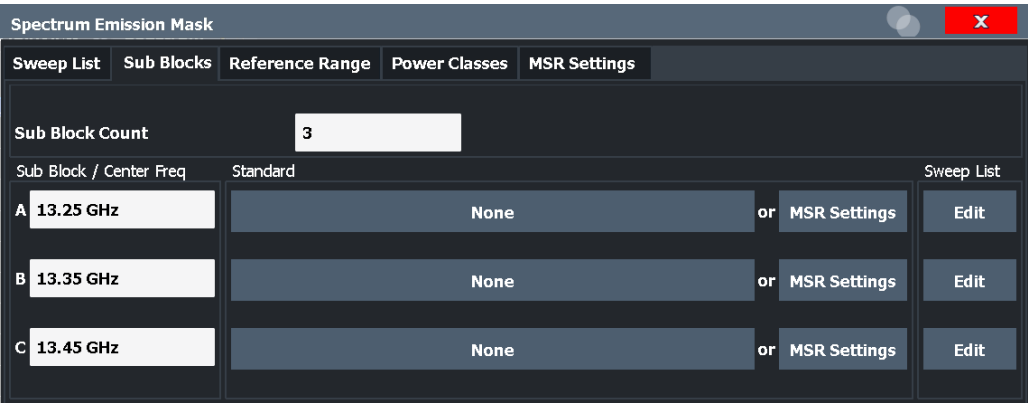
`[SENSe:]ESpectrum<sb>:SSETup` on page 539

**3.5.5.2 Multi-SEM (sub block) settings**

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Sub Blocks"

In the Spectrum application application only, spectrum emissions can be measured for multiple sub blocks of channels (see [Chapter 3.5.4.5, "SEM with multiple sub blocks \("Multi-SEM"\)](#), on page 111). Sub blocks are a set of multiple ranges around a defined center frequency (carrier).

By default, a single sub block is assumed. If more than one sub blocks are defined, additional tabs are inserted for each sub block in the individual tabs of the "Spectrum Emission Mask" configuration dialog box.



|                              |     |
|------------------------------|-----|
| Sub Block Count.....         | 122 |
| Sub Block / Center Freq..... | 122 |
| Standard / MSR Settings..... | 122 |
| Edit Sweep List.....         | 122 |

**Sub Block Count**  
 Defines the number of sub blocks. By default, the familiar SEM measurement with just one single block of ranges is configured.

Remote command:  
[\[SENSe:\]ESpectrum<sb>:SCount](#) on page 524

**Sub Block / Center Freq**  
 Defines the center frequency for an individual sub block. The center frequency determines the reference range used for each block.

For measurements with only one sub block, this setting corresponds to the global setting in the "Frequency" settings (see [Center Frequency](#)).

Remote command:  
[\[SENSe:\]ESpectrum<sb>:SCENTER](#) on page 524

**Standard / MSR Settings**  
 Defines the use of a standard settings file or a multi-standard radio configuration for a particular sub block. For details, see [Chapter 3.5.5.6, "Standard files"](#), on page 128 and [Chapter 3.5.5.5, "MSR settings"](#), on page 125.

Note that *either* a standard *or* an MSR setting can be selected; if one is selected, the other is disabled.

Remote command:  
[\[SENSe:\]ESpectrum<sb>:PRESet\[:STANdard\]](#) on page 521  
[Chapter 6.7.6.3, "Multi SEM measurement configuration"](#), on page 523

**Edit Sweep List**  
 Switches to the Sweep List tab of the "Spectrum Emission Mask" dialog box to configure the individual frequency ranges and mask limits for the corresponding sub block. See [Chapter 3.5.5.1, "Sweep List"](#), on page 116.

3.5.5.3 Reference range

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Reference Range"

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

Spectrum Emission Mask

Sweep List

Sub Blocks

Reference Range

Power Classes

MSR Settings

Sub Block A

Sub Block B

Sub Block C

Power Reference Type

Channel Power

Peak Power

Channel Power Settings

Tx Bandwidth

3.84 MHz

RRC Filter State

On

Off

RRC Alpha

0.22

|                             |     |
|-----------------------------|-----|
| Power Reference Type.....   | 123 |
| Channel Power Settings..... | 123 |
| L Tx Bandwidth.....         | 124 |
| L RRC Filter State.....     | 124 |
| L Alpha:.....               | 124 |

**Power Reference Type**

Defines how the reference power is calculated.

"Channel Power"

Measures the channel power within the reference range using the integration bandwidth method. Additional settings can be configured for this method.  
(See also "IBW method" on page 43)

"Peak Power"

Determines the peak power within the reference range.

Remote command:

[SENSe:]ESpectrum<sb>:RTYPE on page 540

**Channel Power Settings**

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

**Tx Bandwidth ← Channel Power Settings**  
Defines the bandwidth used for measuring the channel power, with:  
Minimum span ≤ "Tx Bandwidth" ≤ of reference range  
Remote command:  
`[SENSe:]ESpectrum<sb>:BWID` on page 539

**RRC Filter State ← Channel Power Settings**  
Activates or deactivates the use of an RRC filter.  
Remote command:  
`[SENSe:]ESpectrum<sb>:FILTer[:RRC][:STATe]` on page 540

**Alpha: ← Channel Power Settings**  
Sets the alpha value of the RRC filter (if activated).  
Remote command:  
`[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHa` on page 539

3.5.5.4 Power classes

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Power Classes"

You can configure power classes which you can then assign to sweep list ranges. For details, see "Power classes" on page 107.

Spectrum Emission Mask

Sweep List

Sub Blocks

Reference Range

Power Classes

MSR Settings

Sub Block A

Used Power Classes: All

Sub Block B

Power Class

PMin ≤ P < PMax

Sub Block C

Power Class 1

-INF

199.9 dBm

Sweep List

Sub Block C

Power Class 2

199.9 dBm

+INF

Sweep List

Add

Remove

|                                  |     |
|----------------------------------|-----|
| Used Power Classes:              | 125 |
| PMin/ PMax                       | 125 |
| Sweep List                       | 125 |
| Adding or Removing a Power Class | 125 |



**Used Power Classes:**

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

If "All" is selected, the power class that corresponds to the currently measured power in the reference range is used for monitoring. The limits assigned to that power class are applied (see ["Abs Limit Start / Stop <n>"](#) on page 119 and ["Rel Limit Start / Stop <n>"](#) on page 119).

Remote command:

```
CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>[:EXCLusive]
```

on page 545

To define all limits in one step:

```
CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:LIMit[:STATe]
```

on page 543

**PMin/ PMax**

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

Note that the power level can be equal to the lower limit(s), but must be lower than the upper limit(s):

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

Otherwise the ranges are corrected automatically.

Remote command:

```
CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MINimum
```

on page 544

```
CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MAXimum
```

on page 544

**Sweep List**

Switches to the Sweep List tab of the "Spectrum Emission Mask" dialog box and focuses the "Limit Check" setting for the corresponding power class (1-4) in the reference range (see ["Limit Check <n>"](#) on page 119).

**Adding or Removing a Power Class**

Adds a new power class at the end of the list or removes the last power class. After adding or removing, the last power class is adapted to end at "+INF". Note that a maximum of four power classes are available.

Remote command:

```
CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:COUNT
```

on page 542

**3.5.5.5 MSR settings**

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "MSR Settings"

## Spectrum emission mask (SEM) measurement

Multi-standard radio (MSR) measurements allow you to perform SEM tests on multiple carriers using different digital standards.

For details, see [Chapter 3.5.4.4, "Multi-standard radio \(MSR\) SEM measurements"](#), on page 111.

| Spectrum Emission Mask |  |
|------------------------|--|
| Sweep List             | Sub Blocks   |
|                        | Reference Range                                      |
|                        | Power Classes  |
|                        | MSR Settings   |
| Sub Block A            | Common Settings                                      |
|                        | Band Category BC2                                    |
| Sub Block B            | Base Station Class Wide Area                         |
|                        | BS Max Output Power 39.0 dBm                         |
| Sub Block C            | Bands <= 3 GHz > 3 GHz                               |
|                        | Base Station RF Bandwidth 10.0 MHz                   |
|                        | Carrier Adjacent to RF Bandwidth Edge                |
|                        | <input type="checkbox"/> GSM/Edge Present            |
|                        | Power Gsm Carrier 39.0 dBm                           |
|                        | <input type="checkbox"/> LTE FDD 1.4MHz/3MHz Present |
|                        | Apply to SEM   |

|   |     |
|---|-----|
| <a href="#">Band Category</a> .....                         | 126 |
| <a href="#">Base Station Class</a> .....                    | 127 |
| <a href="#">Base Station Maximum Output Power</a> .....     | 127 |
| <a href="#">Bands</a> .....                                 | 127 |
| <a href="#">Base Station RF Bandwidth</a> .....             | 127 |
| <a href="#">Carrier Adjacent to RF Bandwidth Edge</a> ..... | 127 |
| <a href="#">Power Gsm Carrier</a> .....                     | 128 |
| <a href="#">Apply to SEM</a> .....                          | 128 |

### Band Category

Defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

|       |                              |
|-------|------------------------------|
| "BC1" | LTE FDD and W-CDMA           |
| "BC2" | LTE FDD, W-CDMA and GSM/EDGE |
| "BC3" | LTE TDD and TD-SCDMA         |

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:BCATegory](#) on page 547

**Base Station Class**

Defines the class of the base station according to its sending range.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:CLASs](#) on page 548

**Base Station Maximum Output Power**

Defines the maximum output power of the base station. Possible values are from 0 dBm to 100 dBm in 1 dB steps.

This setting is only available for base stations with a medium range [Base Station Class](#).

This value is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:MPower](#) on page 550

**Bands**

Defines the frequency range of the bands used by the base station.

This setting is only available for [Band Category](#) 1 or 3.

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:BAND](#) on page 547

**Base Station RF Bandwidth**

Defines the relevant RF bandwidth (span) required to measure all available carriers in MSR SEM measurements.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:RFBWidth](#) on page 551

**Carrier Adjacent to RF Bandwidth Edge**

For particular measurement setups, the specification demands specific limits for the SEM ranges.

These settings are only available for [Band Category](#) 2.

"GSM/Edge Present"

A GSM/EDGE carrier is located at the edge of the RF band.

In this case, the power of the GSM carrier must be specified (see ["Power Gsm Carrier"](#) on page 128).

"LTE FDD 1.4MHz/3MHz Present"

An LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the RF band.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:GSM:CPresent](#) on page 549

[\[SENSe:\]ESpectrum<sb>:MSR:LTE:CPresent](#) on page 550

## Spectrum emission mask (SEM) measurement

**Power Gsm Carrier**

Defines the power of the GSM carrier (if available, see ["Carrier Adjacent to RF Bandwidth Edge"](#) on page 127). Possible values are from 0 dBm to 100 dBm in 1 dB steps.

This setting is only available for [Band Category2](#).

This setting is required to calculate the SEM limits according to standard 3GPP 37.141 V12.2.0.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:GSM:CARRier](#) on page 549

**Apply to SEM**

Configures the SEM sweep list according to the specified MSR settings.

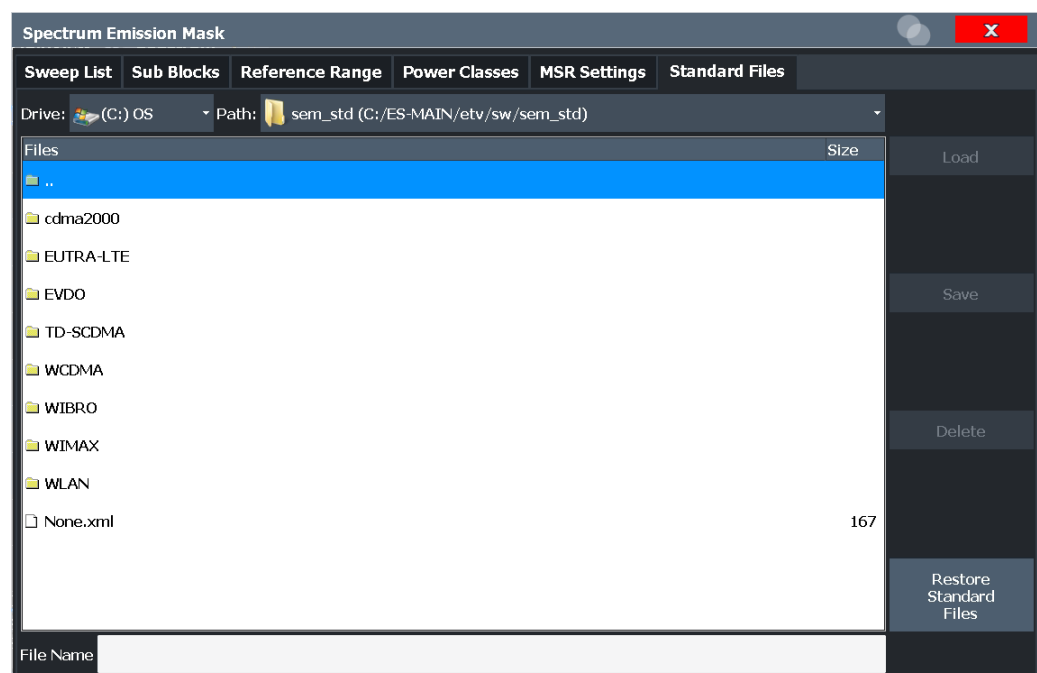
Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:APPLY](#) on page 546

**3.5.5.6 Standard files**

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Standard Files"

You can save the current measurement settings as a user-defined standard (XML file), or load stored measurement settings. Furthermore, you can delete an existing settings file.



For details, see [Chapter 3.5.6.1, "How to manage SEM settings files"](#), on page 135.

**Standard files for sub blocks (Multi-SEM measurements)**

If more than one sub blocks are defined, the "Standard Files" tab and softkey are not available. To load a standard file for an individual sub block, use the [Standard / MSR Settings](#) setting in the "Sub Blocks" tab.



"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

|  |     |
|--|-----|
| Selecting Storage Location - Drive/ Path/ Files..... | 129 |
| File Name.....                                       | 129 |
| Load Standard.....                                   | 129 |
| File Explorer.....                                   | 130 |
| Save Standard.....                                   | 130 |
| Delete Standard.....                                 | 130 |
| Restore Standard Files.....                          | 130 |

**Selecting Storage Location - Drive/ Path/ Files**

Select the storage location of the file on the <instrument> or an external drive.

The default storage location for the SEM settings files is:

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std.

**Note:** Saving instrument settings in 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 limit reached" 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 ESW User Manual.

Remote command:

MMEMory:CATalog?

**File Name**

Contains the name of the data file without the path or extension.

By default, the name of a user file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g.

limit\_lines\_005.

File names must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "\*", "?".

For details on the filename and location, see the R&S ESW User Manual.

**Load Standard**

Loads the selected measurement settings file.

Remote command:

[SENSe:]ESpectrum<sb>:PRESet[:STANdard] on page 521

**File Explorer**

Opens the Microsoft Windows File Explorer.

Remote command:  
not supported

**Save Standard**

Saves the current measurement settings for a specific standard as a file with the defined name.

Remote command:

[SENSe:]ESpectrum<sb>:PRESet:STORe on page 522

**Delete Standard**

Deletes the selected standard. Standards predefined by Rohde & Schwarz can also be deleted. A confirmation query is displayed to avoid unintentional deletion of the standard.

**Note:** Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standard Files" function (see "Restore Standard Files" on page 130).

**Restore Standard Files**

Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

The XML files from the

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_backup  
folder are copied to the

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std folder.

Note that this function overwrites customized standards that have the same name as predefined standards.

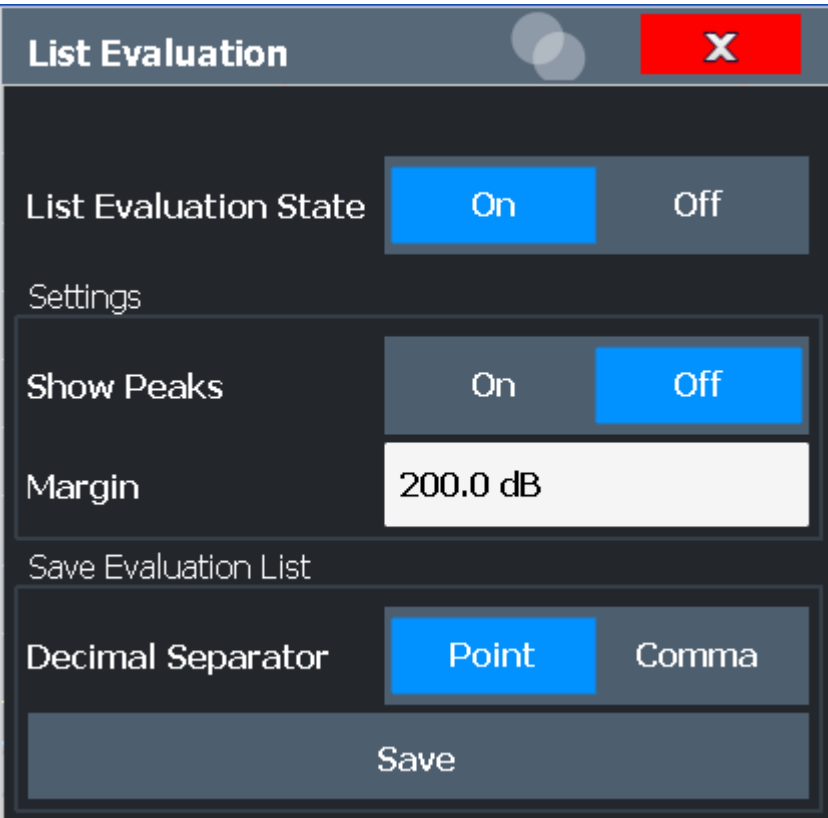
Remote command:

[SENSe:]ESpectrum<sb>:PRESet:REStore on page 522

**3.5.5.7 List evaluation (results configuration)**

**Access:** "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "List Evaluation"

In the "List Evaluation" dialog box, you configure the contents and display of the SEM results.



|  |     |
|--|-----|
| List Evaluation State (result summary).....                | 131 |
| Show Peaks.....  | 131 |
| Margin.....  | 131 |
| Saving the Result Summary (Evaluation List) to a File..... | 132 |

**List Evaluation State (result summary)**

Activates or deactivates the Result Summary.

Remote command:

[CALCulate<n>:ESpectrum:PEAKsearch:AUTO](#) on page 552

[TRACe<n>\[:DATA\]](#) on page 690

**Show Peaks**

If activated, all peaks that have been detected during an active SEM measurement are marked with blue squares in the Spectrum diagram.

Remote command:

[CALCulate<n>:ESpectrum:PEAKsearch:PSHow](#) on page 553

**Margin**

Although a margin functionality is not available for the limit check, you can define a margin (or: *threshold*) for the peak values to be displayed in the result summary. Only peaks that exceed the margin value are displayed (also in the diagram, if activated).

Remote command:

[CALCulate<n>:ESpectrum:PEAKsearch:MARGIN](#) on page 552

**Saving the Result Summary (Evaluation List) to a File**

Exports the Result Summary of the SEM measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the filename and storage location in the file selection dialog box that is displayed when you select the "Save" function.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

For details, see [Chapter 3.5.8.2, "ASCII file export format \(spectrum emission mask\)"](#), on page 144.

Remote command:

[MMEMory:STORe<n>:LIST](#) on page 702

[FORMat:DEXPort:DSEParator](#) on page 698

### 3.5.6 How to perform a spectrum emission mask measurement

SEM measurements can be performed according to a specific standard or freely configured. Configuration for signals with a regular channel definition can be configured quickly and easily. Selecting the SEM measurement is a prerequisite for all other tasks.

For signals with multiple carriers, also in non-contiguous ranges, an SEM measurement with multiple sub blocks can be configured.

For multi-standard radio SEM measurements, configuration for specified scenarios can be done automatically.

The following tasks are described:

- ["To select an SEM measurement"](#) on page 132
- ["To perform an SEM measurement according to a standard"](#) on page 132
- ["To configure a user-defined SEM measurement"](#) on page 132
- ["To perform an MSR SEM measurement"](#) on page 134
- ["To perform a Multi-SEM measurement"](#) on page 134



For remote operation, see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**To select an SEM measurement**

- Press [MEAS], then select the "Spectrum Emission Mask" measurement.

**To perform an SEM measurement according to a standard**

- Load the settings file as described in ["How to load an SEM settings file"](#) on page 135 and start a measurement.

**To configure a user-defined SEM measurement**

1. Define the span of the signal you want to monitor in the general span settings.



2. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.

Starting from the center frequency, determine which sections of the signal to the left and right can be swept and monitored using the same parameters. Criteria for such a range definition may be, for example:

- The signal power level
- The required resolution bandwidth or sweep time
- Transducer factors
- Permitted deviation from the defined signal level, i.e. the required limit values for monitoring

If the signal consists of a transmission channel and adjacent channels, the channel ranges can usually be used for the range definition.

3. If the signal power level to be monitored varies and the limits vary, define power classes. For each range of levels that can be monitored in the same way, define a power class.
  - a) Select "Overview".
  - b) Select "SEM Setup".
  - c) Switch to the "Power Classes" tab.
  - d) To add a power class, select "Add".
  - e) Enter the start and stop power levels to define the class.
  - f) Select the power classes to be used for the current measurement:
    - a specific class
    - all classes, to have the required class selected automatically according to the input level measured in the reference range
4. Select the Sweep List tab of the "Spectrum Emission Mask" dialog box.
5. Insert the required ranges using "Insert before Range" and "Insert after Range", which refer to the currently selected range (the reference range by default). If the signal trace is symmetric to the center frequency, activate the "Sym Setup" option to make setup easier and quicker.
6. Define the measurement parameters for each range as required. If symmetrical setup is activated, you only have to configure the ranges to one side of the center range.
 

In particular, define the limits for each range of the signal, i.e. the area in which the signal level can deviate without failing the limit check. If several power classes were defined (see [step 3](#)), define limits for each power class.

  - a) Define the type of limit check, i.e. whether absolute values or relative values are checked, or both. The type of limit check is identical for all power classes.
  - b) Define the limit start and stop values.
7. If the sweep list settings - other than the limit and transducer values - are identical for several adjacent ranges, activate "Fast SEM" mode to speed up the measurement. You only have to activate the mode for one range, the others are adapted automatically.

8. If necessary, change the settings for the reference power to which all SEM results refer in the "Reference Range" tab.
9. To indicate the determined peaks in the display during an SEM measurement, select "Overview" > "Analysis" > "Show Peaks".
10. To save the current SEM measurement settings to a file to re-use them later, save a settings file as described in ["How to save a user-defined SEM settings file"](#) on page 135.
11. Start a sweep.  
The determined powers and limit deviations for each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.
12. To save the Result Summary, export the results to a file as described in [Chapter 3.5.6.2, "How to save SEM result files"](#), on page 136.

#### To perform an MSR SEM measurement

1. Select "MSR Config".
2. Select the band category that determines the digital standards used in the measurement setup (see ["Band Category"](#) on page 126).
3. Define the bandwidth that contains all relevant carrier signals to be measured.
4. For measurements with GSM/EDGE, LTE FDD and W-CDMA carriers (BC2), define whether a GSM/EDGE or an LTE FDD carrier, or both, are located at the edge of the bandwidth.
5. Select "Apply to SEM".  
The sweep list is configured according to the MSR specification, with the required number of ranges and defined limits.
6. Start a sweep.  
The determined powers and limit deviations for each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.
7. To save the Result Summary, export the results to a file as described in [Chapter 3.5.6.2, "How to save SEM result files"](#), on page 136.

#### To perform a Multi-SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Select "Multi-SEM Config".
3. Define the number of sub blocks (up to 3) that contain the relevant carriers.
4. For each sub block, define the center frequency, that is, the frequency of the TX carrier or a frequency in the dedicated reference range.

5. For each sub block, do one of the following:
  - Select a standard settings file to be used.
  - Select "MSR Settings" and define the MSR configuration as described in ["To perform an MSR SEM measurement"](#) on page 134.
  - Select "Edit" and configure the sweep list manually as defined in ["To configure a user-defined SEM measurement"](#) on page 132. Be sure to select the correct vertical tab for the corresponding sub block within each subtab of the "Spectrum Emission Mask" configuration dialog.  
Define a function to be used for overlapping ranges in the "Multi-Limit Calc" field of the sweep list.
6. Start a sweep.  
The determined powers and limit deviations for each sub block, each gap, and each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.
7. To save the Result Summary, export the results to a file as described in [Chapter 3.5.6.2, "How to save SEM result files"](#), on page 136.

### 3.5.6.1 How to manage SEM settings files

SEM measurement settings can be saved to an XML file which can then be exported to another application or loaded on the R&S ESW again later. Some predefined XML files are provided that contain ranges and parameters according to the selected standard. All XML files are stored under

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std.

For details on the file format of the SEM settings file, see [Chapter 3.5.8.1, "Format description of SEM XML files"](#), on page 138.

SEM settings or standard files are managed in the "Standard" tab of the "Spectrum Emission Mask" dialog box. To display this dialog box, select "Overview" and then "SEM Setup".

#### How to load an SEM settings file

1. From the file selection dialog box, select the settings file (with a .xml extension).
2. Select "Load".

The settings from the selected file are restored to the R&S ESW and you can repeat the SEM measurement with the stored settings.

#### How to save a user-defined SEM settings file

1. Configure the SEM measurement as required (see [Chapter 3.5.6, "How to perform a spectrum emission mask measurement"](#), on page 132).
2. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, define a filename and storage location for the settings file.

3. Select "Save".

The settings are stored to a file with the extension `.xml` as specified.

#### How to delete an SEM settings file

1. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select the file you want to delete.
2. Select "Delete".
3. Confirm the message.

The settings file is removed from the R&S ESW.

#### How to restore default SEM settings files

The R&S ESW is delivered with predefined settings files which can be edited and overwritten. However, you can restore the original files.

- In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select "Restore Standard Files".

The original predefined settings files are available for selection on the R&S ESW.

### 3.5.6.2 How to save SEM result files

The Result Summary from an SEM measurement can be saved to a file, which can be exported to another application for further analysis, for example.

For details on the file format of the SEM export file, see [Chapter 3.5.8.2, "ASCII file export format \(spectrum emission mask\)"](#), on page 144.

1. Configure and perform an SEM measurement as described in [Chapter 3.5.6, "How to perform a spectrum emission mask measurement"](#), on page 132.
2. In the "Overview", select "Analysis".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select "Save".
5. In the file selection dialog box, select a storage location and filename for the result file.
6. Select "Save".

The file with the specified name and the extension `.dat` is stored in the defined storage location.

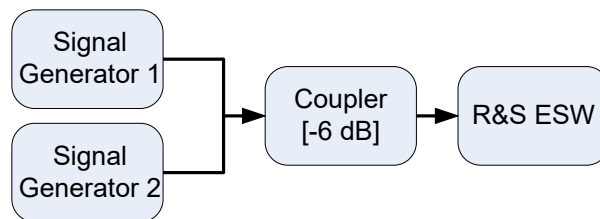
### 3.5.7 Measurement example: Multi-SEM measurement

The following measurement example demonstrates an SEM measurement for a signal with multiple sub blocks.



A programming example demonstrating a SEM measurement in a remote environment is provided in [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

#### Test setup:



#### Signal generator settings (e.g. R&S ESW SMW):

| Device   | Standard  | Center frequency | Level | Test model |
|----------|-----------|------------------|-------|------------|
| SigGen 1 | 3GPP/FDD  | 900 MHz          | 0 dBm | 1-16       |
| SigGen 2 | EUTRA/LTE | 906.5 MHz        | 0 dBm | 1_1_5MHz   |

#### Setting up the measurement

1. Preset the R&S ESW.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *903.25 MHz*.
4. Set the reference level to *10 dBm* with an offset of to *30 dB*.
5. Press [MEAS] or select "Select Measurement" in the "Overview".
6. Select the "SEM" measurement function.
7. Select "Sub Blocks" and enter "Sub Block Count" of 2.
8. For "Sub Block A", define the settings for the 3GPP/FDD signal:
  - Set the "Center Frequency" to *900 MHz*
  - Select "MSR Settings".
  - Set the "Base Station RF Bandwidth" to *5 MHz*.
  - Select "Apply to SEM".
9. For "Sub Block B", define the settings for the EUTRA/LTE signal:
  - Set the "Center Frequency" to *906.5 MHz*
  - Select "MSR Settings".
  - Set the "Base Station RF Bandwidth" to *5 MHz*.
  - Select "Apply to SEM".

## Spectrum emission mask (SEM) measurement

10. Select [RUN SINGLE] to perform a measurement with the new settings.

The results of the measurement for each sub block are displayed in the Result Summary. The summarized limit line is indicated in the Spectrum graph.

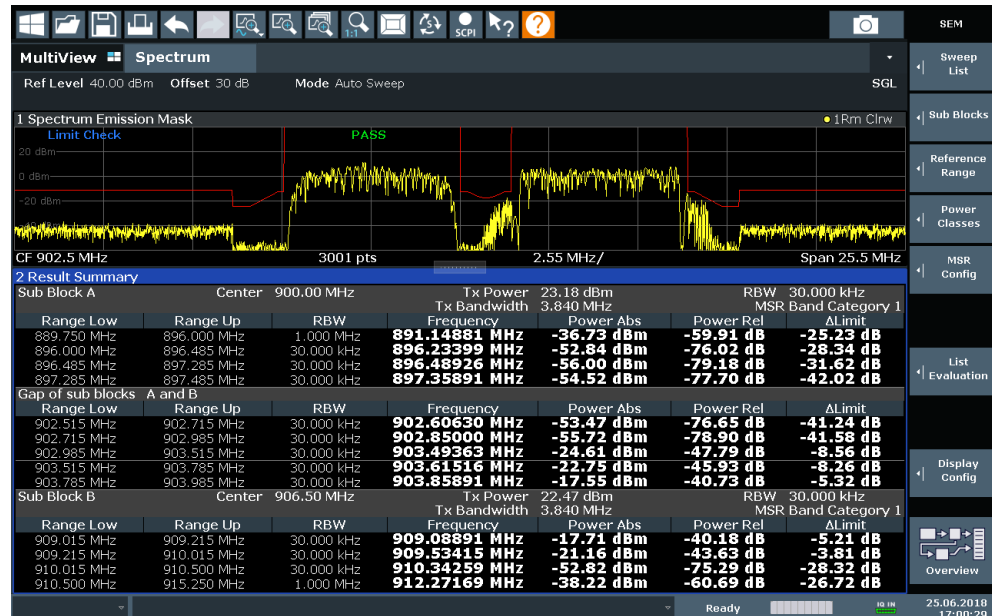


Figure 3-41: Multi-SEM measurement: results of the measurement for each sub block

### 3.5.8 Reference: SEM file descriptions

This reference provides details on the format of the SEM settings and result files.

- [Format description of SEM XML files](#)..... 138
- [ASCII file export format \(spectrum emission mask\)](#)..... 144

#### 3.5.8.1 Format description of SEM XML files

The SEM XML files offer a quick way to change the measurement settings. A set of predefined XML files for different standards is already provided. You can also create and use your own XML files. Alternatively, edit the settings directly in the "Spectrum Emission Mask" dialog box and save the XML file afterwards. This way, you do not have to modify the XML file itself.

In addition to saving the current settings to a file, settings files can also be created independently of the R&S ESW, in an external application. When creating your own XML files, be sure to comply with the following conventions because the R&S ESW can only interpret XML files of a known structure. For sample files, see the C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std directory of the R&S ESW.

To load a settings file, use the "Load" function in the "Standard Files" tab of the "Spectrum Emission Mask" dialog box (see [How to load an SEM settings file](#) on page 135).

All XML files are stored under

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std.

The files for importing range settings obey the rules of the XML standard. The child nodes, attributes, and structure defined for the data import are described here.



Be sure to follow the structure exactly as shown below or else the R&S ESW is not able to interpret the XML file and error messages are shown on the screen. It is recommended that you make a copy of an existing file and edit the copy of the file.

Basically, the file consists of three elements that can be defined:

- The `BaseFormat` element
- The `PowerClass` element
- The `Range` element

### The "BaseFormat" element

It carries information about basic settings. In this element, only the `ReferencePower` child node has any effects on the measurement itself. The other attributes and child nodes are used to display information about the Spectrum Emission Mask standard on the measurement screen. The child nodes and attributes of this element are shown in [Table 3-12](#).

#### Example:

In the sample file `PowerClass_39_43.xml` under

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std\WCDMA\3GPP, these attributes are defined as follows:

- `Standard="W-CDMA 3GPP"`
- `LinkDirection="DL"`
- `PowerClass="(39,43)dBm"`

### The "PowerClass" element

It is embedded in the `BaseFormat` element and contains settings information about the power classes. Up to four different power classes can be defined. For details, refer to [Chapter 3.5.5.4, "Power classes"](#), on page 124. The child nodes and attributes of this element are shown in [Table 3-13](#).

### The "Range" element

This element is embedded in the `PowerClass` element. It contains the settings information of the range. There have to be at least three defined ranges: one reference range and at least one range to either side of the reference range. The maximum number of ranges is 30. Note that the R&S ESW uses the same ranges in each power class. Therefore, the contents of the ranges of each defined power class have to be identical to the first power class. The `Start` and `Stop` values of the two `Limit` nodes that are used to determine the power class are an exception. Note also that you must define two limit nodes: one that defines the limit in absolute values and one in relative

values. Make sure units for the `Start` and `Stop` nodes are identical for each `Limit` node.

For details, refer to [Chapter 3.5.5.1, "Sweep List"](#), on page 116. The child nodes and attributes of this element are shown in [Table 3-14](#).

The following tables show the child nodes and attributes of each element and show if a child node or attribute is mandatory for the R&S ESW to interpret the file or not. The hierarchy of the XML cannot be seen in the tables. View one of the predefined files already stored on the R&S ESW in the "C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\sem\_std" directory, or check the structure as shown below.

Below, a basic example of the structure of the file is shown, containing all mandatory attributes and child nodes. Note that the `PowerClass` element and the `Range` element are themselves elements of the `BaseFormat` element. They must be inserted where noted. They are separated here simply to provide a better overview. Also, no example values are given here to allow a quick reference to the tables above. Italic font shows the placeholders for the values.

- The `BaseFormat` element is structured as follows:
  - `<RS_SEM_ACP_FileFormat Version="1.0.0.0">`  
`<Name>"Standard"</Name>`  
`<Instrument>`  
`<Type>"Instrument Type"</Type>`  
`<Application>"Application"</Application>`  
`</Instrument>`  
`<LinkDirection Name="Name">`  
`<ReferencePower>`  
`<Method>"Method"</Method>`  
`</ReferencePower>`  
`<PowerClass Index="n">`  
`<!-- For contents of the PowerClass node, see Table 3-13 -->`  
`<!-- Define up to four PowerClass nodes -->`  
`</PowerClass>`  
`</LinkDirection>`  
`</RS_SEM_ACP_File>`
- The "PowerClass" element is structured as follows:
  - `<PowerClass Index="n">`  
`<StartPower Unit="dBm" InclusiveFlag="true" Value="StartPowerValue"/>`  
`<StopPower Unit="dBm" InclusiveFlag="false" Value="StopPowerValue"/>`  
`<DefaultLimitFailMode>"Limit Fail Mode"</DefaultLimitFailMode>`  
`<Range Index="n">`  
`<!-- For contents of the Range node, see Table 3-14 -->`  
`<!-- Define up to twenty Range nodes -->`  
`</Range>`  
`...`  
`</PowerClass>`
- The "Range" element is structured as follows:
  - `<Range Index="n">`



```

<Name="Name">
<ChannelType>"Channel Type"</Channel Type>
<WeightingFilter>
<Type>"FilterType"</Type>
<RollOffFactor>"Factor"</RollOffFactor>
<Bandwidth>"Bandwidth"</Bandwidth>
</WeightingFilter>
<FrequencyRange>
<Start>"RangeStart"</Start>
<Stop>"RangeStop"</Stop>
</FrequencyRange>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<RBW Bandwidth="Bandwidth" Type="FilterType"/>
<VBW Bandwidth="Bandwidth"/>
<Detector>"Detector"</Detector>
<Sweep Mode="SweepMode" Time="SweepTime"/>
<Amplitude>
<ReferenceLevel Unit="dBm" Value="Value"/>
<RFAttenuation Mode="Auto" Unit="dB" Value="Value"/>
<Preamplifier State="State"/>
</Amplitude>
<MeasPointsMin>1</MeasPointsMin>
<CalcRuleMulti>Sum</CalcRuleMulti>
</Range>

```

Table 3-12: Attributes and child nodes of the BaseFormat element

| Child Node      | Attribute         | Value                       | Parameter Description   | Mand. |
|-----------------|-------------------|-----------------------------|-------------------------|-------|
|                 | FileFormatVersion | 1.0.0.0                     |                         | Yes   |
|                 | Date              | YYYY-MM-DD<br>HH:MM:SS      | Date in ISO 8601 format | No    |
| Name            |                   | <string>                    | Name of the standard    | Yes   |
| Instrument      | Type              | FSL                         | Name of the instrument  | No    |
|                 | Application       | SA   K72   K82              | Name of the application | No    |
| LinkDirection   | Name              | Downlink   Uplink  <br>None |                         | Yes   |
|                 | ShortName         | DL   UL                     |                         | No    |
| Reference-Power |                   |                             |                         | Yes   |

## Spectrum emission mask (SEM) measurement

| Child Node        | Attribute                                   | Value | Parameter Description | Mand. |
|-------------------|---|-------|-----------------------|-------|
| Method            | TX Channel Power  <br>TX Channel Peak Power |       |                       | Yes   |
| Reference-Channel | <string>                                    |       |                       | No    |

Table 3-13: Attributes and child nodes of the PowerClass element

| Child Node           | Attribute     | Value  | Parameter description  | Mand. |
|----------------------|---------------|--|--|-------|
| StartPower           | Value         | <power in dBm>   | The start power must be equal to the stop power of the previous power class. The StartPower value of the first range is -200 | Yes   |
|                      | Unit          | dBm  |  | Yes   |
|                      | InclusiveFlag | true   |  | Yes   |
| StopPower            | Value         | <power in dBm>   | The stop power must be equal to the start power of the next power class. The StopPower value of the last range is 200        | Yes   |
|                      | Unit          | dBm  |  |       |
|                      | InclusiveFlag | false  |  | Yes   |
| DefaultLimitFailMode |               | Absolute   Relative<br>  Absolute and Relative<br>  Absolute or Relative |  | Yes   |

Table 3-14: Attributes and child nodes of the Range element (normal ranges)

| Child node      | Attribute  | Value         | Parameter description                           | Mand.  |
|-----------------|------------|---------------|---|--|
|                 | Index      | 0...19        | Indices are continuous and have to start with 0 | Yes  |
|                 | Name       | <string>      | Name of the range                               | Only if ReferenceChannel contains a name and the range is the reference range          |
|                 | Short-Name | <string>      | Short name of the range                         | No   |
| ChannelType     |            | TX   Adjacent |   | Yes  |
| WeightingFilter |            |               |   | Only if ReferencePower method is TX Channel Power and the range is the reference range |
| Type            |            | RRC   CFilter | Type of the weighting filter                    | Yes  |

## Spectrum emission mask (SEM) measurement

| Child node      | Attribute | Value  | Parameter description  | Mand.   |
|-----------------|-----------|--|--|---|
| Roll Off Factor |           | 0...1  | Excess bandwidth of the filter   | Only if the filter type is RRC                |
| Bandwidth       |           | <bandwidth in Hz>  | Filter bandwidth   | Only if the filter type is RRC                |
| FrequencyRange  |           |  |  | Yes   |
| Start           |           | <frequency in Hz>  | Start value of the range   | Yes   |
| Stop            |           | <frequency in Hz>  | Stop value of the range  | Yes   |
| Limit           |           | dBm/Hz   dBm   dBc   dBr   dB                                      | A Range must contain exactly two limit nodes; one of the limit nodes has to have a relative unit (e.g. dBc), the other one must have an absolute unit (e.g. dBm) | Yes   |
| Start           | Value     | <numeric_value>  | Power limit at start frequency   | Yes   |
|                 | Unit      | dBm/Hz   dBm   dBc   dBr   dB                                      | Sets the unit of the start value   |   |
| Stop            | Value     | <numeric_value>  | Power limit at stop frequency  |   |
|                 | Unit      | dBm/Hz   dBm   dBc   dBr   dB                                      | Sets the unit of the stop value  |   |
| LimitFailMode   |           | Absolute   Relative   Absolute and Relative   Absolute or Relative | If used, it has to be identical to DefaultLimitFailMode  | No  |
| RBW             | Bandwidth | <bandwidth in Hz>  | "RBW" on page 118  | Yes   |
|                 | Type      | NORM   PULS   CFIL   RRC   |  | No  |
| VBW             | Bandwidth | <bandwidth in Hz>  | "VBW" on page 118  | Yes   |
| Detector        |           | NEG   POS   SAMP   RMS   AVER   QUAS                               | If used, it has to be identical in all ranges.   | No  |
| Sweep           | Mode      | Manual   Auto  | "Sweep Time Mode" on page 118  | Yes   |
|                 | Time      | <time in sec>  | "Sweep Time" on page 118   | No  |
| Amplitude       |           |  |  | No  |
| ReferenceLevel  | Value     | <power in dBm>   | "Ref Level" on page 118  | Yes, if the ReferenceLevel child node is used |

## Spectrum emission mask (SEM) measurement

| Child node    | Attribute | Value         | Parameter description     | Mand.   |
|---------------|-----------|---------------|---------------------------|---|
|               | Unit      | dBm           | Defines dBm as unit       | Yes, if the ReferenceLevel node is used       |
| RFAttenuation | Mode      | Manual   Auto | "RF Att Mode" on page 118 | Yes, if the ReferenceLevel child node is used |

## 3.5.8.2 ASCII file export format (spectrum emission mask)

When trace data from an SEM measurement is exported, the data is stored in ASCII format as described below. The first part of the file lists information about the signal analyzer and the general setup.

| File contents                     | Explanation                             |
|-----------------------------------|---|
| File header                       |   |
| Type;ESW-26                       | Model                                   |
| Version;1.00;                     | Firmware version                        |
| Date;31.Mar 17;                   | Storage date of data set                |
| Mode;ANALYZER;SEM;                | Operating mode and measurement function |
| Center Freq;13250000000.000000;Hz | X-axis settings                         |
| Freq Offset;0.000000;Hz           |   |
| Span;25500000.000000;Hz           |   |
| x-Axis;LIN;                       |   |
| Start;13237250000.000000;Hz       |   |
| Stop;13262750000.000000;Hz        |   |
| Level Offset;0.000000;dB          | Y-axis settings                         |
| Ref Position;100.000000;%         |   |
| y-Axis;LOG;                       |   |
| Level Range;100.000000;dB         |   |
| Trace settings                    |   |
| Trace Mode;CLR/WRITE;             |   |
| Detector;RMS;                     |   |
| Sweep Count;0;                    |   |
| Trace 1.;                         |   |
| x-Unit;Hz;                        |   |
| y-Unit;dBm;                       |   |
| List evaluation settings          |   |

## Spurious emissions measurement

| File contents  | Explanation   |
|--|---|
| Margin;200;  | Peak List margin  |
| <b>Reference range settings</b>  |   |
| RefType; CPOWER;   | Reference power type  |
| TxBandwidth;3840000;;Hz  | Channel power settings  |
| Filter State; ON;  |   |
| Alpha;0.22;  |   |
| PeaksPerRange;1;   | Max. number of peaks per range to be detected   |
| Values;2;  | Number of detected peaks  |
| <b>File data section</b>   |   |
| 0;-12750000;-2515000;30000;13242367500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL; | Measured peak values:<br><range number>;<br><start frequency>;<br><stop frequency>;<br><resolution bandwidth of range>;<br><frequency of peak>;<br><absolute power in dBm of peak>;<br><relative power in dBc of peak>; (related to the channel power)<br><distance to the limit line in dB>; (positive value means above the limit)<br><limit fail (pass = 0, fail =1)>; |
| 2;2515000;12750000;30000;13257632500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;   |   |

## 3.6 Spurious emissions measurement

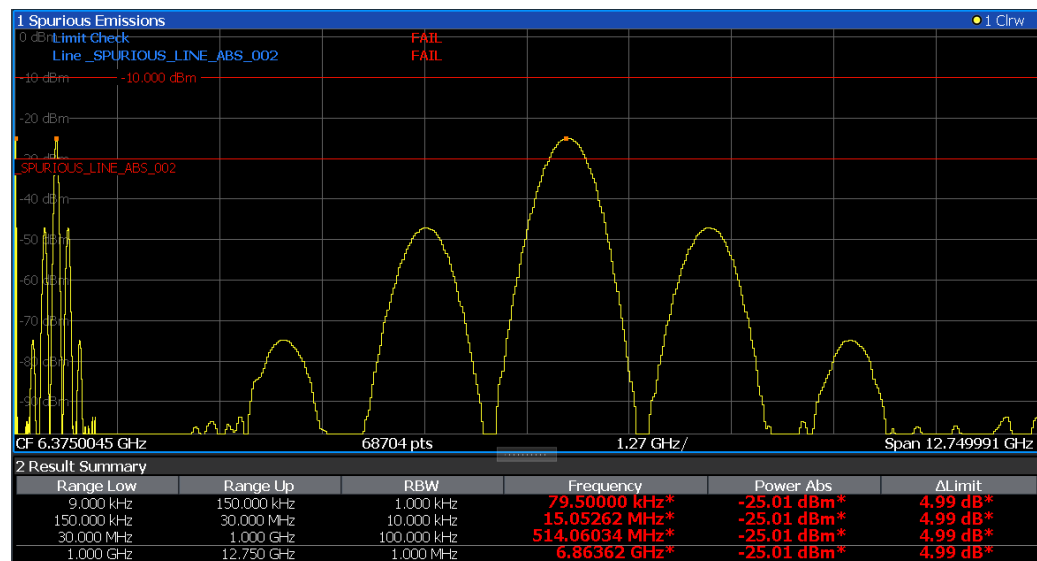
Spurious Emissions measurements monitor unwanted RF products outside the assigned frequency band generated by an amplifier.

- [About the measurement](#)..... 145
- [Spurious emissions measurement results](#)..... 146
- [Spurious emissions basics](#)..... 147
- [Spurious emissions measurement configuration](#)..... 149
- [How to perform a spurious emissions measurement](#)..... 155
- [Reference: ASCII export file format \(spurious\)](#)..... 157

### 3.6.1 About the measurement

The Spurious Emissions measurement monitors unwanted RF products outside the assigned frequency band generated by an amplifier. The spurious emissions are usually measured across a wide frequency range. The Spurious Emissions measurement allows a flexible definition of all parameters. A result table indicates the largest deviation.

tions of the absolute power from the limit line for each range, and the results can be checked against defined limits automatically.



### 3.6.2 Spurious emissions measurement results

The measured signal, including any spurious emissions, and optionally the detected peaks are displayed in the Spurious Emissions measurement diagram. If defined, the limit lines and the limit check results are also indicated. In addition to the graphical results, a result table can be displayed to evaluate the measured powers and limit check results (see also [Chapter 3.6.3.2, "Limit lines in spurious measurements"](#), on page 148). The details of the evaluation list can be configured.

| 2 Result Summary |             |             |                |             |          |
|------------------|-------------|-------------|----------------|-------------|----------|
| Range Low        | Range Up    | RBW         | Frequency      | Power Abs   | ΔLimit   |
| 9.000 kHz        | 150.000 kHz | 1.000 kHz   | 79.50000 kHz*  | -25.01 dBm* | 4.99 dB* |
| 150.000 kHz      | 30.000 MHz  | 10.000 kHz  | 15.05262 MHz*  | -25.01 dBm* | 4.99 dB* |
| 30.000 MHz       | 1.000 GHz   | 100.000 kHz | 514.06034 MHz* | -25.01 dBm* | 4.99 dB* |
| 1.000 GHz        | 12.750 GHz  | 1.000 MHz   | 6.86362 GHz*   | -25.01 dBm* | 4.99 dB* |

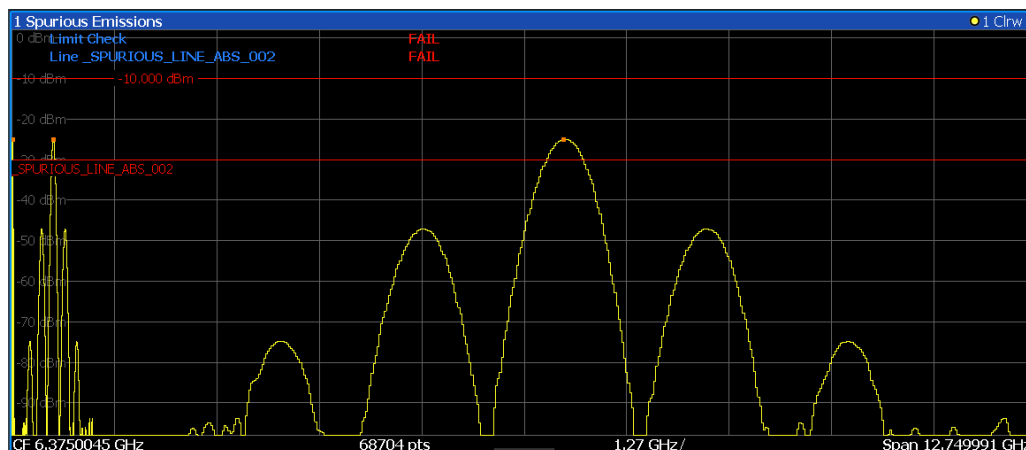
The following information is provided in the evaluation list for each range:

| Column    | Description   |
|-----------|---|
| Range Low | Frequency range start for the range the peak value belongs to                   |
| Range Up  | Frequency range end for the range the peak value belongs to                     |
| RBW       | RBW of the range  |
| Frequency | Frequency at the peak value   |
| Power Abs | Absolute power level at the peak value  |
| ΔLimit    | Deviation of the absolute power level from the defined limit for the peak value |

By default, one peak per range is displayed. However, you can change the settings to:

- Display all peaks

- Display a certain number of peaks per range
- Display only peaks that exceed a threshold ("Margin")
- Display detected peaks as blue squares in the diagram, as well as in the peak list



Furthermore, you can save the evaluation list to a file.

### Retrieving Results via Remote Control

The measured spurious values of the displayed trace can be retrieved using the `TRAC:DATA? SPUR` command (see `TRACe<n>[:DATA]` on page 690).

## 3.6.3 Spurious emissions basics

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

- [Ranges and range settings](#)..... 147
- [Limit lines in spurious measurements](#)..... 148

### 3.6.3.1 Ranges and range settings

#### Conditions for ranges

The following rules apply to ranges:

- The minimum span of a range is 20 Hz.
- The individual ranges must not overlap (but can have gaps).
- The maximum number of ranges is 30
- The maximum number of sweep points in all ranges is limited to 100001.

You can define a span that is smaller than the combined span of the ranges. In this case, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.



### Defining ranges by remote control

In Spurious Emissions measurements, there are no remote commands to insert new ranges between existing ranges directly. However, you can delete or redefine the existing ranges to create the required order.

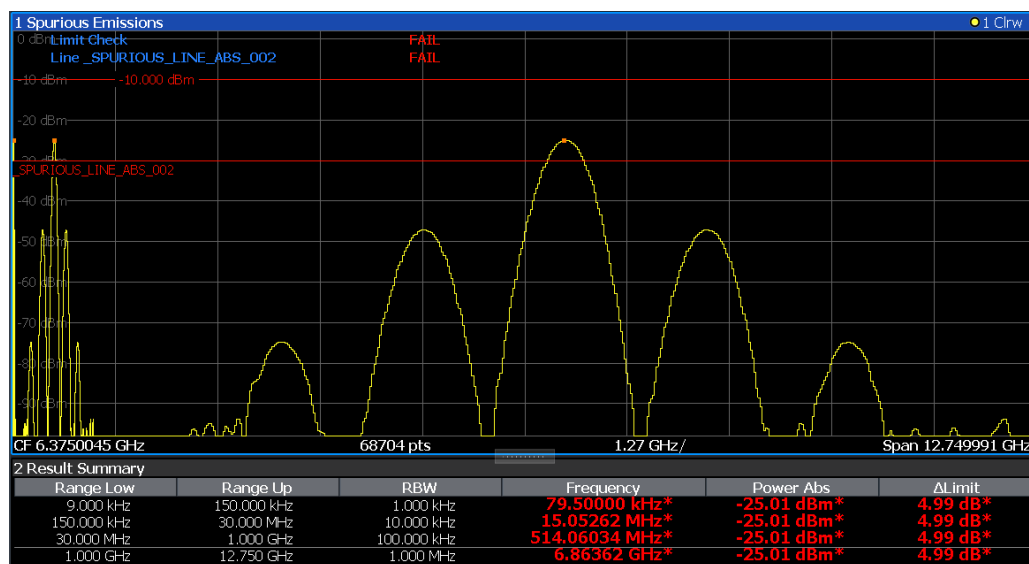
A remote command example for defining parameters and ranges in Spurious Emissions measurements is described in [Chapter 6.7.7.7, "Programming example: spurious emissions measurement"](#), on page 568.

### 3.6.3.2 Limit lines in spurious measurements

Limit lines allow you to check the measured data against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using [Lines]. For Spurious measurements, however, a special limit line is available via the Sweep List, and it is strongly recommended that you use only this limit line definition.

In the Sweep List, you can define a limit line that varies its level according to the specified frequency ranges. A distinguished limit line is automatically defined according to the current Sweep List settings every time the settings change. This limit line is labeled "\_SPURIOUS\_LINE\_ABS\_<xxx>", where <xxx> is an index to distinguish limit lines between different channels.

If a limit check is activated in the Sweep List, the "\_SPURIOUS\_LINE\_ABS\_<xxx>" limit line is indicated by a red line in the display. The result of the limit check is indicated at the top of the diagram. Note that only "Pass" or "Fail" is indicated; a margin function as for general limit lines is not available. Also, only absolute limits can be checked, not relative ones.



As for general limit lines, the results of each limit line check are displayed (here: "\_SPURIOUS\_LINE\_ABS\_<xxx>"), as well as the combined result for all defined limit lines ("Limit Check").



The limit check is considered to be "failed!" if any signal level outside the absolute limits is measured.

If the limit check is activated, the limit line values for each range are displayed in the evaluation list. Furthermore, the largest deviations of the absolute power from the limit line for each range are displayed. Values that exceed the limit are indicated in red and by an asterisk (\*).



Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list can be defined. Furthermore, you can define how many peaks per range are listed. For details, see [Chapter 3.6.4.3, "List evaluation"](#), on page 154.

### 3.6.4 Spurious emissions measurement configuration

**Access:** "Overview" > "Select Measurement" > "Spurious Emissions"

The spurious emissions measurement is started immediately with the default settings.

The remote commands required to perform these tasks are described in [Chapter 6.7.7, "Spurious emissions"](#), on page 557.

- [Sweep list](#)..... 149
- [Adjusting the X-Axis to the range definitions](#)..... 153
- [List evaluation](#)..... 154

#### 3.6.4.1 Sweep list

**Access:** "Overview" > "Select Measurement" > "Spurious Emissions" > Sweep List

For Spurious Emissions measurements, the input signal is split into several frequency ranges which are swept individually and for which different limitations apply.



If you edit the sweep list, always follow the rules and consider the limitations described in [Chapter 3.6.3.1, "Ranges and range settings"](#), on page 147.

| Spurious Emissions |             |             |             |             |
|--------------------|-------------|-------------|-------------|-------------|
|                    | Range 1     | Range 2     | Range 3     | Range 4     |
| Range Start        | 9 kHz       | 150 kHz     | 30 MHz      | 1 GHz       |
| Range Stop         | 150 kHz     | 30 MHz      | 1 GHz       | 12.75 GHz   |
| Filter Type        | Normal(3dB) | Normal(3dB) | Normal(3dB) | Normal(3dB) |
| RBW                | 1 kHz       | 10 kHz      | 100 kHz     | 1 MHz       |
| VBW                | 3 kHz       | 30 kHz      | 300 kHz     | 3 MHz       |
| Sweep Time Mode    | Auto        | Auto        | Auto        | Auto        |
| Sweep Time         | 14.1 ms     | 29.9 ms     | 32.1 ms     | 35.3 ms     |
| Detector           | RMS         | RMS         | RMS         | RMS         |
| Ref Level          | -10 dBm     | -10 dBm     | -10 dBm     | -10 dBm     |
| RF Att Mode        | Auto        | Auto        | Auto        | Auto        |
| RF Attenuation     | 0 dB        | 0 dB        | 0 dB        | 0 dB        |
| Preamp             | Off         | Off         | Off         | Off         |
| Sweep Points       | 701         | 4001        | 32001       | 32001       |
| Stop After Sweep   |             |             |             |             |
| Transducer         | None        | None        | None        | None        |
| Limit Check        | Absolute    | Absolute    | Absolute    | Absolute    |
| Abs Limit Start    | -30 dBm     | -30 dBm     | -30 dBm     | -30 dBm     |
| Abs Limit Stop     | -30 dBm     | -30 dBm     | -30 dBm     | -30 dBm     |

Insert before Range
Insert after Range
Delete Range
Adjust X-Axis

|  |     |
|--|-----|
| Range Start / Range Stop.....                | 150 |
| Filter Type.....                             | 151 |
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| VBW.....                                     | 151 |
| Sweep Time Mode.....                         | 151 |
| Sweep Time.....                              | 151 |
| Detector.....                                | 151 |
| Reference Level.....                         | 152 |
| RF Attenuation Mode.....                     | 152 |
| RF Attenuation.....                          | 152 |
| Preamp.....                                  | 152 |
| Sweep Points.....                            | 152 |
| Stop After Sweep.....                        | 152 |
| Transducer.....                              | 153 |
| Limit Check.....                             | 153 |
| Abs Limit Start/ Abs Limit Stop.....         | 153 |
| Insert before Range/ Insert after Range..... | 153 |
| Delete Range.....                            | 153 |

### Range Start / Range Stop

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

You can define a span that is smaller than the overall span of the ranges. In this case, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

Remote command:

[SENSe:]LIST:RANGe<ri>[:FREQuency]:START on page 561

[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP on page 561

### Filter Type

Sets the filter type for this range.

For details on filter types, see [Chapter 4.6.1.6, "Which data may pass: filter types"](#), on page 301.

Remote command:

[SENSe:]LIST:RANGe<ri>:FILTer:TYPE on page 560

### RBW

Sets the RBW value for this range.

For details on the RBW, see [Chapter 4.6.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 298.

Remote command:

[SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution on page 558

### VBW

Sets the VBW value for this range.

For details on the VBW, see [Chapter 4.6.1.2, "Smoothing the trace using the video bandwidth"](#), on page 299.

Remote command:

[SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo on page 558

### Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode, see [Chapter 4.6.1.7, "How long the data is measured: Sweep Time"](#), on page 302

Remote command:

[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO on page 565

### Sweep Time

Sets the sweep time value for the range.

For details on the sweep time, see [Chapter 4.6.1.7, "How long the data is measured: Sweep Time"](#), on page 302

Remote command:

[SENSe:]LIST:RANGe<ri>:SWEep:TIME on page 564

### Detector

Sets the detector for the range.

For details, refer to [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 345.

Remote command:

[SENSe:]LIST:RANGe<ri>:DETector on page 559

**Reference Level**

Sets the reference level for the range.

For details on the reference level, see [Chapter 4.5.1.1, "Reference level"](#), on page 290.

Remote command:

`[SENSe:]LIST:RANGe<ri>:RLEVel` on page 564

**RF Attenuation Mode**

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation, see [Chapter 4.3.1.1, "Increasing measurement sensitivity \(or avoiding an input mixer overload\)"](#), on page 223.

Remote command:

`[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO` on page 562

**RF Attenuation**

Sets the attenuation value for that range.

For details on attenuation, see [Chapter 4.3.1.1, "Increasing measurement sensitivity \(or avoiding an input mixer overload\)"](#), on page 223.

Remote command:

`[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation` on page 561

**Preamp**

Switches the preamplifier on or off.

If you have the optional low noise amplifier, you can also use that for the measurement (but not both at the same time).

For details on the preamplifier, see ["Preamplifier"](#) on page 294.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATe` on page 530

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:LNA:STATe` on page 530

**Sweep Points**

Sets the number of sweep points for the specified range.

For details on sweep points, see [Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count"](#), on page 303.

Remote command:

`[SENSe:]LIST:RANGe<ri>:POINTs[:VALue]` on page 564

**Stop After Sweep**

This command configures the sweep behavior.

"On"                      The R&S ESW stops after one range is swept and continues only if you confirm (a message box is displayed).

"Off"                      The R&S ESW sweeps all ranges in one go.

Remote command:

`[SENSe:]LIST:RANGe<ri>:BREak` on page 558

**Transducer**

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

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

For details on transducers, see the user manual of the R&S ESW.

Remote command:

`[SENSe:]LIST:RANGe<ri>:TRANsducer` on page 565

**Limit Check**

Activates or deactivates the limit check for all ranges.

For details on limit checks, see [Chapter 3.6.3.2, "Limit lines in spurious measurements"](#), on page 148.

"ABSOLUTE"      Signal is checked against absolute limit values

"NONE"            No limit check is performed.

Remote command:

`[SENSe:]LIST:RANGe<ri>:LIMit:STATe` on page 563

`CALCulate<n>:LIMit<li>:FAIL?` on page 777

**Abs Limit Start/ Abs Limit Stop**

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

Remote command:

`[SENSe:]LIST:RANGe<ri>:LIMit:START` on page 563

`[SENSe:]LIST:RANGe<ri>:LIMit:STOP` on page 563

**Insert before Range/ Insert after Range**

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

**Delete Range**

Deletes the currently focused range. The range numbers are updated accordingly.

**3.6.4.2 Adjusting the X-Axis to the range definitions**

**Access:** "Overview" > "Select Measurement" > "Spurious Emissions" > "Adjust X-Axis"

The frequency axis of the measurement diagram can be adjusted automatically so that the span of all sweep list ranges corresponds to the displayed span. Thus, the x-axis range is set from the start frequency of the first sweep range to the stop frequency of the last sweep range.

Remote command:

`[SENSe:]LIST:XADJust` on page 568

3.6.4.3 List evaluation

**Access:** "Overview" > "Select Measurement" > "Spurious Emissions" > "List Evaluation"

Configure the contents and display of the result list.

List Evaluation

List Evaluation State

OnOff

Settings

Show Peaks

OnOff

Margin

50.0 dB

Details

OnOff

Peaks per Range

25

Save Evaluation List

Decimal Separator

PointComma

Save

|                            |     |
|----------------------------|-----|
| List Evaluation State..... | 154 |
| Show Peaks.....            | 154 |
| Margin.....                | 155 |
| Details.....               | 155 |
| Peaks per Range.....       | 155 |
| Save Evaluation List.....  | 155 |

**List Evaluation State**  
Activates or deactivates the list evaluation.  
Remote command:  
CALCulate<n>:PEAKsearch:AUTO on page 566

**Show Peaks**  
If activated, all peaks that have been detected during an active list evaluation are marked with blue squares in the diagram.  
Remote command:  
CALCulate<n>:PEAKsearch:PSHow on page 567

**Margin**

A margin functionality is not available for the limit check. However, you can define a margin (=threshold) for the peak values to be displayed in the evaluation list. Only peaks that exceed the margin value are displayed (also in the diagram, if activated).

Remote command:

[CALCulate<n>:PEAKsearch:MARGin](#) on page 566

**Details**

Configures how detailed the list in the Result Summary is.

|     |   |
|-----|---|
| On  | Includes all detected peaks (up to a maximum defined by "Peaks per Range"). |
| Off | Includes only one peak per range.   |

Remote command:

[CALCulate<n>:ESpectrum:PEAKsearch:DEtails](#) on page 566

**Peaks per Range**

Defines the maximum number of peaks per range that are stored in the list. Once the selected number of peaks has been reached, the peak search is stopped in the current range and continued in the next range. The maximum value is 50.

Remote command:

[CALCulate<n>:PEAKsearch:SUBRanges](#) on page 567

**Save Evaluation List**

Exports the evaluation list of the Spurious Emissions measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

For details, see ["How to Save the Spurious Emissions Evaluation List"](#) on page 156.

Remote command:

[MMEMory:STORe<n>:LIST](#) on page 702

[FORMat:DEXPort:DSEParator](#) on page 698

**3.6.5 How to perform a spurious emissions measurement**

The following step-by-step instructions demonstrate how to perform spurious emissions measurements.



For remote operation, see [Chapter 6.7.7.7, "Programming example: spurious emissions measurement"](#), on page 568.

1. Press [MEAS], then select the "Spurious Emissions" measurement.

2. Define the span of the signal to be monitored in the general span settings.
3. Select "Overview", then select "Spurious Setup".  
The "Spurious Emissions" dialog box is displayed.
4. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.  
Define the required ranges in the Sweep List using "Insert before Range" and "Insert after Range", which refer to the currently selected range.
5. Define the measurement parameters for each range as required.
6. Optionally, define a limit check.
  - a) Activate the limit check by setting "Limit Check" to "ABSOLUTE". The limit check is always activated or deactivated for all ranges simultaneously.
  - b) Define the limit line's start and stop values for each range of the signal. If a signal level higher than the defined limit is measured, the limit check fails, which may indicate a spurious emission.
7. Configure the peak detection during a Spurious Emissions measurement: select "Evaluations" in the "Overview".
  - To indicate the determined peaks in the display, activate the "Show Peaks" option.
  - To restrict peak detection, define a "Margin". Only peaks that exceed this value are detected.
  - To allow for more peaks per range to be detected than the default 1, increase the "Peaks per Range" value and set "Details" to "On".
8. Start a sweep.  
The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
9. To save the evaluation list, export the results to a file as described in ["How to Save the Spurious Emissions Evaluation List"](#) on page 156.

#### How to Save the Spurious Emissions Evaluation List

The evaluation list from a Spurious Emissions measurement can be saved to a file, which can be exported to another application for further analysis, for example.

1. Configure and perform a Spurious Emissions measurement as described in [Chapter 3.6.5, "How to perform a spurious emissions measurement"](#), on page 155.
2. Select "Evaluations" in the "Overview".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select "Save".



5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select "Save".

The file with the specified name and the extension `.dat` is stored in the defined storage location.

### 3.6.6 Reference: ASCII export file format (spurious)

The file has a header containing important parameters for scaling, several data sections containing the sweep settings per range, and a data section containing the peak list.

The header data is made up of three columns, separated by ';', with the syntax:

Parameter name; numeric value; basic unit

| File contents                     | Explanation                             |
|-----------------------------------|---|
| File header                       |   |
| Type;ESW-26                       | Model                                   |
| Version;1.00;                     | Firmware version                        |
| Date;31.Mar 11;                   | Storage date of data set                |
| Mode;ANALYZER; SPURIOUS;          | Operating mode and measurement function |
| Center Freq;13250000000.000000;Hz | X-axis settings                         |
| Freq Offset;0.000000;Hz           |   |
| Span;26499982000.000000;Hz        |   |
| x-Axis;LIN;                       |   |
| Start;9000.000000;Hz              |   |
| Stop;8000000000.000000;Hz         |   |
| Level Offset;0.000000;dB          | Y-axis settings                         |
| Ref Position;100.000000;%         |   |
| y-Axis;LOG;                       |   |
| Level Range;100.000000;dB         |   |
| Trace settings                    |   |
| Trace Mode;CLR/WRITE;             |   |
| Sweep Count;1;                    |   |
| TRACE 1:                          |   |
| Trace Mode;CLR/WRITE;             |   |
| x-Unit;Hz;                        |   |
| y-Unit;dBm;                       |   |

| File contents   | Explanation  |
|---|--|
| <b>List evaluation settings</b>   |  |
| Margin;6.000000;s   | Peak List margin   |
| PeaksPerRange;25;   | Max. number of peaks per range to be detected  |
| Values;3;   | Number of detected peaks   |
| <b>File data section</b>  |  |
| 0;9000;150000;1000;79500;-25.006643295288086;-12.006643295288086;PASS;              | Measured peak values:<br><range number>;<br><start frequency>;<br><stop frequency>;<br><resolution bandwidth of range>;<br><frequency of peak>;<br><absolute power in dBm of peak>;<br><distance to the limit line in dB>; (positive value means above the limit)<br><limit fail (pass = 0, fail =1)>; |
| 0;9000;150000;1000;101022.11126961483;-47.075111389160156;-34.075111389160156;PASS; |  |
| 0;9000;150000;1000;58380.171184022824;-47.079341888427734;-34.079341888427734;PASS; |  |
|   |  |
|   |  |

## 3.7 Statistical measurements (APD, CCDF)

To measure the amplitude distribution, the R&S ESW has simple measurement functions to determine both the Amplitude Probability Distribution (APD) and the Complementary Cumulative Distribution Function (CCDF). Only one of the signal statistic functions can be switched on at a time.

- [About the measurements](#)..... 158
- [Typical applications](#)..... 159
- [APD and CCDF results](#)..... 159
- [APD and CCDF basics - gated triggering](#)..... 161
- [APD and CCDF configuration](#)..... 162
- [How to perform an APD or CCDF measurement](#)..... 168
- [Examples](#)..... 169
- [Optimizing and troubleshooting the measurement](#)..... 172

### 3.7.1 About the measurements

The probability of amplitude values can be measured with the Amplitude Probability Distribution function (APD). During a selectable measurement time all occurring amplitude values are assigned to an amplitude range. The number of amplitude values in the individual ranges is counted and the result is displayed as a histogram.

Alternatively, the Complementary Cumulative Distribution Function (CCDF) can be displayed. It shows the probability that the mean signal power amplitude will be exceeded in percent.

Only one of the signal statistic functions can be switched on at a time. When a statistic function is switched on, the R&S ESW is set into zero span mode automatically. The R&S ESW measures the statistics of the signal applied to the RF input with the defined analysis bandwidth. To avoid affecting the peak amplitudes the video bandwidth is automatically set to 10 times the analysis bandwidth. The sample detector is used for detecting the video voltage.

Statistic measurements on pulsed signals can be performed using a gated trigger. For details see [Chapter 3.7.4, "APD and CCDF basics - gated triggering"](#), on page 161.

### 3.7.2 Typical applications

Digital modulated signals are similar to white noise within the transmit channel, but are different in their amplitude distribution. In order to transmit the modulated signal without distortion, all amplitudes of the signal have to be transmitted linearly from the output power amplifier. Most critical are the peak amplitude values. Degradation in transmit quality caused by a transmitter two port network is dependent on the amplitude of the peak values as well as on their probability.

If modulation types are used that do not have a constant envelope in zero span, the transmitter has to handle peak amplitudes that are greater than the average power. This includes all modulation types that involve amplitude modulation, QPSK for example. CDMA transmission modes in particular may have power peaks that are large compared to the average power.

For signals of this kind, the transmitter must provide large reserves for the peak power to prevent signal compression and thus an increase of the bit error rate at the receiver. The peak power or the crest factor of a signal is therefore an important transmitter design criterion. The crest factor is defined as the peak power to mean power ratio or, logarithmically, as the peak level minus the average level of the signal. To reduce power consumption and cut costs, transmitters are not designed for the largest power that could ever occur, but for a power that has a specified probability of being exceeded (e.g. 0.01 %).

The statistical functions provide information on such signal criteria.

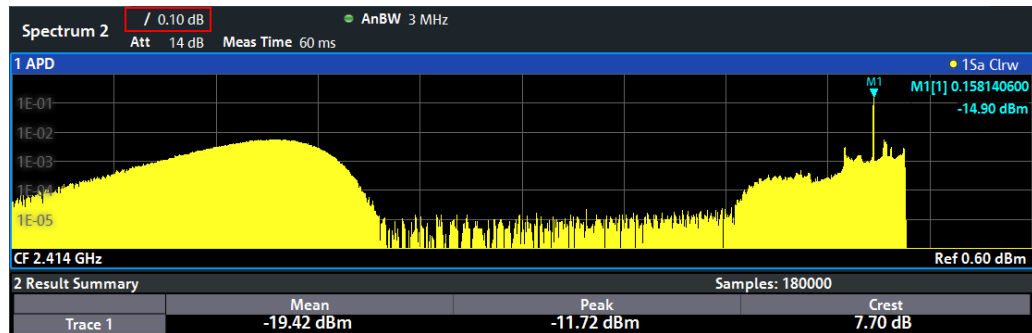
### 3.7.3 APD and CCDF results

#### Amplitude Probability Distribution (APD)

As a result of the Amplitude Probability Distribution (APD) function, the probability of measured amplitude values is displayed. During a selectable measurement time all measured amplitude values are assigned to an amplitude range (*bin*). The number of amplitude values in the individual ranges is counted and the result is displayed as a histogram. Each bar of the histogram represents the percentage of measured amplitudes within the specific amplitude range. The x-axis represents the amplitude values and is scaled in absolute values (dBm).



The size of each amplitude range (bin) determines the resolution of the histogram and is indicated in the channel bar, for example / 0.10 dB. In this case, a single bar in the histogram represents an amplitude range of 0.10 dB.



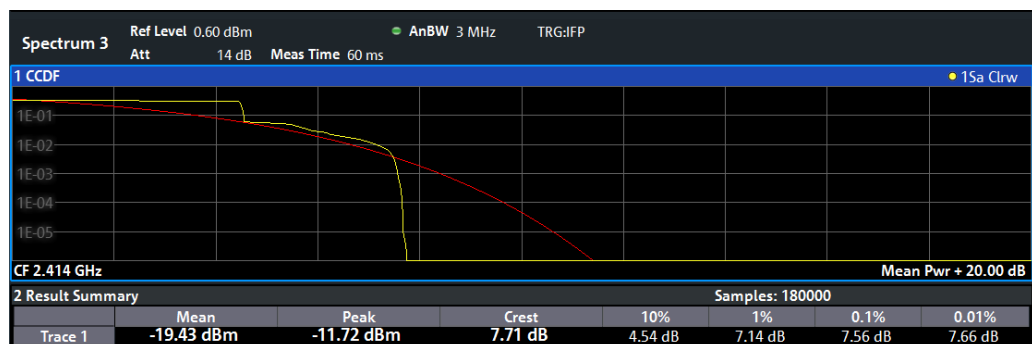
In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:
  - Mean amplitude
  - Peak amplitude
  - Crest factor

The crest factor is defined as the peak power to mean power ratio or, logarithmically, as the peak level minus the average level of the signal.

### Complementary Cumulative Distribution Function (CCDF)

The Complementary Cumulative Distribution Function (CCDF) shows the probability that the signal power amplitude exceeds the mean value in percent. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.



A red line indicates the ideal Gaussian (normal) distribution for the measured amplitude range.

The displayed amplitude range is indicated as "Mean Pwr" + "<x dB>"

In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:

|               |   |
|---------------|---|
| <b>Mean</b>   | Mean power  |
| <b>Peak</b>   | Peak power  |
| <b>Crest</b>  | Crest factor (peak power – mean power)                        |
| <b>10 %</b>   | 10 % probability that the level exceeds mean power + [x] dB   |
| <b>1 %</b>    | 1 % probability that the level exceeds mean power + [x] dB    |
| <b>0,1 %</b>  | 0,1 % probability that the level exceeds mean power + [x] dB  |
| <b>0,01 %</b> | 0,01 % probability that the level exceeds mean power + [x] dB |

### Percent marker

In addition to the results for specific percentages in the table, a percent marker can be activated for a freely selectable percentage. This marker indicates how many level values are over <x> % above the mean power.



### Percent marker

As all markers, the percent marker can be moved simply by selecting it with a finger or mouse cursor and dragging it to the desired position.

### Diagram Scaling

The scaling for both the x-axis and y-axis of the statistics diagram can be configured. In particular, you can restrict the range of amplitudes to be evaluated and the probabilities to be displayed.

### Remote commands:

`CALCulate<n>:STATistics:CCDF:X<t>?` on page 577

`CALCulate<n>:STATistics:RESult<res>?` on page 577

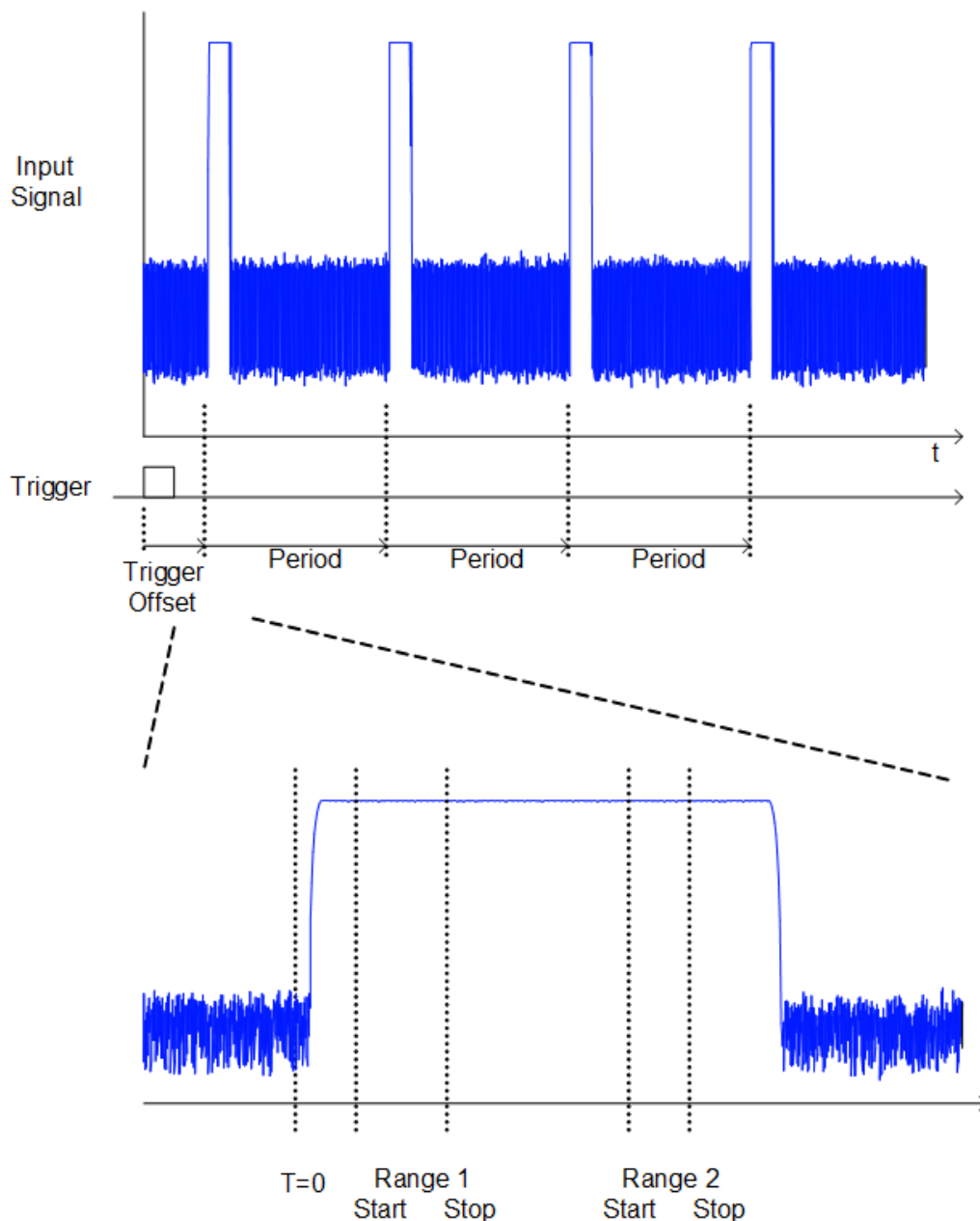
## 3.7.4 APD and CCDF basics - gated triggering

Statistic measurements on pulsed signals can be performed using a gated trigger. An external or power trigger is required as a time (frame) reference.

The gate ranges define the part of the measured data taken into account for the statistics calculation. These ranges are defined relative to a reference point T=0. The gate interval is repeated for each period until the end of the capture buffer.

The reference point T=0 is defined by the external trigger event and the instrument's trigger offset.

For each trace you can define up to 3 separate ranges of a single period to be traced.



### 3.7.5 APD and CCDF configuration

Configuration consists of the following settings:

- Make sure the specified reference level is higher than the measured peak value (see ["Reference Level"](#) on page 292).
- [Basic settings](#)..... 163
- [Gate range definition for APD and CCDF](#)..... 165
- [Scaling for statistics diagrams](#)..... 166

### 3.7.5.1 Basic settings

**Access:** "Overview" > "Select Measurement" > "APD"/"CCDF" > "APD Config"/ "CCDF Config"

The remote commands required to perform these tasks are described in [Chapter 6.7.8, "Statistics"](#), on page 570.

| CCDF                |          |
|---------------------|----------|
| Percent Marker      | 0.0 %    |
| Analysis Bandwidth  | 80.0 MHz |
| Number of Samples   | 100 000  |
| Gated Trigger       | On Off   |
| Normal Distribution | On Off   |
| Edit Gate Ranges    |          |
| Adjust Settings     |          |

Both dialog boxes are identical except for the "Percent Marker" setting, which is only available for CCDF measurements.

|                                 |     |
|---------------------------------|-----|
| Percent Marker (CCDF only)..... | 163 |
| Analysis Bandwidth.....         | 163 |
| Number of Samples.....          | 164 |
| Gated Trigger.....              | 164 |
| Normal Distribution.....        | 164 |
| Edit Gate Ranges.....           | 164 |
| Adjust Settings.....            | 164 |

#### Percent Marker (CCDF only)

Defines a probability value. Thus, the power which is exceeded with a given probability can be determined very easily. If marker 1 is deactivated, it is switched on automatically.

Remote command:

`CALCulate<n>:MARKer<m>:Y:PERCent` on page 571

#### Analysis Bandwidth

Defines the analysis bandwidth.

For correct measurement of the signal statistics, the analysis bandwidth has to be wider than the signal bandwidth in order to measure the peaks of the signal amplitude correctly. To avoid influencing the peak amplitudes, the video bandwidth is automatically set to 10 MHz. The sample detector is used for detecting the video voltage.

The calculated measurement time is displayed for reference only.

Remote command:

[\[SENSe:\]BANDwidth\[:RESolution\]](#) on page 665

### Number of Samples

Defines the number of power measurements that are taken into account for the statistics.

For statistics measurements with the R&S ESW, the number of samples to be measured is defined instead of the sweep time. Since only statistically independent samples contribute to statistics, the sweep or measurement time is calculated automatically and displayed in the channel bar ("Meas Time"). The samples are statistically independent if the time difference is at least 1/RBW. The measurement time is, therefore, expressed as follows:

$$\text{Meas Time} = N_{\text{Samples}} / \text{RBW}$$

The maximum number of samples is limited by the hardware capability. For gated triggered APD or CCDF measurements, the maximum number is limited further, if necessary, to accommodate for very small ranges within a relatively long period. In this case, the smallest gate/period ratio is considered, and the number is adapted to capture full periods of data. If the defined number of samples exceeds the limit, it is automatically reduced to the maximum value.

Remote command:

[CALCulate<n>:STATistics:NSAMples](#) on page 571

### Gated Trigger

Activates and deactivates gating for statistics functions for the ACP and the CCDF measurements. The gate ranges are defined using the [Edit Gate Ranges](#) function.

Remote command:

[\[SENSe:\]SWEep:EGATe](#) on page 678

### Normal Distribution

Enables or disables the red trace in the CCDF display indicating the normal distribution.

Remote command:

[DISPlay\[:WINDow<n>\]:STATistics:CCDF:GAUSS](#) on page 578

### Edit Gate Ranges

Opens a dialog box to configure up to 3 gate ranges for each trace. For details see [Chapter 3.7.5.2, "Gate range definition for APD and CCDF"](#), on page 165.

### Adjust Settings

Adjusts the level settings according to the measured difference between peak and minimum power for APD measurement or peak and mean power for CCDF measurement in order to obtain maximum power resolution. Adjusts the reference level to the current input signal.

Remote command:

[CALCulate<n>:STATistics:SCALE:AUTO ONCE](#) on page 574



### 3.7.5.2 Gate range definition for APD and CCDF

**Access:** "Overview" > "Select Measurement" > "APD"/"CCDF" > "APD Config"/ "CCDF Config" > "Edit Gate Ranges"

You can configure gate ranges for gated triggering in statistical measurements.

For background information on defining gate ranges see [Chapter 3.7.4, "APD and CCDF basics - gated triggering"](#), on page 161.

The remote commands required to perform these tasks are described in [Chapter 6.7.8.3, "Gate ranges"](#), on page 572.

| Gate Ranges   |         |         |         |         |         |         |
|---------------|---------|---------|---------|---------|---------|---------|
|               | Trace 1 | Trace 2 | Trace 3 | Trace 4 | Trace 5 | Trace 6 |
| Comment       |         |         |         |         |         |         |
| Period        | 2 ms    | 2 ms    | 2 ms    | 2 ms    | 2 ms    | 2 ms    |
| Range 1 Use   | On      | Off     | Off     | Off     | Off     | Off     |
| Range 1 Start | 0 s     | 0 s     | 0 s     | 0 s     | 0 s     | 0 s     |
| Range 1 Stop  | 1 ms    | 1 ms    | 1 ms    | 1 ms    | 1 ms    | 1 ms    |
| Range 2 Use   | Off     | Off     | Off     | Off     | Off     | Off     |
| Range 2 Start | 2 ms    | 2 ms    | 2 ms    | 2 ms    | 2 ms    | 2 ms    |
| Range 2 Stop  | 3 ms    | 3 ms    | 3 ms    | 3 ms    | 3 ms    | 3 ms    |
| Range 3 Use   | Off     | Off     | Off     | Off     | Off     | Off     |
| Range 3 Start | 4 ms    | 4 ms    | 4 ms    | 4 ms    | 4 ms    | 4 ms    |
| Range 3 Stop  | 5 ms    | 5 ms    | 5 ms    | 5 ms    | 5 ms    | 5 ms    |

Up to three ranges can be defined for each of the six available traces.

|  |     |
|--|-----|
| <a href="#">Comment</a> .....                    | 165 |
| <a href="#">Period</a> .....                     | 165 |
| <a href="#">Range &lt;x&gt; Use</a> .....        | 166 |
| <a href="#">Range &lt;x&gt; Start/Stop</a> ..... | 166 |

#### Comment

An optional comment can be defined for the gate range settings of each trace.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>:COMMeNt on page 572

#### Period

Length of the period to be traced. The period is the same for all traces. If you change the period for one trace, it is automatically changed for all traces.

Make sure the defined period is not longer than the total measurement time of the current measurement. Keep in mind that the measurement time depends on the bandwidth and the number of samples (see ["Number of Samples"](#) on page 164). The current measurement time is indicated as "Meas Time" in the channel bar.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>:PERIoD on page 572

**Range <x> Use**

Activates tracing of the defined range during a gated measurement.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>[:STATe<gr>] on page 573

**Range <x> Start/Stop**

Defines the start and stop points of the range within the tracing period. Make sure the value for the stopping time is smaller than the length of the period.

**Note:** You can define the time values with a greater numerical resolution than is displayed; the values are only rounded for display.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>:START<gr> on page 572

[SENSe:] SWEep:EGATe:TRACe<t>:STOP<gr> on page 573

**3.7.5.3 Scaling for statistics diagrams**

**Access:** "Overview" > "Amplitude" > "Scale" tab

**Or:** [AMPT] > "Scale Config"

For statistics displays, scale settings are available for both the y-axis and the x-axis.

The remote commands required to perform these tasks are described in [Chapter 6.7.8.4, "Diagram scale"](#), on page 574.

| Amplitude       |         | Scale            |         |
|-----------------|---------|------------------|---------|
| X-Axis          |         | Y-Axis           |         |
| Range           | 20 dB   | Y-Unit           | Pct Abs |
| Ref Level       | 0.0 dBm | Y-Max            | 1.0     |
| Offset          | 0.0 dB  | Y-Min            | 1.0E-06 |
| Adjust Settings |         | Default Settings |         |

Figure 3-42: Scale settings for CCDF diagram



In statistical diagrams, the x-axis displays the signal level values (= y-axis in standard display), while the y-axis displays the probability of the values.

|                                      |     |
|--------------------------------------|-----|
| X-Axis.....                          | 167 |
| L Ref Level.....                     | 167 |
| L Range.....                         | 167 |
| L Shifting the Display (Offset)..... | 167 |
| Y-Axis.....                          | 167 |
| L Y-Unit.....                        | 167 |
| L Y-Max/ Y-Min.....                  | 167 |
| Default Settings.....                | 168 |
| Adjust Settings.....                 | 168 |

### X-Axis

Defines the scaling settings for signal level values.

#### Ref Level ← X-Axis

Defines the reference level for the signal levels in the currently active unit (dBm, dBμV, etc.).

For the APD function this value corresponds to the right diagram border. For the CCDF function there is no direct representation of this value on the diagram as the x-axis is scaled relatively to the measured mean power.

Remote command:

`CALCulate<n>:STATistics:SCALE:X:RLEVel` on page 575

#### Range ← X-Axis

Defines the level range in dB to be evaluated by the statistics measurement.

Remote command:

`CALCulate<n>:STATistics:SCALE:X:RANGE` on page 575

#### Shifting the Display (Offset) ← X-Axis

Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the x-axis is changed accordingly. The setting range is ±200 dB in 0.1 dB steps.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RLEVel:OFFSet` on page 660

### Y-Axis

Defines the scaling settings for the probability distribution.

#### Y-Unit ← Y-Axis

Defines the scaling type of the y-axis as either percentage or absolute. The default value is absolute scaling.

Remote command:

`CALCulate<n>:STATistics:SCALE:Y:UNIT` on page 576

#### Y-Max/ Y-Min ← Y-Axis

Defines the upper (max) and lower (min) limit of the displayed probability range. Values on the y-axis are normalized which means that the maximum value is 1.0. The minimum value must be in the range:

$1\text{E-}9 < \text{Y-Min} < 0.1$

The distance between "Y-Max" and "Y-Min" must be at least one decade.

Remote command:

[CALCulate<n>:STATistics:SCALE:Y:UPPer](#) on page 576

[CALCulate<n>:STATistics:SCALE:Y:LOWer](#) on page 576

### Default Settings

Resets the x- and y-axis scalings to their preset values.

|                     |        |
|---------------------|--------|
| X-axis ref level:   | 0 dBm  |
| X-axis range APD:   | 100 dB |
| X-axis range CCDF:  | 20 dB  |
| Y-axis upper limit: | 1.0    |
| Y-axis lower limit: | 1E-6   |

Remote command:

[CALCulate<n>:STATistics:PRESet](#) on page 574

### Adjust Settings

Adjusts the level settings according to the measured difference between peak and minimum power for APD measurement or peak and mean power for CCDF measurement in order to obtain maximum power resolution. Adjusts the reference level to the current input signal.

Remote command:

[CALCulate<n>:STATistics:SCALE:AUTO ONCE](#) on page 574

## 3.7.6 How to perform an APD or CCDF measurement

The following step-by-step instructions demonstrate how to perform basic statistic measurements.



For remote operation, see [Chapter 6.7.8.7, "Programming example: measuring statistics"](#), on page 578.

### To start a basic statistic measurement

1. Press [MEAS], then select the "APD" or "CCDF" measurement.
2. Start a sweep.

As soon as the defined number of samples have been measured, the statistical evaluation is displayed.

### To perform a statistic measurement using gate ranges

For pulsed signals, the transmission intervals should not be included in the statistical evaluation. Thus, you must define gate ranges to be included in the measurement.

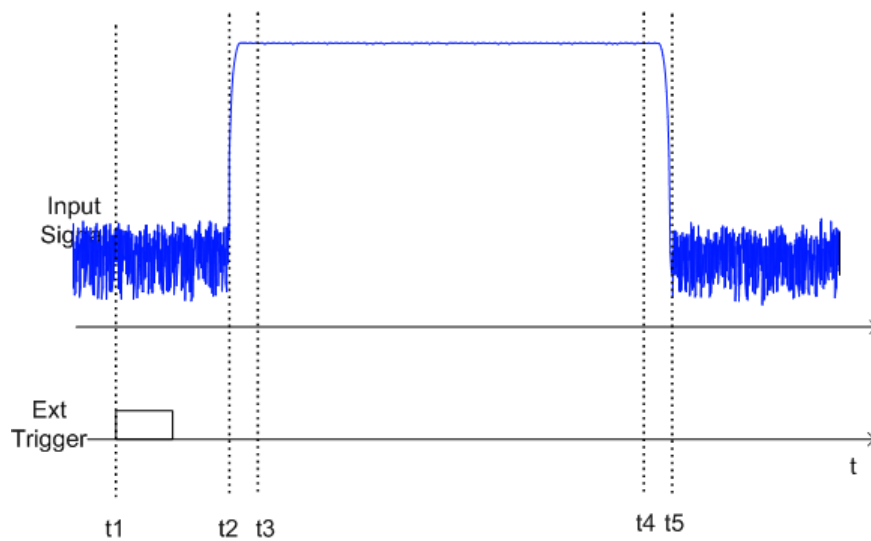
1. Press [MEAS Config], then select "APD Config" or "CCDF Config".  
The "APD" or "CCDF" dialog box is displayed.
2. Select "Edit Gate Ranges".
3. Define the time period for which the input signal is to be analyzed, for example the duration of 3 signal pulses.
4. For each active trace, define up to three ranges within the time period to be measured. In the example covering 3 pulses, you could define one range for each pulse.
  - a) Assuming the external trigger determines  $T=0$  as the start of the first pulse, define the start time of range 1 at 0 s.
  - b) Define the stop time of range 1 at the duration of the first pulse.
  - c) Activate range 1 by setting "Range 1 Use" to *On*.
  - d) Define the start time of range 2 as (duration of pulse 1 + duration of interval)
  - e) Define the stop time of range 2 as (start time of range 2 + duration of pulse 2)
  - f) Activate range 2 by setting "Range 2 Use" to *On*.
  - g) Define the third range in the same way.
5. Start a sweep.

As soon as the defined number of samples have been measured, the statistical evaluation is displayed. Only the signal levels within the pulse periods are considered.

## 3.7.7 Examples

### 3.7.7.1 Configuration example: gated statistics

A statistics evaluation has to be done over the useful part of the signal between  $t_3$  and  $t_4$ . The period of the GSM signal is 4.61536 ms.



t1: External positive trigger slope

t2: Begin of burst (after 25  $\mu$ s)

t3: Begin of useful part, to be used for statistics (after 40  $\mu$ s)

t4: End of useful part, to be used for statistics (after 578  $\mu$ s)

t5: End of burst (after 602  $\mu$ s)

The instrument has to be configured as follows:

|                |                             |  |
|----------------|-----------------------------|--|
| Trigger Offset | $t2 - t1 = 25 \mu\text{s}$  | now the gate ranges are relative to t2 |
| Range1 Start   | $t3 - t2 = 15 \mu\text{s}$  | start of range 1 relative to t2        |
| Range1 End     | $t4 - t2 = 553 \mu\text{s}$ | end of range 1 relative to t2          |

### 3.7.7.2 Measurement example – measuring the APD and CCDF of white noise generated by the R&S ESW



#### Setting the analysis bandwidth

When the amplitude distribution is measured, the analysis bandwidth must be set so that the complete spectrum of the signal to be measured falls within the bandwidth. This is the only way of ensuring that all the amplitudes will pass through the IF filter without being distorted. If the selected bandwidth is too small for a digitally modulated signal, the amplitude distribution at the output of the IF filter becomes a Gaussian distribution according to the central limit theorem and thus corresponds to a white noise signal. The true amplitude distribution of the signal therefore cannot be determined.



A programming example demonstrating a statistics measurement in a remote environment is provided in [Chapter 6.7.8.7, "Programming example: measuring statistics"](#), on page 578.

1. Preset the R&S ESW.
2. Set the reference level to  $-60\text{ dBm}$ .

The R&S ESW's intrinsic noise is displayed at the top of the screen.

3. Select the "APD" measurement function from the "Select Measurement" dialog box.

The R&S ESW sets the frequency span to 0 Hz and measures the amplitude probability distribution (APD). The number of uncorrelated level measurements used for the measurement is 100000. The mean power and the peak power are displayed in dBm. The crest factor (peak power – mean power) is output as well.

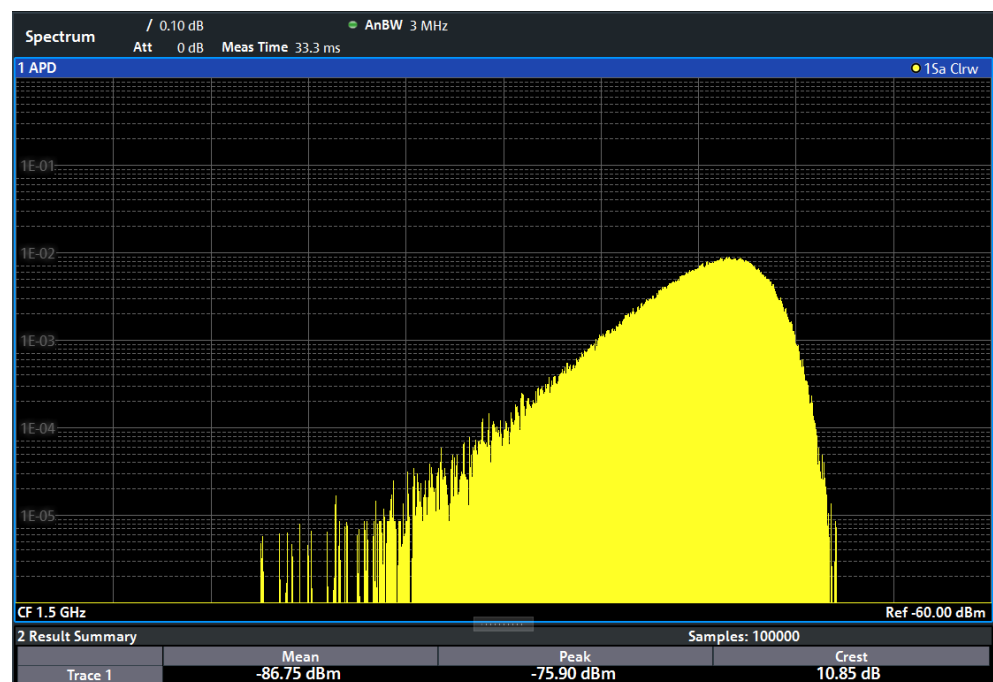


Figure 3-43: Amplitude probability distribution of white noise

4. Now select the "CCDF" measurement function from the "Select Measurement" dialog box.



Figure 3-44: CCDF of white noise

The CCDF trace indicates the probability that a level will exceed the mean power. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.

### 3.7.8 Optimizing and troubleshooting the measurement

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

- Make sure the defined bandwidth is wide enough for the signal bandwidth of the device under test to be fully analyzed (see ["Analysis Bandwidth"](#) on page 163).
- If the complete signal is to be measured, increase the number of samples so that the resulting measurement time is longer than one period of a burst signal.
- If only parts of the signal are to be examined, define a trigger source and a gate.

## 3.8 Time domain power measurement

The Time Domain Power measurement determines the power of a signal in the time domain.

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



|   |     |
|---|-----|
| • <a href="#">About the measurement</a> .....   | 173 |
| • <a href="#">Time domain power results</a> .....                                     | 173 |
| • <a href="#">Time domain power basics - range definition using limit lines</a> ..... | 174 |
| • <a href="#">Time domain power configuration</a> .....                               | 174 |
| • <a href="#">How to measure powers in the time domain</a> .....                      | 176 |
| • <a href="#">Measurement example</a> .....   | 177 |

### 3.8.1 About the measurement

Using the Time Domain Power measurement function, the R&S ESW determines the power of the signal in zero span by summing up the power at the individual measurement points and dividing the result by the number of measurement points. Thus it is possible to measure the power of TDMA signals during transmission, for example, or during the muting phase. Both the mean power and the RMS power can be measured.

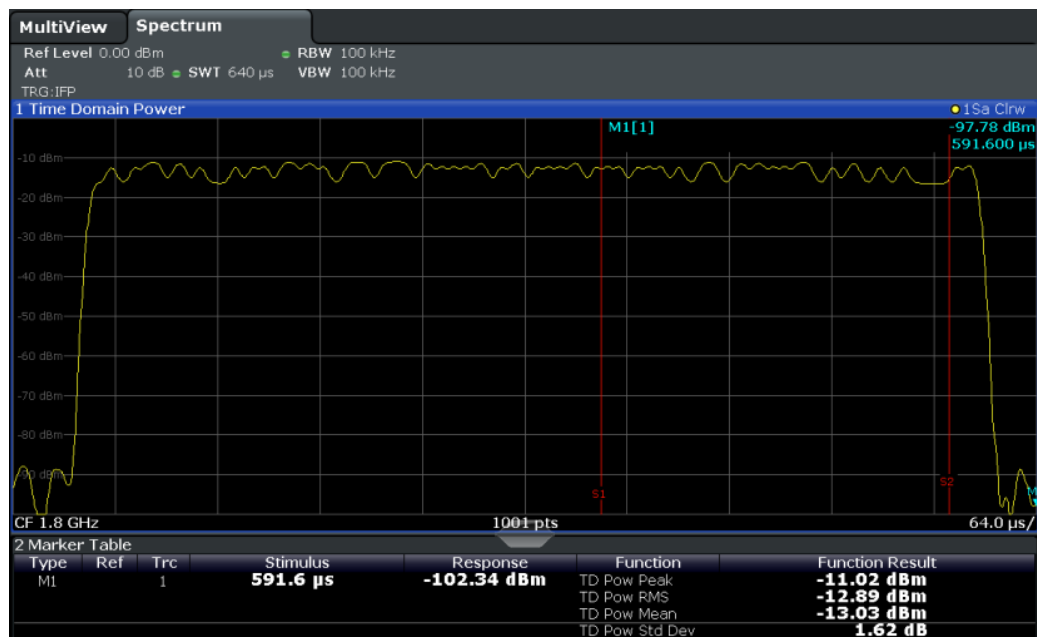
For this measurement, the sample detector is recommended. The sample detector is activated automatically if the detector is in auto mode.

### 3.8.2 Time domain power results

Several different power results can be determined simultaneously:

| Mode    | Description   |
|---------|---|
| Peak    | Peak value from the points of the displayed trace or a segment thereof.   |
| RMS     | RMS value from the points of the displayed trace or a segment thereof.  |
| Mean    | Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated.<br><br>For example to measure the mean power during a GSM burst |
| Std Dev | The standard deviation of the measurement points from the mean value.   |

The result is displayed in the marker results, indicated by "Power" and the selected power mode, e.g. "RMS". The measured values are updated after each sweep or averaged over a user-defined number of sweeps (trace averaging).



The results can also be queried using the remote commands described in [Chapter 6.7.9, "Time domain power"](#), on page 580.

### 3.8.3 Time domain power basics - range definition using limit lines

The range of the measured signal to be evaluated for the power measurement can be restricted using limit lines. The left and right limit lines (S1, S2) define the evaluation range and are indicated by vertical red lines in the diagram. If activated, the power results are only calculated from the levels within the limit lines.

For example, if both the on and off phase of a burst signal are displayed, the measurement range can be limited to the transmission or to the muting phase. The ratio between signal and noise power of a TDMA signal for instance can be measured by using a measurement as a reference value and then varying the measurement range.



In order to get stable measurement results for a limited evaluation range, usually a trigger is required.

### 3.8.4 Time domain power configuration

**Access:** "Overview" > "Select Measurement" > "Time Domain Power" > "Time Dom Power Config"

Time Domain Power

X

Results

|         |    |     |
|---------|----|-----|
| Peak    | On | Off |
| RMS     | On | Off |
| Mean    | On | Off |
| Std Dev | On | Off |

Limits

|       |    |     |
|-------|----|-----|
| State | On | Off |
| Left  |    |     |
| Right |    |     |

The remote commands required to perform these tasks are described in [Chapter 6.7.9.1, "Measurement configuration"](#), on page 580.

|  |     |
|--|-----|
| <a href="#">Results</a> .....                  | 175 |
| <a href="#">Limit State</a> .....              | 176 |
| <a href="#">Left Limit / Right Limit</a> ..... | 176 |

**Results**

Activates the power results to be evaluated from the displayed trace or a limited area of the trace.

|        |   |
|--------|---|
| "Peak" | Peak power over several measurements (uses trace averaging, Max Hold)   |
| "RMS"  | RMS value from the points of the displayed trace or a segment thereof.  |
| "Mean" | Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated. |

"Std Dev"      The standard deviation of the measurement points from the mean value.  
 The measurement of the mean power is automatically switched on at the same time.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak[:STATe]` on page 582

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:RESult?` on page 585

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS[:STATe]` on page 582

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:RESult?` on page 586

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN[:STATe]` on page 581

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:RESult?` on page 584

### Limit State

Switches the limitation of the evaluation range on or off. Default setting is off.

If deactivated, the entire sweep time is evaluated. If switched on, the evaluation range is defined by the left and right limit. If only one limit is set, it corresponds to the left limit and the right limit is defined by the stop frequency. If the second limit is also set, it defines the right limit.

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 726

### Left Limit / Right Limit

Defines a power level limit for line S1 (left) or S2 (right).

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 725

`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 725

## 3.8.5 How to measure powers in the time domain

The step-by-step procedure to measure powers in the time domain is described here in detail.

### To measure the power in the time domain

1. Select [MEAS].
2. From the "Select Measurement" dialog box, select the "Time Domain Power" measurement function.
3. Select the type of power measurement results to be determined by selecting the corresponding softkeys.
4. To restrict the power evaluation range, define limits:
  - a) Select "Time Dom Power Config" to display the "Time Domain Power" configuration dialog box.
  - b) Switch on the limits by setting the "Limit State" to "On".  
The limit lines S1 and S2 are displayed.
  - c) Define the left limit (limit line S1), the right limit (S2), or both.

5. Start a sweep.

The measured powers are displayed in the marker results.

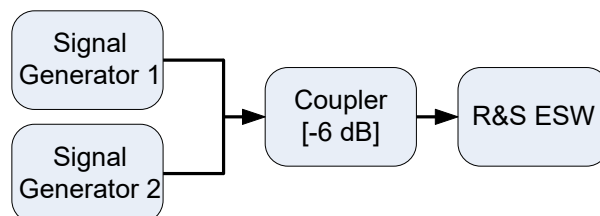
### 3.8.6 Measurement example

This measurement example demonstrates the time domain power calculation for a GSM burst.



For remote operation, see [Chapter 6.7.9.4, "Programming example: time domain power"](#), on page 588.

#### Test setup:



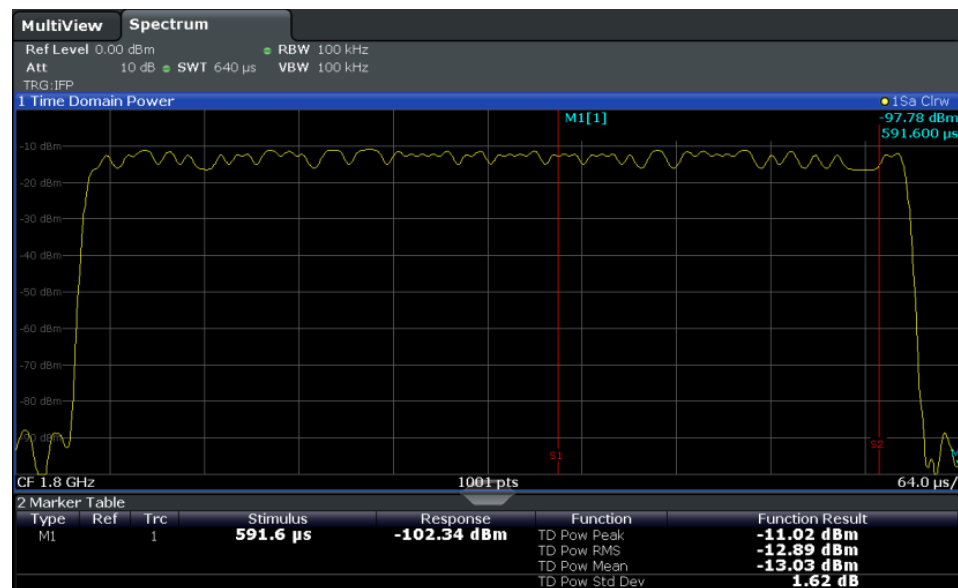
#### Signal generator settings (e.g. R&S SMW):

|             |          |
|-------------|----------|
| Frequency:  | 1.8 GHz  |
| Level:      | -10 dBm  |
| Modulation: | GSM/EDGE |

#### Procedure:

1. Preset the R&S ESW.
2. Set the center frequency to *1.8 GHz*.
3. Set the RBW to *100 kHz*.
4. Set the sweep time to *640 μs*.
5. Set the trigger source to "IF Power".
6. Define a trigger offset of *-50 μs*.
7. Select the "Time Domain Power" measurement function from the "Select Measurement" dialog box.
8. In the Time Domain Power configuration dialog box, set all four results to "On".
9. Set the "Limit State" to "On".
10. Define the left limit at *326 μs* and the right limit at *538 μs*.  
This range corresponds to the useful part of the GSM burst.

The mean power of the useful part of the GSM burst is calculated to be -13 dBm.



### 3.9 Harmonic distortion measurement

The "Harmonic Distortion" measurement measures harmonics and their distortion, including the total harmonic distortion.

- [About the measurement](#)..... 178
- [Harmonic distortion basics](#)..... 179
- [Harmonic distortion results](#)..... 181
- [Harmonic distortion configuration](#)..... 182
- [How to determine the harmonic distortion](#)..... 184

#### 3.9.1 About the measurement

With this measurement it is possible to measure the harmonics easily, for example from a VCO. In addition, the total harmonic distortion (THD) is calculated.

For measurements in the frequency domain, the Harmonic Distortion measurement starts with an automatic search for the first harmonic (= peak) within the set frequency range. The center frequency is set to this frequency and the reference level is adjusted accordingly.

For measurements in zero span, the center frequency remains unchanged.

The Harmonic Distortion measurement then performs zero span sweeps at the center frequency and at each harmonic, i.e. at frequencies that are a multiple of the center frequency.

As a result, the zero span sweeps on all harmonics are shown, as well as the RMS values and the total harmonic distortion (THD).



An application note discussing harmonics measurement is available from the Rohde & Schwarz website:

[1EF78: Measurement of Harmonics using Spectrum Analyzers](#)

### 3.9.2 Harmonic distortion basics

Measuring the harmonics of a signal is a frequent problem which can be solved best using a signal analyzer. In general, every signal contains harmonics. Harmonics are generated by nonlinear characteristics, which add frequencies to a pure sinewave. They can often be reduced by low pass filters. Since the signal analyzer itself has a nonlinear characteristic, for example in its first mixer, measures must be taken to ensure that harmonics produced in the signal analyzer do not cause spurious results. If necessary, the fundamental wave must be attenuated selectively with respect to the other harmonics with a high pass filter. Harmonics are particularly critical regarding high-power transmitters such as transceivers because large harmonics can interfere with other radio services.

Harmonic distortion can be determined as the level of the individual components, or as the root mean square of all components together, the total harmonic distortion (THD). The THD is set in relation to the power of the fundamental frequency (= center frequency).

#### Obtainable dynamic range

When harmonics are being measured, the obtainable dynamic range depends on the second harmonic intercept of the signal analyzer. The second harmonic intercept is the virtual input level at the RF input mixer at which the level of the 2nd harmonic becomes equal to the level of the fundamental wave. In practice, however, applying a level of this magnitude would damage the mixer. Nevertheless the available dynamic range for measuring the harmonic distance of a DUT can be calculated relatively easily using the second harmonic intercept.

As shown in [Figure 3-45](#), the level of the 2<sup>nd</sup> harmonic drops by 20 dB if the level of the fundamental wave is reduced by 10 dB.

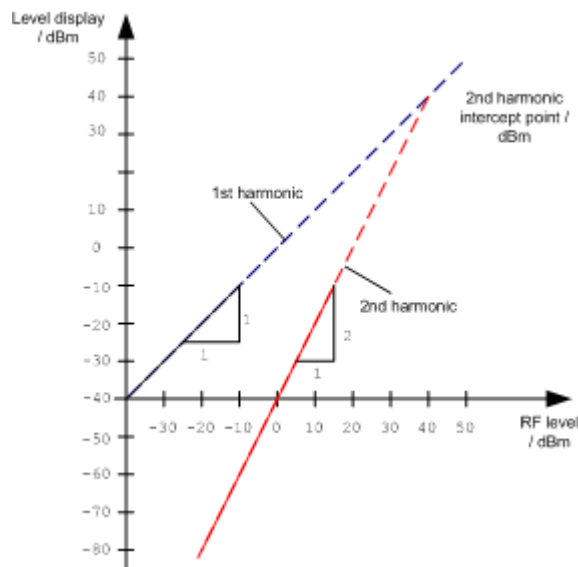


Figure 3-45: Extrapolation of the 1st and 2nd harmonics to the 2nd harmonic intercept at 40 dBm

The following formula for the obtainable harmonic distortion  $d_2$  in dB is derived from the straight-line equations and the given intercept point:

$$d_2 = \text{S.H.I.} - P_1 \quad (1)$$

where:

|        |   |                           |
|--------|---|---------------------------|
| $d_2$  | = | harmonic distortion       |
| S.H.I. | = | second harmonic intercept |
| $P_1$  | = | mixer level/dBm           |



The mixer level is the RF level applied to the RF input minus the set RF attenuation.

The formula for the internally generated level  $P_1$  at the 2<sup>nd</sup> harmonic in dBm is:

$$P_1 = 2 * P_1 - \text{S.H.I.} \quad (2)$$

The lower measurement limit for the harmonic is the noise floor of the signal analyzer. The harmonic of the measured DUT should – if sufficiently averaged by means of a video filter – be at least 4 dB above the noise floor so that the measurement error due to the input noise is less than 1 dB.

### Rules for measuring high harmonic ratios

The following rules for measuring high harmonic ratios can be derived:

- Select the smallest possible IF bandwidth for a minimal noise floor.
- Select an RF attenuation which is high enough to measure the harmonic ratio only.



The maximum harmonic distortion is obtained if the level of the harmonic equals the intrinsic noise level of the receiver. The level applied to the mixer, according to (2), is:

$$P_I = \frac{P_{noise} / dBm + IP2}{2}$$

At a resolution bandwidth of 10 Hz (noise level -143 dBm, S.H.I. = 40 dBm), the optimum mixer level is – 51.5 dBm. According to (1) a maximum measurable harmonic distortion of 91.5 dB minus a minimum S/N ratio of 4 dB is obtained.



#### Detecting the origin of harmonics

If the harmonic emerges from noise sufficiently (approx. >15 dB), it is easy to check (by changing the RF attenuation) whether the harmonics originate from the DUT or are generated internally by the signal analyzer. If a harmonic originates from the DUT, its level remains constant if the RF attenuation is increased by 10 dB. Only the displayed noise is increased by 10 dB due to the additional attenuation. If the harmonic is exclusively generated by the signal analyzer, the level of the harmonic is reduced by 20 dB or is lost in noise. If both – the DUT and the signal analyzer – contribute to the harmonic, the reduction in the harmonic level is correspondingly smaller.

#### High-sensitivity harmonics measurements

If harmonics have very small levels, the resolution bandwidth required to measure them must be reduced considerably. The sweep time is, therefore, also increased considerably. In this case, the measurement of individual harmonics is carried out with the R&S ESW set to a small span. Only the frequency range around the harmonics will then be measured with a small resolution bandwidth.

#### Required measurement time

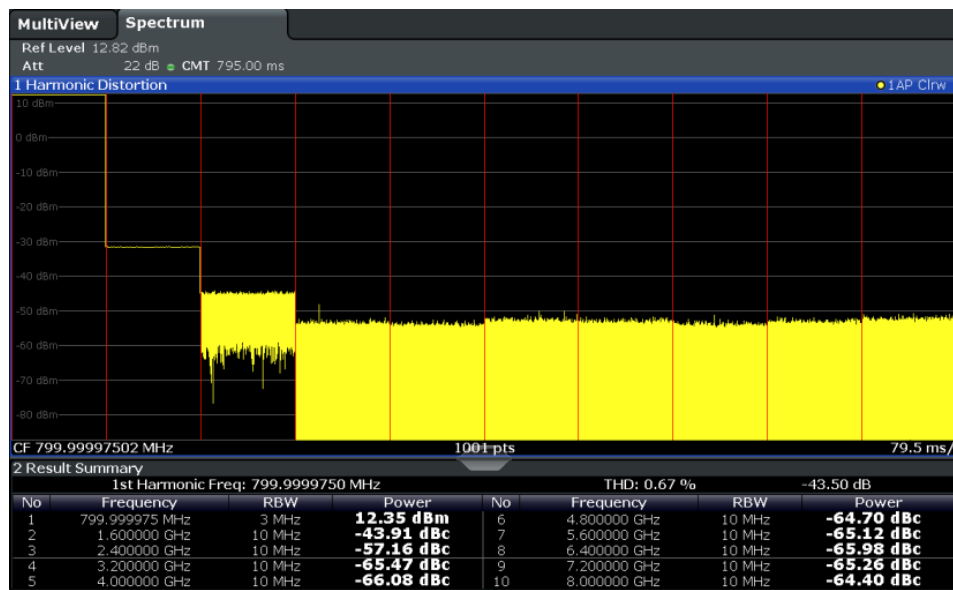
During the harmonics measurement, zero span sweeps are performed at the center frequency and at each harmonic. The duration of each sweep ("Harmonic Sweep Time", **SWT**) and the "Number of Harmonics" (n) are defined in the "Harmonic Distortion" configuration dialog box. Thus, the required measurement time for the harmonic distortion measurement (*Cumulated Measurement Time*, **CMT**) is:

$$CMT = n * SWT$$

The required measurement time is indicated as "CMT" in the channel bar.

### 3.9.3 Harmonic distortion results

As a result of the harmonics distortion measurement, the zero span sweeps of all detected harmonics are shown in the diagram, separated by red display lines. This provides a very good overview of the measurement.



In addition, a result table is displayed providing the following information:

- First harmonic frequency
- THD (total harmonic distortion), relative and absolute values
- For each detected harmonic:
  - Frequency
  - RBW
  - Power

### Remote commands

The results can also be queried using remote commands.

The first harmonic frequency can be read out via the general center frequency command `[SENSe:]FREQuency:CENTer` on page 652.

THD: `CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:DISTortion?`  
on page 591

List of harmonics: `CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:LIST`  
on page 591

## 3.9.4 Harmonic distortion configuration

**Access:** "Overview" > "Select Measurement" > "Harmonic Distortion" > "Harmonic Distortion Config"

| Harmonic Distortion |         |
|---------------------|---------|
| Number of Harmonics | 10      |
| Harmonic Sweep Time | 79.5 ms |
| Harmonic RBW Auto   | On      |
| Adjust Settings     |         |

The remote commands required to perform these tasks are described in [Chapter 6.7.10.2, "Measurement configuration"](#), on page 590.

|                          |     |
|--------------------------|-----|
| Number of Harmonics..... | 183 |
| Harmonic Sweep Time..... | 183 |
| Harmonic RBW Auto.....   | 183 |
| Adjust Settings.....     | 183 |

### Number of Harmonics

Defines the number of harmonics to be measured. The range is from 1 to 26. Default is 10.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:NHARmonics` on page 590

### Harmonic Sweep Time

Defines the sweep time for the zero span measurement on each harmonic frequency. This setting is identical to the normal sweep time for zero span, see also ["Sweep Time"](#) on page 306.

Remote command:

`[SENSe:]SWEep:TIME:AUTO` on page 672

### Harmonic RBW Auto

Enables/disables the automatic adjustment of the resolution bandwidth for Normal (3dB) (Gaussian) and 5-Pole filter types.

The automatic adjustment is carried out according to:

$$RBW_n = RBW_1 * n$$

If  $RBW_n$  is not available, the next higher value is used.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:BANDwidth:AUTO`  
on page 590

### Adjust Settings

If harmonic measurement was performed in the frequency domain, a new peak search is started in the frequency range that was set before starting the harmonic measurement. The center frequency is set to this frequency and the reference level is adjusted accordingly.

If harmonic measurement was performed in the time domain, this function adjusts the reference level only.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:PRESet` on page 590

### 3.9.5 How to determine the harmonic distortion



In [Chapter 5.4.6, "Measurement example: measuring harmonics using marker functions"](#), on page 430, measuring harmonics was described using marker functions. This task can be performed much simpler using the Harmonic Distortion measurement, as described in the following procedure.

For remote operation, see [Chapter 6.7.10.5, "Example: measuring the harmonic distortion"](#), on page 592.

1. Select the "Harmonic Distortion" measurement function from the "Select Measurement" dialog box.
2. Define the number of harmonics to be determined using "Number of Harmonics".
3. Perform a sweep.

The trace for the determined harmonics are displayed in the diagram, separated by red display lines. The measured power for each harmonic in relation to the fundamental is indicated in the result table.

4. If the signal changes significantly during or after the harmonics measurement, use the "Adjust Settings" function to adjust the settings automatically and restart the measurement.

## 3.10 Third order intercept (TOI) measurement

The third order intercept point of the R&S ESW can be determined if a two-tone signal with equal carrier levels is applied to the input.

`CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?` on page 593

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- [TOI basics](#)..... 185
- [TOI results](#)..... 189
- [TOI configuration](#)..... 190
- [How to determine the third order intercept](#)..... 191
- [Measurement example – measuring the R&S ESW's intrinsic intermodulation](#).... 192

### 3.10.1 About the TOI measurement

If several signals are applied to a two-port transmission device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals, which intermodulate at the characteristic. The intermodulation products of lower order have a special effect, since their level is largest and they are near the useful signals. The intermodulation product of third order causes the highest interference. It is the intermodulation product generated from one of the useful signals and the 2nd harmonic of the second useful signal for two-tone modulation.

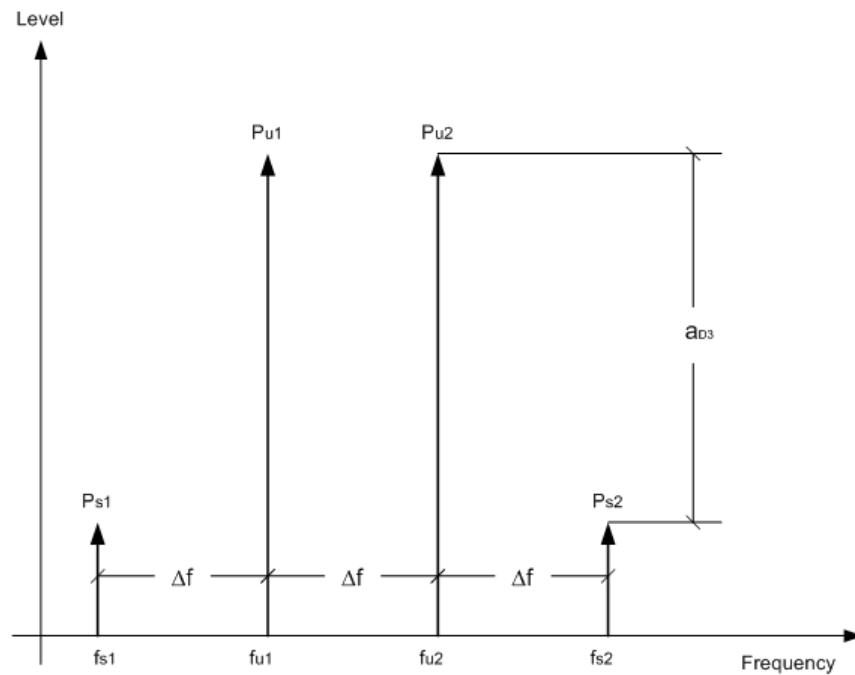
To measure the third order intercept point (TOI), a two-tone signal with equal carrier levels is expected at the R&S ESW input. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Marker 3 and marker 4 are placed on the intermodulation products.

The R&S ESW calculates the third order intercept point from the level difference between the first 2 markers and the markers 3 and 4, and displays it in the marker table.

### 3.10.2 TOI basics

If several signals are applied to a two-port transmission device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals, which intermodulate at the characteristic.

The frequencies of the intermodulation products are above and below the useful signals. [Figure 3-46](#) shows intermodulation products  $P_{S1}$  and  $P_{S2}$ , generated by the two useful signals  $P_{U1}$  and  $P_{U2}$ .



**Figure 3-46: Intermodulation products  $P_{s1}$  and  $P_{s2}$**

The intermodulation product at  $f_{i2}$  is generated by mixing the 2nd harmonic of useful signal  $P_{u2}$  and useful signal  $P_{u1}$ .

The intermodulation product at  $f_{i1}$  is generated by mixing the 2nd harmonic of useful signal  $P_{u1}$  and useful signal  $P_{u2}$ .

$$f_{i1} = 2 \times f_{u1} - f_{u2} \quad (1)$$

$$f_{i2} = 2 \times f_{u2} - f_{u1} \quad (2)$$

#### Dependency on level of useful signals

The level of the intermodulation products depends on the level of the useful signals. If the two useful signals are increased by 1 dB, the level of the intermodulation products increases by 3 dB. Thus, the spacing  $a_{D3}$  between intermodulation signals and useful signals is reduced by 2 dB, as shown in [Figure 3-47](#).

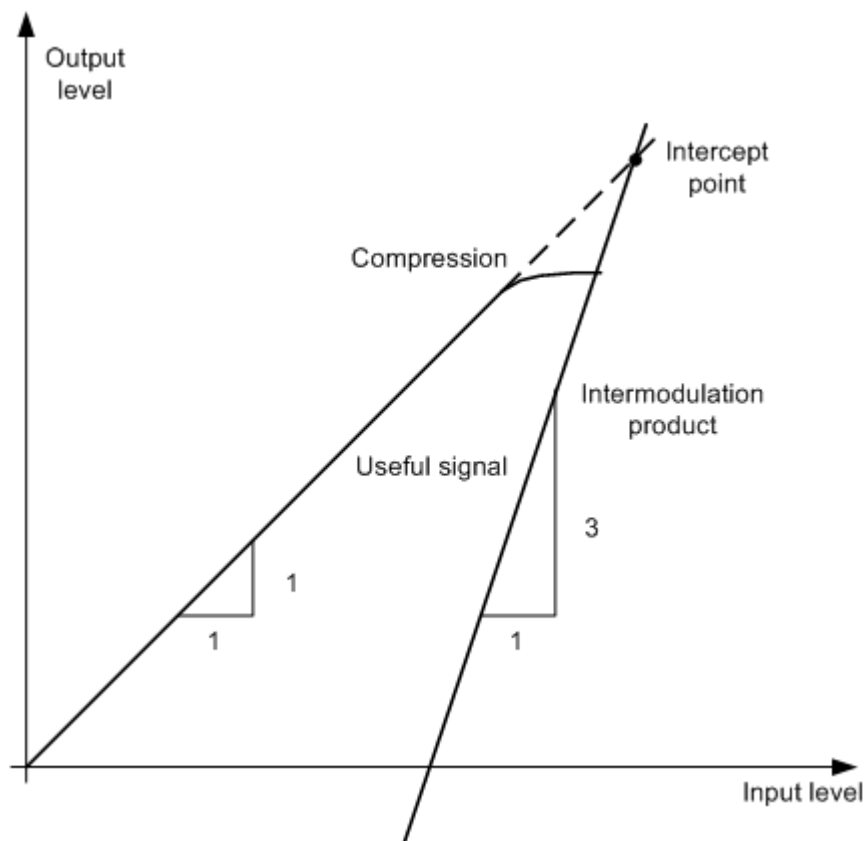


Figure 3-47: Dependency of intermodulation products on level of useful signals

The useful signals at the two-port output increase proportionally with the input level as long as the two-port is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. Beyond a certain input level, the two-port goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as quickly as the useful signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly, since the useful level is limited by the maximum two-port output power.

#### Calculation method

However, the intercept point can be calculated from the known line slopes and the measured spacing  $a_{D3}$  between intermodulation signals and useful signals at a given level  $P_U$  according to the following formula:

$$IP3 = \frac{a_{D3}}{2} + P_U$$

#### Example:

Assume that the measured spacing between intermodulation and useful signal is 60 dB at the input level  $P_U = -20$  dBm. Then the third order intercept point (TOI) is calculated according to the following formula:

$$IP3 = \frac{60}{2} + (-20\text{dBm}) = 10\text{dBm}$$

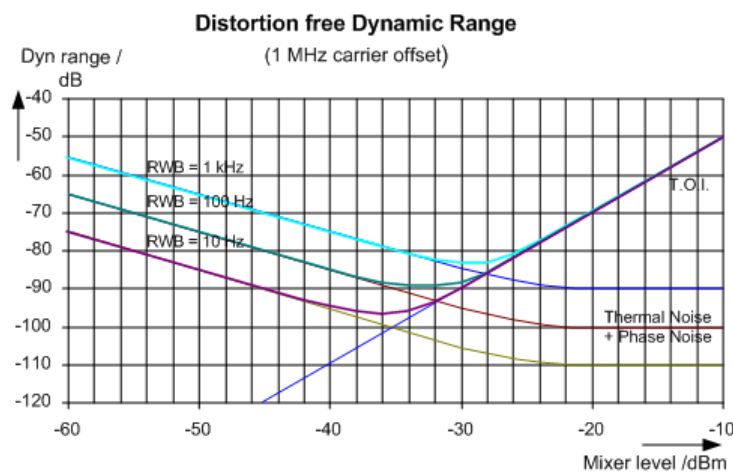
### Intermodulation-free dynamic range

The "Intermodulation-free dynamic range" is the level range in which no internal intermodulation products are generated if two-tone signals are measured. It is determined by the third order intercept point, the phase noise and the thermal noise of the signal analyzer. At high signal levels, the range is determined by intermodulation products. At low signal levels, intermodulation products disappear below the noise floor, i.e. the noise floor and the phase noise of the signal analyzer determine the range. The noise floor and the phase noise depend on the resolution bandwidth that has been selected. At the smallest resolution bandwidth, the noise floor and phase noise are at a minimum and so the maximum range is obtained. However, a large increase in sweep time is required for small resolution bandwidths. It is therefore best to select the largest resolution bandwidth possible to obtain the range that is required. Since phase noise decreases as the carrier-offset increases, its influence decreases with increasing frequency offset from the useful signals.

The following diagrams illustrate the intermodulation-free dynamic range as a function of the selected bandwidth and of the level at the input mixer (= signal level – set RF attenuation) at different useful signal offsets.



For typical values for your instrument, see the specifications document.



**Figure 3-48: Intermodulation-free range as a function of level at the input mixer and the set resolution bandwidth**

Sample values at 2 GHz:

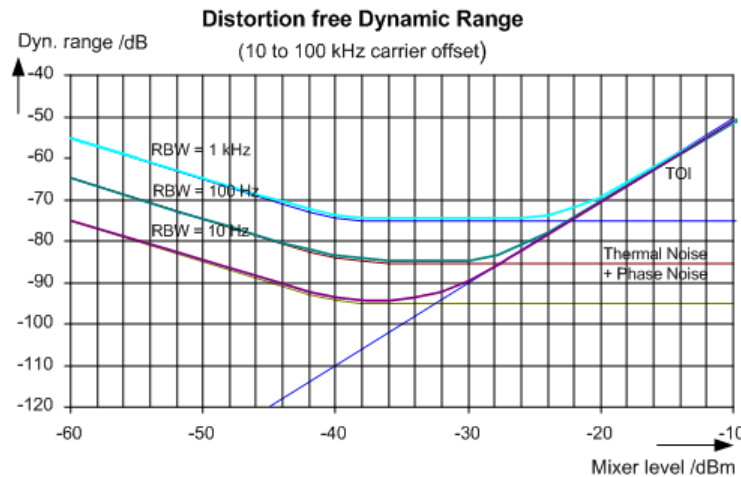
- Useful signal offset = 1 MHz
- DANL = -145 dBm/Hz
- TOI = 15 dBm



## Third order intercept (TOI) measurement

The optimum mixer level, i.e. the level at which the intermodulation distance is at its maximum, depends on the bandwidth. At a resolution bandwidth of 10 Hz, it is approx. -35 dBm. At 1 kHz, it increases to approx. -30 dBm.

Phase noise has a considerable influence on the intermodulation-free range at carrier offsets between 10 kHz and 100 kHz ( see [Figure 3-49](#)). At greater bandwidths, the influence of the phase noise is greater than it would be with small bandwidths. The optimum mixer level at the bandwidths under consideration becomes almost independent of bandwidth and is approx. -40 dBm.



**Figure 3-49: Intermodulation-free dynamic range as a function of level at the input mixer and of the selected resolution bandwidth**

Sample values at 2 GHz:

- Useful signal offset = 10 kHz to 100 kHz
- DANL = -145 dBm/Hz
- TOI = 15 dBm



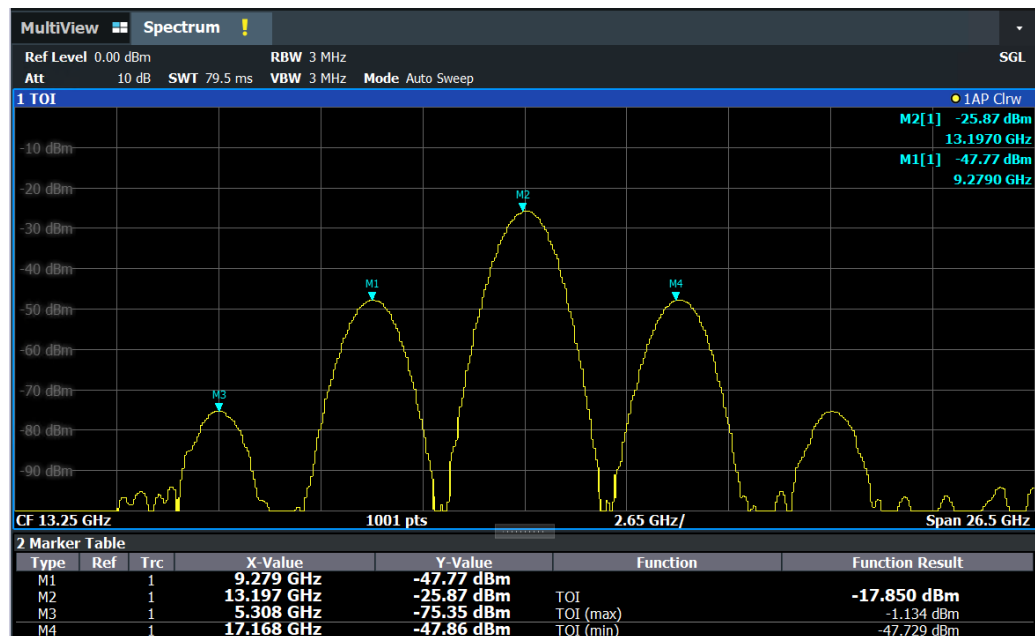
When you measure the intermodulation products of a DUT with a very high dynamic range, the used resolution bandwidth is usually very small. In this case, it is best to measure the levels of the useful signals and those of the intermodulation products separately, using a small span. The measurement time is reduced, in particular if the offset of the useful signals is large. To find signals reliably when the frequency span is small, it is best to synchronize the signal sources and the R&S ESW.

### 3.10.3 TOI results

As a result of the TOI measurement, the following values are displayed in the marker area of the diagram:

## Third order intercept (TOI) measurement

| Label     | Description   |
|-----------|---|
| TOI       | Third-order intercept point for averaged levels (see also <a href="#">Chapter 3.10.3, "TOI results"</a> , on page 189 and <a href="#">Figure 3-46</a> ):<br>$P_{U-AVG} + (P_{U-AVG} - P_{S-AVG})/2$ |
| TOI (max) | $P_{U-MAX} + (P_{U-MAX} - P_{S-MIN})/2$   |
| TOI (min) | $P_{U-MIN} + (P_{U-MIN} - P_{S-MAX})/2$   |
| M1        | Maximum of first useful signal  |
| M2        | Maximum of second useful signal   |
| M3        | First intermodulation product   |
| M4        | Second intermodulation product  |



## Remote command

The TOI can also be queried using the remote commands:

`CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?` on page 593.

`CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MAXimum?` on page 594

`CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MINimum?` on page 593

## 3.10.4 TOI configuration

**Access:** "Overview" > "Select Measurement" > "Third Order Intercept" > "TOI Config"

Third Order Intercept

X

|          |           |
|----------|-----------|
| Marker 1 | 2.634 GHz |
| Marker 2 | 5.281 GHz |
| Marker 3 | 2.634 GHz |
| Marker 4 | 7.929 GHz |

Search Signals

The remote commands required to perform these tasks are described in [Chapter 6.7.11, "Third order intercept point \(TOI\)"](#), on page 592.

[Marker 1/Marker 2/Marker 3/Marker 4](#)..... 191

[Search Signals](#)..... 191

**Marker 1/Marker 2/Marker 3/Marker 4**  
 Indicates the detected characteristic values as determined by the TOI measurement (see [Chapter 3.10.3, "TOI results"](#), on page 189).  
 The marker positions can be edited; the TOI is then recalculated according to the new marker values.  
 To reset all marker positions automatically, use the [Search Signals](#) function.  
 Remote command:  
[CALCulate<n>:MARKer<m>:X](#) on page 720  
[CALCulate<n>:DELTamarker<m>:X](#) on page 718  
[CALCulate<n>:DELTamarker<m>:X:RELative?](#) on page 734

**Search Signals**  
 Performs a new search on the input signals and recalculates the TOI according to the measured values.  
 Remote command:  
[CALCulate<n>:MARKer<m>:FUNCTION:TOI:SEARChsignal ONCE](#) on page 594

3.10.5 How to determine the third order intercept



The precise TOI for the R&S ESW in relation to the input signals is provided in the specifications document.

For remote operation, see [Chapter 6.7.11.2, "Programming example: measuring the TOI"](#), on page 595.

1. Apply a two-tone signal with equal carrier levels to the R&S ESW input.
2. On the R&S ESW, press [MEAS].

3. Select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

The calculated TOI is indicated in the marker information. The markers required for calculation are displayed in the marker table.

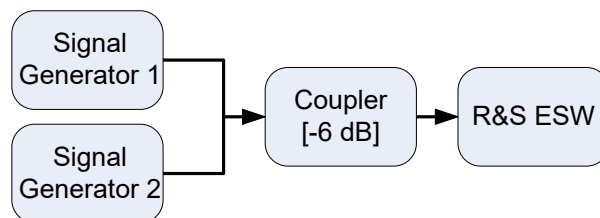
4. If the signal changes significantly during or after the TOI measurement, use the "Search Signals" function to start a new signal search automatically and restart the calculation of the TOI.

### 3.10.6 Measurement example – measuring the R&S ESW's intrinsic inter-modulation



A programming example demonstrating a TOI measurement in a remote environment is provided in [Chapter 6.7.11.2, "Programming example: measuring the TOI"](#), on page 595.

#### Test setup:



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

| Device             | Level  | Frequency |
|--------------------|--------|-----------|
| Signal generator 1 | -4 dBm | 799.6 MHz |
| Signal generator 2 | -4 dBm | 800.4 MHz |

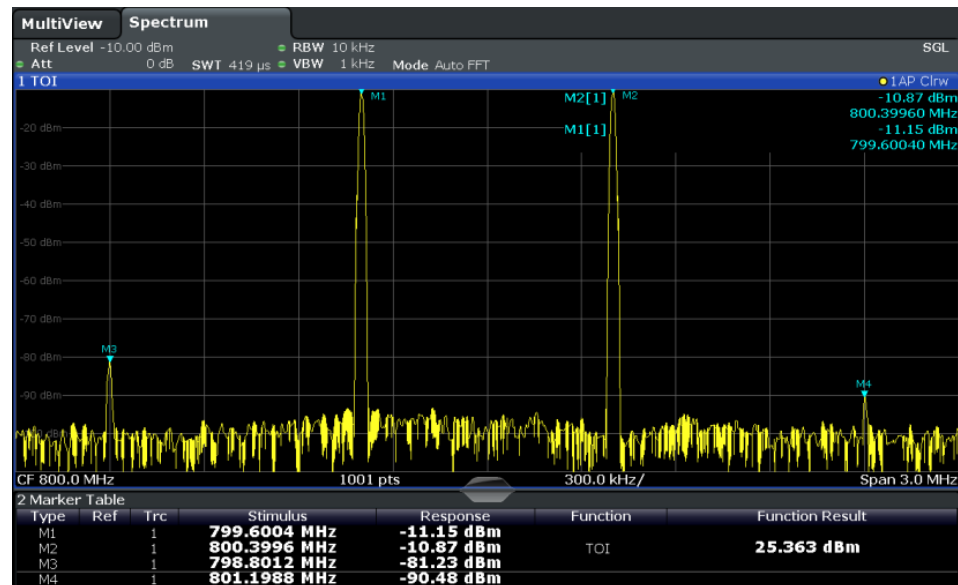
#### Setting up the measurement

1. Preset the R&S ESW.
2. Set the center frequency to *800 MHz* and the frequency span to *3 MHz*.
3. Set the reference level to *-10 dBm* and RF attenuation to *0 dB*.
4. Set the resolution bandwidth to *10 kHz*.  
The noise is reduced, the trace is smoothed further and the intermodulation products can be seen clearly.
5. Set the VBW to *1 kHz*.

### Measuring intermodulation using the Third Order Intercept (TOI) measurement function

1. Select [MEAS] > "Third Order Intercept".

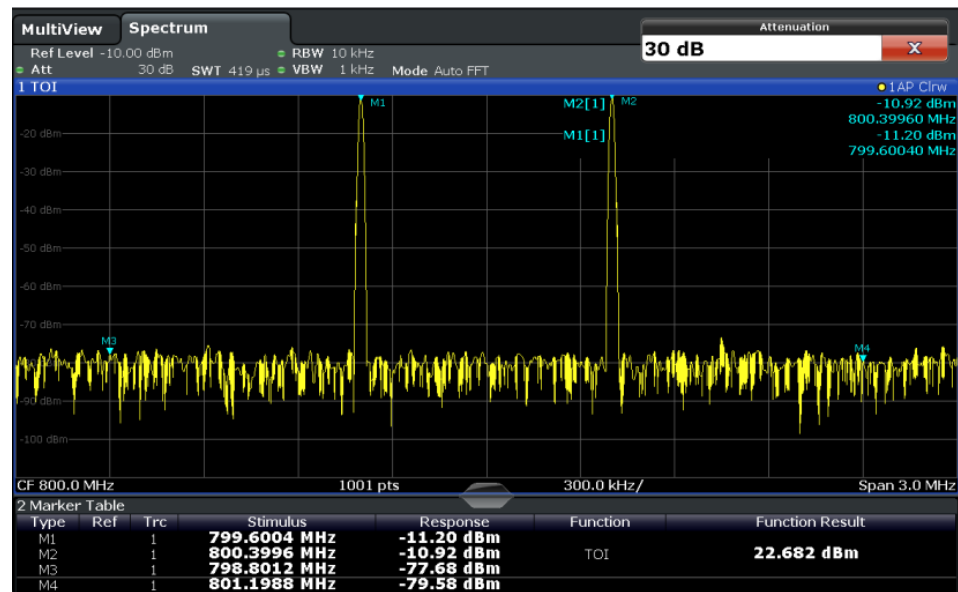
The R&S ESW activates four markers to measure the intermodulation distance. Two markers are positioned on the useful signals and two on the intermodulation products. The TOI is calculated from the level difference between the useful signals and the intermodulation products. It is then displayed on the screen:



The third order intercept (TOI) is displayed in the marker information.

2. The level of a signal analyzer's intrinsic intermodulation products depends on the RF level of the useful signals at the input mixer. When the RF attenuation is added, the mixer level is reduced and the intermodulation distance is increased. With an additional RF attenuation of 10 dB, the levels of the intermodulation products are reduced by 20 dB. The noise level is, however, increased by 10 dB. Increase the RF attenuation to 20 dB to reduce intermodulation products.

The R&S ESW's intrinsic intermodulation products disappear below the noise floor.



### 3.11 AM modulation depth measurement

This measurement determines the AM modulation depth of an AM-modulated carrier.

- [About the measurement](#).....194
- [AM modulation depth results](#).....195
- [AM modulation depth configuration](#).....195
- [Optimizing and troubleshooting the measurement](#).....196
- [How to determine the AM modulation depth](#).....197

#### 3.11.1 About the measurement

The AM modulation depth, also known as a modulation index, indicates how much the modulated signal varies around the carrier amplitude. It is defined as:

$$M_{\text{Depth}} = \text{peak signal amplitude} / \text{unmodulated carrier amplitude}$$

So for  $M_{\text{Depth}} = 0.5$ , for example, the carrier amplitude varies by 50% above and below its unmodulated level, and for  $M_{\text{Depth}} = 1.0$  it varies by 100%.

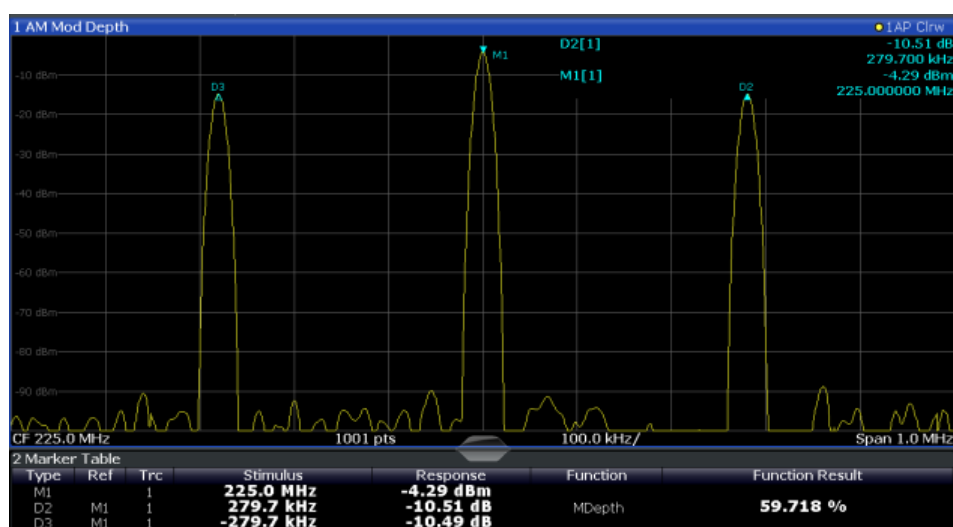
When this measurement is activated, marker 1 is set to the peak level, which is considered to be the carrier level. Delta markers 2 and 3 are automatically set symmetrically to the carrier on the adjacent peak values of the trace. The markers can be adjusted manually, if necessary.

The R&S ESW calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated as the ratio between the power values at the reference marker and at the delta markers. If the powers of the two AM side bands are unequal, the mean value of the two power values is used for AM modulation depth calculation.

### 3.11.2 AM modulation depth results

As a result of the AM Modulation Depth measurement, the following values are displayed in the marker area of the diagram:

| Label  | Description  |
|--------|--|
| MDepth | AM modulation depth in percent                     |
| M1     | Maximum of the signal (= carrier level)            |
| D2     | Offset of next peak to the right of the carrier    |
| D3     | Offset of the next peak to the left of the carrier |



Remote command:

The AM modulation depth can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNCTION:MDEPTH:RESult<t>?` on page 596.

### 3.11.3 AM modulation depth configuration

**Access:** "Overview" > "Select Measurement" > "AM Modulation Depth" > "AM Mod Depth Config"

AM Modulation Depth

X

Marker 1

2.634 GHz

Marker 2

5.281 GHz

Marker 3

0.0 Hz

Search Signals

The remote commands required to perform these tasks are described in [Chapter 6.7.12, "AM modulation depth"](#), on page 596.

|  |     |
|--|-----|
| <a href="#">Marker 1/Marker 2/Marker 3</a> ..... | 196 |
| <a href="#">Search Signals</a> .....             | 196 |

### Marker 1/Marker 2/Marker 3

Indicates the detected characteristic values as determined by the AM Modulation Depth measurement:

| Marker | Description  |
|--------|--|
| M1     | Maximum of the signal (= carrier level)            |
| D2     | Offset of next peak to the right of the carrier    |
| D3     | Offset of the next peak to the left of the carrier |

The marker positions can be edited; the modulation depth is then recalculated according to the new marker values.

To reset all marker positions automatically, use the [Search Signals](#) function.

**Note:** Moving the marker positions manually. When the position of delta marker 2 is changed, delta marker 3 is moved symmetrically with respect to the reference marker 1.

Delta marker 3, on the other hand, can be moved for fine adjustment independently of marker 2.

Marker 1 can also be moved manually for re-adjustment without affecting the position of the delta markers.

Remote command:

[CALCulate<n>:MARKer<m>:X](#) on page 720

[CALCulate<n>:DELTamarker<m>:X](#) on page 718

[CALCulate<n>:DELTamarker<m>:X:RELative?](#) on page 734

### Search Signals

Performs a new search on the input signal and recalculates the AM Modulation Depth according to the measured values.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:SEARChsignal ONCE](#)  
on page 596

## 3.11.4 Optimizing and troubleshooting the measurement

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

- Set the center frequency to the frequency of the device under test.
- Adjust the span so the peaks to the left and right of the carrier, produced by the AM modulated signal, are clearly visible.  
If the span is too wide, these signals may fall together with the carrier and the measurement can not be performed.



If the span is too narrow, these signals are outside of the measured span and the delta markers can not find these peaks.

The rule of thumb is to set the span to three times the value of the AM modulation frequency.

### 3.11.5 How to determine the AM modulation depth

The following step-by-step instructions demonstrate how to determine the AM modulation depth.



For remote operation, see [Chapter 6.7.12.2, "Example: measuring the AM modulation depth"](#), on page 597.

1. Apply a modulated carrier signal to the R&S ESW input.
2. On the R&S ESW, press [MEAS].
3. Select the "AM Modulation Depth" measurement function from the "Select Measurement" dialog box.  
The calculated AM Modulation Depth is indicated in the marker information. The markers required for calculation are displayed in the marker table.
4. If the signal changes significantly during or after the AM Modulation Depth measurement, use the "Search Signals" function to start a new peak search automatically and restart the calculation of the AM Modulation Depth.

## 3.12 Electromagnetic interference (EMI) measurement

The electromagnetic interference (EMI) measurement is suitable for measurements according to commercial and military electromagnetic compatibility (EMC) standards. The functionality of the measurement is particularly useful in research and development.

The EMI measurement features:

- EMI marker functionality
- Marker demodulation
- Measurement bandwidths and detectors for EMI measurements
- Logarithmic scaling of the frequency axis
- Additional predefined limit lines for EMC standards
- Predefined transducer factors
- LISN control
- [About the EMI measurement](#)..... 198
- [EMI measurement results](#)..... 198
- [EMI measurement basics](#)..... 200
- [EMI measurement configuration](#)..... 206

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|---|-----|
| • <a href="#">EMI result analysis</a> .....   | 214 |
| • <a href="#">How to perform EMI measurements</a> .....                             | 215 |
| • <a href="#">Measurement example: measuring radio frequency interference</a> ..... | 217 |
| • <a href="#">Optimizing and troubleshooting EMI measurements</a> .....             | 219 |

### 3.12.1 About the EMI measurement

EMI measurements can be very time-consuming, especially if weighting detectors are required for the measurement. In addition, EMC testing often requires various procedures to locate local EMI maxima. Such procedures are, for example, movements of an absorbing clamp, variations in the height of the test antenna or the rotation of the DUT.

Covering all test setups with one of the (slow) EMI weighting detectors over the required frequency range can lead to very long measurement times.

Splitting the measurement procedure into several stages, however, can eliminate this problem.

The first stage is a peak search, used to get a rough idea about the location of peak levels that can indicate interference over the required frequency range. This stage uses a detector that allows for a fast sweep time, e.g. the peak detector.

During the second stage, or final test, the R&S ESW performs the actual EMC test, a refined measurement with detectors designed for and required by EMC standards. To keep measurement times brief, the R&S ESW performs a final measurement only on frequencies you have marked with a marker or delta marker. You can assign a different detector to every marker and thus test a particular frequency easily for compliance.

Optionally, you can activate continuous demodulation of the signal during the initial measurement and at the peak marker positions during the final test.

After the final measurement, you can check the signal levels against specified limits.

### 3.12.2 EMI measurement results

As the result of an EMI measurement, the measured signal levels and active markers are displayed in a Spectrum diagram.

## Electromagnetic interference (EMI) measurement

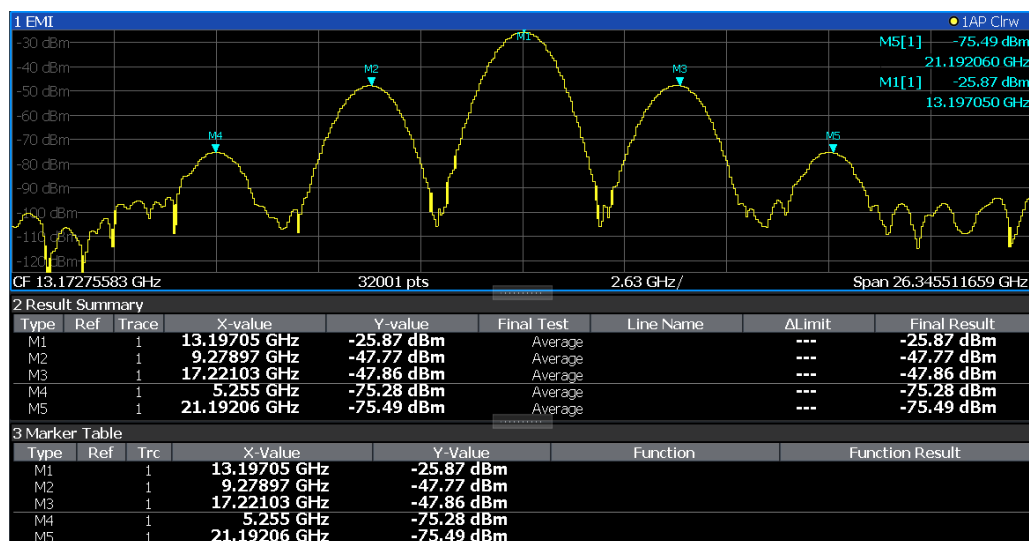


Figure 3-50: EMI measurement results

## Initial peak search results - Marker Table

As a result of the initial peak search, the active markers are set to the positive peaks of the measured signal.

If **auto peak search** and **limit lines** are active, the active markers are set to the peak **delta** values between the measured signal and the limit lines.

The active marker levels and positions are displayed in the **Marker Table**.



The marker results are also displayed in the Result Summary; in addition, the Marker Table contains the marker results for those markers for which no final EMI test is performed.

## Final test results - Result Summary

The results of the final EMI tests at the active marker frequencies are displayed in the **Result Summary**.

The Result Summary provides the following information:

| Label      | Description                                       |
|------------|---|
| Type       | Marker name                                       |
| Ref        | Reference marker for delta markers                |
| Trace      | Assigned trace                                    |
| X-value    | Marker x-value (frequency for final test)         |
| Y-value    | Marker y-value (level during initial measurement) |
| Final Test | Detector used for final EMI test                  |
| Line name  | Line activated for limit check                    |

| Label          | Description  |
|----------------|--|
| $\Delta$ Limit | Delta between measured level and limit line (if active)<br>The value is colored to indicate the following states: <ul style="list-style-type: none"> <li>• <b>green</b>: does not exceed limit</li> <li>• <b>yellow</b>: within margin</li> <li>• <b>red</b>: exceeds limit</li> </ul> |
| Final Result   | Value measured during final EMI test using specified detector at marker frequency  |

### 3.12.3 EMI measurement basics

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

- [Resolution bandwidth and filter types](#)..... 200
- [Detectors and dwell time](#)..... 201
- [Frequency resolution - sweep points and scaling](#)..... 202
- [Controlling V-Networks \(LISN\)](#)..... 203
- [Using transducer factors](#)..... 203
- [Initial measurement - peak search](#)..... 204
- [Final measurement at the marker position](#)..... 205
- [Limit checks](#)..... 205

#### 3.12.3.1 Resolution bandwidth and filter types

EMI testing requires resolution filters with a 6 dB bandwidth. The EMI measurement adds the following bandwidths, which comply to commercial and military standards, to those already available with the base unit:

Commercial (CISPR, FFC etc.)

- 200 Hz
- 9 kHz
- 120 kHz
- 1 MHz (not with quasi-peak detector, see ["Quasi-peak detector \(CISPR filter only\)"](#) on page 201)

Military (MIL Std)

- 10 Hz
- 100 Hz
- 1 kHz
- 10 kHz
- 100 kHz
- 1 MHz

If you select a CISPR or MIL filter type, the corresponding RBW that is closest to the currently selected RBW value is used. In this case, the channel bar indicates "RBW (CISPR)".

For the quasi-peak, CISPR Average, or RMS Average detector, the bandwidth is fixed depending on the frequency. For more information, see [Chapter 3.12.3.2, "Detectors and dwell time"](#), on page 201.

### 3.12.3.2 Detectors and dwell time

The EMI measurement adds new detectors to those already available with the base unit. The additional detectors are especially designed for and required by EMI applications.

See:

- ["Quasipeak detector"](#) on page 350
- ["CISPR average detector"](#) on page 351
- ["RMS average detector"](#) on page 351

The detector to be used for the initial peak search is configured in the trace settings (see [Chapter 5.3.2.1, "Trace settings"](#), on page 366). The detector for the final test is configured in the EMI marker settings, see [Chapter 3.12.4.1, "EMI marker configuration"](#), on page 206.

#### Dwell time

EMC tests often require a specific *dwell time* for an EMI measurement. The dwell time defines how long the R&S ESW measures the signal at the individual frequencies. Each detector needs a different period of time to fully charge and discharge. For details on defining the dwell time for an EMI measurement, see ["Defining a dwell time for the final measurement"](#) on page 205.

#### RMS detector

The RMS detector displays the root mean square (RMS) value over the specified dwell time. The integration time is the specified dwell time.

See ["RMS detector"](#) on page 348

#### Sample detector

The sample detector displays the last value from the samples allocated to a pixel.

The sample detector is used for noise or phase noise marker calculation. However, it is unreliable if the displayed span is much greater than the resolution bandwidth or if the tuning steps of the local oscillator are too large. The sample detector is not recommended for EMI tests.

See ["Sample detector"](#) on page 350

#### Quasi-peak detector (CISPR filter only)

See ["Quasipeak detector"](#) on page 350

#### CISPR Average detector (CISPR filter only)

See ["CISPR average detector"](#) on page 351

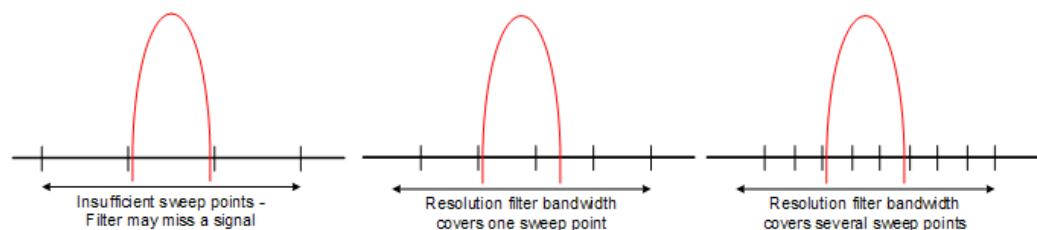
**RMS Average detector (CISPR filter only)**

See ["RMS average detector"](#) on page 351

**3.12.3.3 Frequency resolution - sweep points and scaling**

The number of sweep points defines the number of measurement values collected during one sweep. Thus, increasing the sweep points also increases the accuracy of the results regarding the frequency resolution.

Because EMI measurements often cover a large frequency range, be sure to define an adequate number of sweep points, especially when performing the measurement on a logarithmic axis. As on a linear axis, the distance from one sweep point to the next is calculated graphically on a logarithmic axis, and is not based on the frequency itself. Thus, the frequency resolution between two sweep points deteriorates with higher frequencies.

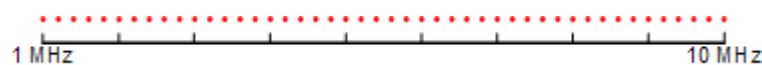


The resolution bandwidth should cover at least one sweep point (more is better). If this condition is not met, signals or interferences can be missed during refined measurement of narrowband interferers. If the distance between two sweep points is larger than  $RBW/2$ , a warning is displayed in the status bar ("Increase Sweep Points"). If possible for the selected RBW and span, the minimum required number of sweep points to fulfill this condition is indicated. If the number of sweep points exceeds the limit, reduce the span or increase the RBW.

The R&S ESW EMI measurement supports a maximum of 512001 sweep points.

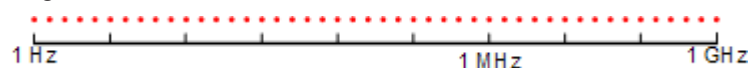
**Example:**

Linear axis:



With a linear axis, the distance between the sweep points is equal, e.g. 200 kHz.

Logarithmic axis:



With a logarithmic axis, the distance between sweep points is variable. In the spectrum from 10 Hz to 100 Hz, the distance is a few Hz. Between 100 MHz and 1 GHz, the distance is several MHz.

This number is based on typical bands measured with a single resolution bandwidth. There are sufficient sweep points to make sure that a signal is found during the refined

measurement, even when covering 30 MHz to 1 GHz with logarithmic scaling and 120 kHz RBW.

#### 3.12.3.4 Controlling V-Networks (LISN)

For measurements on power lines, EMI measurement adds functionality to the R&S ESW to control a line impedance stabilization network (LISN) directly. Thus you can determine the interference caused by power supplies and cables.

You can connect the LISN to the user port of the R&S ESW. Control cables for the various LISNs are available as accessories. The R&S ESW then controls which phase of the LISN is to be tested and outputs the information to the user port.

The EMI measurement supports several V-networks. For each type of network, you can define the phase you want to test for interferences. The EMI measurement allows you to test one phase at a time.

**Table 3-15: Supported networks and phases**

| Network type                | Phases        |
|-----------------------------|---------------|
| <b>Two-line V-networks</b>  |               |
| ESH3-Z5                     | N, L1         |
| ENV216 / AMN6500            | N, L1         |
| <b>Four-line V-networks</b> |               |
| ESH2-Z5                     | N, L1, L2, L3 |
| ENV4200                     | N, L1, L2, L3 |
| ENV432                      | N, L1, L2, L3 |

For the ENV216 / AMN6500 network, a 150 kHz highpass filter is available to protect the input of the R&S ESW.

#### 3.12.3.5 Using transducer factors

The R&S ESW EMI measurement provides functionality to include transducer factors in the test setup. Transducers are devices like antennas, probes or current probes that are connected to the R&S ESW to measure interferences or wanted signals. The transducer converts the measured value such as field strength, current or RFI voltage into a voltage across 50  $\Omega$ . During the measurement, the transducer is considered a part of the instrument.

A transducer usually has a frequency-dependent transducer factor that includes the frequency response of the corresponding device. During level measurement, the transducer factor automatically converts the results into the correct unit and magnitude. A transducer factor consists of a maximum of 1001 reference values. Each reference value includes frequency, unit and level.

For more information about transducer factors, see the user manual of the R&S ESW.

### 3.12.3.6 Initial measurement - peak search

The purpose of an initial peak search is to find signals with a high interference level quickly. The peak search is performed with a fast detector like the peak or average detector. The initial peak search is the basis for a possible refined measurement of interferences with the detectors specific to EMI measurements.

The results of the initial peak search are shown in the Marker Table (see [Chapter 3.12.2, "EMI measurement results"](#), on page 198).

Peak searches can be performed automatically or manually.

#### Automatic peak search

If enabled, the automatic peak search starts as soon as you select the EMI measurement and one or more markers are active. During automatic peak search, the R&S ESW looks for the strongest peaks in the frequency range you are measuring and positions a marker on those peaks after each sweep. If a **limit line** is assigned to the trace, the peak search is based on the level difference between the trace and the limit line. For each active marker, a peak is searched. You can use up to 16 markers simultaneously.

The largest peak is always assigned to the active marker with the lowest number; subsequent peaks are assigned to the active markers in ascending order.

The R&S ESW allows you to distribute markers among several traces. If you do so, the marker with the lowest number assigned to a particular trace is positioned on the largest peak of the corresponding trace.

#### Manual peak search

If automatic peak search is off, you can set the markers to any frequency you need more information about manually. You can change the marker position with the rotary knob or the cursors, or position it to a particular frequency with the numbers.

Setting markers is the same as setting markers in other spectrum measurements. For more information, see [Chapter 5.4.2, "Marker settings"](#), on page 395.

#### Searching for peaks over several traces

You can search for peaks on six traces simultaneously with a different weighting detector for each trace.

In this case, the R&S ESW searches for peaks on all traces separately, if you have assigned at least one marker to each trace.

A typical selection for EMI measurement is to use the peak and the average detector. After initial measurement, search for peaks on the peak trace and the average trace separately. Thus, you can consider the distribution of narrowband and wideband sources of interference.



**Example:**

- In the initial measurement, determine the peak on one trace using the average detector by assigning a marker to that trace. For the marker frequency, perform a refined measurement using the CISPR or RMS average detector.
- In the initial measurement, determine the peak on another trace using the peak detector by assigning another marker to that trace. For this marker frequency, perform a refined measurement using the quasi-peak detector.

**3.12.3.7 Final measurement at the marker position**

Finding peaks with the help of an initial marker peak search reduces data to be evaluated and thus measurement time. A final measurement with a special EMI detector can then refine the initial results.

The R&S ESW EMI measurement performs the final measurement automatically as soon as a detector for the final test is defined for an EMI marker and the marker is activated. The final measurement starts immediately after the marker has been set. The advantage of an immediate final measurement is that it eliminates the risk of measurement errors based on frequency drifts of the disturbance signal.

The final measurement at the marker frequency can have a different detector than during the initial peak search. Thus, the final measurement consumes much less time because detectors with a long measurement time are needed only at the critical frequency.

The R&S ESW EMI measurement also allows you to use multiple detectors for the final measurement. The advantage of multiple detections is that you only need one test run to see if the results comply with the limits specified in a standard. The detectors for the final EMI tests are defined in the marker configuration, as opposed to the *trace* detector which is used for the initial peak search.

The results of the final measurement are shown in the Result Summary (see [Chapter 3.12.2, "EMI measurement results"](#), on page 198).

**Defining a dwell time for the final measurement**

EMC tests often require a specific *dwell time* for an EMI measurement. The dwell time defines how long the R&S ESW measures the signal at the frequencies of the marker positions. The dwell time is identical for all EMI final measurements and is thus defined in the EMI measurement configuration. Select a dwell time according to the characteristics of the measured signal. See also [Chapter 3.12.3.2, "Detectors and dwell time"](#), on page 201.

**3.12.3.8 Limit checks**

General limit line functionality is provided by the R&S ESW base unit. The base unit also provides various predefined limit lines that you can use for various applications.

When using limit lines in combination with EMI measurements, the marker levels from the initial measurement are compared to the limit line values. The result of the limit line check is displayed in the diagram as usual.

In the EMI Result Summary, the limit check is based on the results of the final test. Since the marker can be determined using a different detector than the final test results, the two limit check results can differ. The difference between the limit line and the measured value is colored to indicate the following states:

- **green:** does not exceed limit
- **yellow:** within margin
- **red:** exceeds limit

For more information on using limit lines, see [Chapter 5.5.2.1, "Basics on limit lines"](#), on page 434.

### 3.12.4 EMI measurement configuration

**Access:** "Overview" > "Select Measurement" > "EMI" > "EMI Config"

On the R&S ESW, EMI measurement configuration consists of the following settings.

In addition, some common settings are also relevant for EMI measurements:

- [Chapter 5.5.2.2, "Limit line settings and functions"](#), on page 439
- [EMI marker configuration](#).....206
- [EMI final measurement configuration](#).....209
- [LISN control settings](#).....213

#### 3.12.4.1 EMI marker configuration

**Access:** [MKR] > "Marker Config"

The final peak search for the EMI measurement is defined by the marker configuration.

| Markers         | Marker Settings |        | Search     | Marker Functions |            |                |       |                     |  |
|-----------------|-----------------|--------|------------|------------------|------------|----------------|-------|---------------------|--|
| 1-5             | Selected        | State  | X-Value    | Type             | Ref Marker | Link to Marker | Trace | Final Test Detector |  |
|                 | Marker 1        | On Off | 3.75 GHz   | Norm Delta       |            | Off            | 1     | Off                 |  |
| 6-11            | Delta 1         | On Off | -750.0 MHz | Norm Delta       | 1          | Off            | 1     | Off                 |  |
|                 | Delta 2         | On Off | -750.0 MHz | Norm Delta       | 1          | Off            | 1     | Off                 |  |
| 12-16           | Delta 3         | On Off | -750.0 MHz | Norm Delta       | 1          | Off            | 1     | Off                 |  |
|                 | Delta 4         | On Off | -750.0 MHz | Norm Delta       | 1          | Off            | 1     | Off                 |  |
|                 | Delta 5         | On Off | -750.0 MHz | Norm Delta       | 1          | Off            | 1     | Off                 |  |
| All Markers Off |                 |        |            |                  |            |                |       |                     |  |

|                                      |     |
|--------------------------------------|-----|
| Selected Marker.....                 | 207 |
| Marker State.....                    | 207 |
| Marker Position X-value.....         | 207 |
| Marker Type.....                     | 207 |
| Reference Marker.....                | 207 |
| Linking to Another Marker.....       | 208 |
| Assigning the Marker to a Trace..... | 208 |
| Final Test Detector.....             | 208 |
| Select Marker.....                   | 209 |

### 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 719

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 717

### 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 720

`CALCulate<n>:DELTamarker<m>:X` on page 718

### 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 719

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 717

### 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 a fixed reference point is configured (see ["Defining a Fixed Reference"](#) on page 400), the reference point ("FXD") can also be selected instead of another marker.

Remote command:

`CALCulate<n>:DELTaMarker<m>:MREference` on page 716

### 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<ms>:LINK:TO:MARKer<md>` on page 718

`CALCulate<n>:DELTaMarker<ms>:LINK:TO:MARKer<md>` on page 715

`CALCulate<n>:DELTaMarker<m>:LINK` on page 714

### 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 719

### Final Test Detector

Defines the detector to be used for the final EMI test at the marker frequency.

For details, see [Chapter 3.12.3.2, "Detectors and dwell time"](#), on page 201.

**Note:** The trace detector configured in the trace settings is used for the initial peak search only, see [Chapter 5.3.2.1, "Trace settings"](#), on page 366.

|                |   |
|----------------|---|
| "Off"          | No final test is performed.   |
| "PositivePeak" | Determines the maximum signal level that was detected during the specified dwell time.  |
| "Average"      | Determines the average signal level of the samples that were collected during the specified dwell time.   |
| "Quasi-Peak"   | Determines the maximum signal level weighted to CISPR 16-1-1 that was detected during the dwell time.<br>The "Quasi-Peak" detector is only available for the CISPR filter, and not for an RBW of 1 MHz. |

|                 |  |
|-----------------|--|
| "CISPR Average" | <p>Determines a weighted average signal level according to CISPR 16-1-1.</p> <p>The average value according to CISPR 16-1-1 is the maximum value detected while calculating the linear average value during the specified dwell time.</p> <p>The "CISPR Average" detector is only available for the CISPR filter.</p>  |
| "RMS Average"   | <p>A combination of the RMS detector (for pulse repetition frequencies above a corner frequency) and the Average detector (for pulse repetition frequencies below the corner frequency).</p> <p>Lowpass filters of the second order determine the average value (simulation of a mechanical pointer instrument).</p> <p>The "RMS Average" detector is only available for the CISPR filter.</p> |

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DETECTOR](#) on page 608

[CALCulate<n>:DELTAmarker<m>:FUNCTION:FMEasurement:DETECTOR](#) on page 607

### Select Marker

The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.



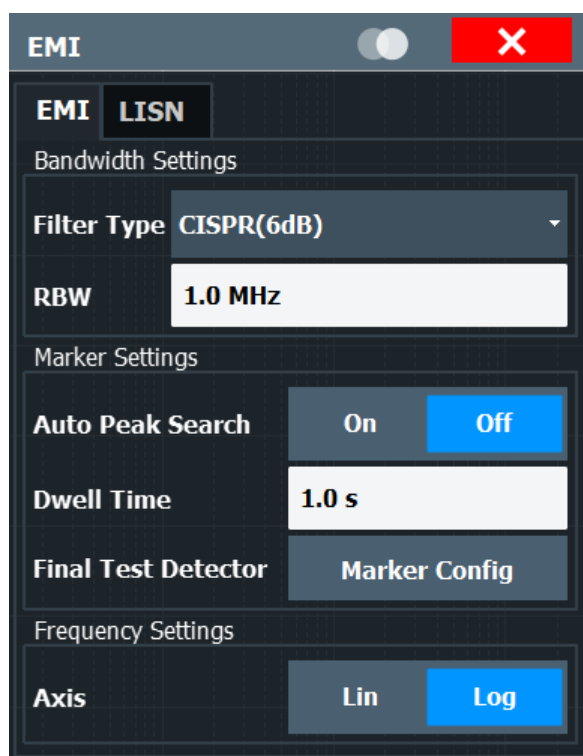
Remote command:

[CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 719

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 717

### 3.12.4.2 EMI final measurement configuration

The final EMI measurement can be performed with different settings than the initial peak search. These settings are described here.



The detector to be used for the final EMI test can be defined differently for each frequency, thus the detector is configured in the EMI marker settings, see ["Final Test Detector"](#) on page 208.

|  |     |
|--|-----|
| <a href="#">Filter Type</a> .....            | 210 |
| <a href="#">RBW</a> .....                    | 211 |
| <a href="#">Automatic Peak Search</a> .....  | 211 |
| <a href="#">Dwell Time</a> .....             | 211 |
| <a href="#">Final Test Detector</a> .....    | 211 |
| <a href="#">Frequency Axis Scaling</a> ..... | 212 |
| <a href="#">Res BW CISPR</a> .....           | 212 |
| <a href="#">Res BW MIL</a> .....             | 213 |

### Filter Type

Defines the filter type.

The following filter types are available:

- Normal (3dB)
- Gauss (6 dB)
- CISPR (6 dB)
- MIL Std (6 dB)
- Channel
- RRC (not available for sweep type "FFT")
- 5-Pole (not available for sweep type "FFT")

For more information, see [Chapter 4.6.1.6, "Which data may pass: filter types"](#), on page 301.

**Note:** The RBW filter configured in the bandwidth settings is identical to the filter configured in the EMI configuration.

Remote command:

`[SENSe:]BANDwidth[:RESolution]:TYPE` on page 665

### RBW

Defines the resolution bandwidth. The available resolution bandwidths are specified in the specifications document. Numeric input is always rounded to the nearest possible bandwidth.

If "Auto" is selected, the resolution bandwidth is coupled to the selected span (for span > 0). If the span is changed, the resolution bandwidth is automatically adjusted.

If the resolution bandwidth is defined manually, a green bullet is displayed next to the "RBW" display in the channel bar.

For a list of supported filters, see the specifications document.

For more information see [Chapter 4.6.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 298.

**Note:** Restrictions.

- For EMI measurements using the quasipeak detector, the 1 MHz RBW filter is not available (see [Chapter 3.12.3.1, "Resolution bandwidth and filter types"](#), on page 200).

Remote command:

`[SENSe:]BANDwidth[:RESolution]` on page 665

`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 664

### Automatic Peak Search

If activated, a peak search is performed automatically for all active markers after each sweep.

If Auto peak search *and* limit lines are active, the active markers are set to the peak *delta* values between the measured signal and the limit lines.

**Note:** The general search functions [Auto Max Peak Search / Auto Min Peak Search](#) are not available for EMI measurements.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:PEAKsearch:AUTO`  
on page 760

### Dwell Time

Sets the dwell time for the EMI marker measurement.

For more information see [Chapter 3.12.3.2, "Detectors and dwell time"](#), on page 201.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DWELL` on page 609

### Final Test Detector

Defines the detector to be used for the final EMI test at the marker frequency.

For details, see [Chapter 3.12.3.2, "Detectors and dwell time"](#), on page 201.

**Note:** The trace detector configured in the trace settings is used for the initial peak search only, see [Chapter 5.3.2.1, "Trace settings"](#), on page 366.

|                 |   |
|-----------------|---|
| "Off"           | No final test is performed.   |
| "PositivePeak"  | Determines the maximum signal level that was detected during the specified dwell time.  |
| "Average"       | Determines the average signal level of the samples that were collected during the specified dwell time.   |
| "Quasi-Peak"    | Determines the maximum signal level weighted to CISPR 16-1-1 that was detected during the dwell time.<br>The "Quasi-Peak" detector is only available for the CISPR filter, and not for an RBW of 1 MHz.   |
| "CISPR Average" | Determines a weighted average signal level according to CISPR 16-1-1.<br>The average value according to CISPR 16-1-1 is the maximum value detected while calculating the linear average value during the specified dwell time.<br>The "CISPR Average" detector is only available for the CISPR filter.  |
| "RMS Average"   | A combination of the RMS detector (for pulse repetition frequencies above a corner frequency) and the Average detector (for pulse repetition frequencies below the corner frequency).<br>Lowpass filters of the second order determine the average value (simulation of a mechanical pointer instrument).<br>The "RMS Average" detector is only available for the CISPR filter. |

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DETECTOR` on page 608  
`CALCulate<n>:DELTAmarker<m>:FUNCTION:FMEasurement:DETECTOR`  
 on page 607

### Frequency Axis Scaling

Switches between linear and logarithmic scaling for the frequency axis.

Logarithmic scaling is only available for  $f_{\text{stop}} \geq 1.4 \cdot f_{\text{start}}$ .

By default, the frequency axis has linear scaling. Logarithmic scaling of the frequency axis, however, is common for measurements over large frequency ranges as it enhances the resolution of the lower frequencies. On the other hand, high frequencies get more crowded and become harder to distinguish.

For more information see [Chapter 4.4.1.3, "Coping with large frequency ranges - logarithmic scaling"](#), on page 282.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACE<t>:X:SPACing` on page 696

### Res BW CISPR

Automatically sets the measurement bandwidth for commercial EMC standards according to CISPR.

For more information, see [Chapter 3.12.3.1, "Resolution bandwidth and filter types"](#), on page 200.



Remote command:

Filter type:

[SENSe:]BANDwidth[:RESolution]:TYPE on page 665

Filter bandwidth:

[SENSe:]BANDwidth[:RESolution] on page 665

### Res BW MIL

Automatically sets the measurement bandwidth for military EMC standards.

For more information, see [Chapter 3.12.3.1, "Resolution bandwidth and filter types"](#), on page 200.

Remote command:

Filter type:

[SENSe:]BANDwidth[:RESolution]:TYPE on page 665

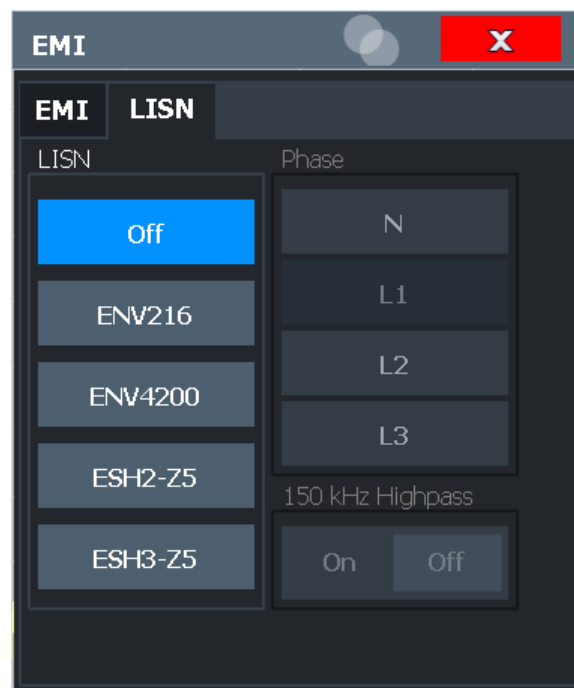
Filter bandwidth:

[SENSe:]BANDwidth[:RESolution] on page 665

### 3.12.4.3 LISN control settings

**Access:** [MEAS CONFIG] > "LISN Config"

For measurements with power lines, the following settings are available for the R&S ESW to control which phase of the LISN is to be tested (e.g. for EMI measurements).



For more information, see [Chapter 3.12.3.4, "Controlling V-Networks \(LISN\)"](#), on page 203.

|                       |     |
|-----------------------|-----|
| LISN Type.....        | 214 |
| Phase.....            | 214 |
| 150 kHz Highpass..... | 214 |

### LISN Type

Selects the network type and activates output to the network via the user port of the R&S ESW. The network type determines the supported phases (see [Table 3-15](#)).

"Off" disables LISN control and output.

Remote command:

`INPut:LISN[:TYPE]` on page 611

### Phase

Selects the phase to be measured. Phase N and L1 are included in all four LISN.

Phase L2 and L3 are only included in four-line networks.

You can select one phase only for each measurement.

Remote command:

`INPut:LISN:PHASe` on page 610

### 150 kHz Highpass

Enables or disables the use of an additional 150 kHz highpass filter to protect the R&S ESW LISN from excessive input.

The filter is available for the ENV 216 network only.

Remote command:

`INPut:LISN:FILTeR:HPASs[:STATe]` on page 610

## 3.12.5 EMI result analysis

The EMI measurement provides functionality to analyze the results.

### Marker demodulation

The R&S ESW is able to demodulate AM and FM signals for acoustic tests and monitoring purposes.

When the demodulator function is active, the EMI measurement demodulates the signal continuously (regardless of the "Continuous Demodulation" setting in the marker function configuration). The demodulation begins as soon as a marker is activated. During the initial measurement, demodulation is performed for the entire measurement span; during the final measurement only the detected peak marker positions are demodulated (for the defined dwell time). You can listen to the results during the measurement using headphones or the internal speaker.

For more information, see [Chapter 5.4.4.7, "Demodulating marker values and providing audio output \(marker demodulation\)"](#), on page 421.

### Limit lines

General limit line functionality is provided by the R&S ESW base unit. The base unit also provides various predefined limit lines that you can use for various applications.

Limit line configuration is described in [Chapter 5.5.2.2, "Limit line settings and functions"](#), on page 439.

### Test reports

The R&S ESW features a test report generator. A test report is a document that summarizes the results and configuration of measurements.

Test reports are based on a general template, and are completed with user-defined, measurement-specific contents. You can create multiple templates for different applications.

## 3.12.6 How to perform EMI measurements

The following step-by-step instructions demonstrate how to perform an EMI measurement with the R&S ESW.



For remote operation, see [Chapter 6.7.16, "Programming example: EMI measurement"](#), on page 614.

1. Select [MODE] on the front panel and select the "Spectrum" application.
2. Define the frequency range of the EMI measurement.
  - a) Select [FREQ] and then the "Frequency Config" .
  - b) Define the start and stop frequency.
3. Configure the traces for the initial EMI measurement.
  - a) Select [TRACE] .
  - b) Select the "Trace Config" to configure as many traces as required.
  - c) Define the detectors to use for the initial measurement, for example the peak detector and the average detector.
4. Select [MEAS] on the front panel and select the "EMI" measurement.

The EMI main menu is displayed.
5. Select the "EMI Config" .
6. Define the resolution bandwidth and filter type to be used for the measurement.

By default, the R&S ESW uses a filter with a 3-db bandwidth. EMI measurements usually require a filter with a 6 dB bandwidth.
7. Define the dwell time for which each marker position is measured during the final measurement.
8. To obtain an overview of peak values in the input signal during the initial measurement, activate the "Auto Peak Search".

As soon as a sweep is started, the R&S ESW looks for the strongest peaks in the frequency range you are measuring and positions one of the active markers on those peaks. The number of active markers determines the number of detected peaks; no additional markers are activated.

9. Define the type of scaling for the frequency axis according to the definition of the limit lines in the standard.
10. Optionally, select the "LISN Config" to configure a LISN control.
11. Configure the EMI measurement markers.
  - a) Select "Marker Config".
  - b) Activate the number of markers or delta markers you want to analyze.
  - c) For each active marker, select a detector to be used for the "Final Test", that is: the subsequent EMI measurement at the marker position.
  - d) If you already know which frequencies cause irregular values, set the markers to those positions. (Otherwise perform an initial peak search to obtain an overview, see [step 8](#)).
12. Optionally, select the "Marker Demod Config" to configure continuous marker demodulation.  
 Demodulation begins immediately with the next measurement. During the initial measurement, demodulation is performed for the entire measurement span; during the final measurement only the detected peak marker positions are demodulated (for the defined dwell time).
13. Increase the number of sweep points for the EMI measurement.
  - a) Select [SWEEP] on the front panel.
  - b) Select the "Sweep Config" .
  - c) Set the number of "Sweep Points" so that the distance between two sweep points is smaller than  $RBW/2$ .
14. Optionally, select or configure limit lines to check the marker results against.
  - a) Select [Lines] and then the "Lines Config" , then select the "Lines Config" tab.
  - b) In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".  
 All limit lines that comply with the following conditions are displayed in the overview:
    - Stored in the `limits` subfolder of the main installation folder of the instrument
    - File extension `.LIN`
    - Compatible to the current EMI measurement settings
  - c) Select the "Check Traces" setting for a limit line in the overview.
  - d) Select the trace numbers to be included in the limit check. You can assign the same limit line to several traces.
15. The default unit dBm is not suitable for EMI measurements. Define a suitable unit for the measured values, or select a transducer.  
 To change the unit:

Select [AMPT] > "Amplitude Config" > "Unit".

To select a transducer:

- a) Select [SETUP].
- b) Select "Transducer".
- c) In the "Transducer" dialog box, set the "View Filter" to "Show Compatible" to determine the available transducers for the current EMI measurement setup.
- d) In the overview, select the "Active" setting for a transducer line.

16. Select [RUN SINGLE] to start a new EMI measurement.

If activated, a peak search is performed. For each active marker, a final measurement is performed using the specified detector for the specified dwell time. If activated, the signal is demodulated at the active marker positions.

The specified traces to be checked are compared with the active limit lines. The status of the limit check for the final measurement is indicated in the Result Summary.

### 3.12.7 Measurement example: measuring radio frequency interference

A common measurement task that you can do with the EMI measurement is to detect radio frequency interference (RFI) or electromagnetic interferences (EMI).

The measurement shows signal levels over a particular frequency range. A typical frequency range for EMI measurements is 150 kHz to 1 GHz. Usually, the captured signal characteristics are unknown. Thus, the best way to start the measurement is to preset the R&S ESW and perform a peak search to obtain a general overview.

If you perform measurements according to a particular EMI standard, a preset also eliminates the risk of wrong settings inherited from previous measurements. Note that EMI measurements are possible in the Spectrum application only.



A programming example demonstrating an EMI measurement in a remote environment is provided in [Chapter 6.7.16, "Programming example: EMI measurement"](#), on page 614.

#### Preparing the measurement

1. Select [PRESET] .  
The R&S ESW restores the default settings.
2. Define the frequency range of the measurement.
  - a) Select [FREQ] .
  - b) Select "Start Frequency".
  - c) Enter a frequency of *150 kHz*.
  - d) Select "Stop Frequency".
  - e) Enter a frequency of *1 GHz*.

The R&S ESW scales the horizontal axis accordingly.

3. Select [MEAS] on the front panel and select the "EMI" measurement.  
The EMI main menu is displayed.
4. Select the "EMI Config" .
5. Define the resolution bandwidth and filter type for the measurement.  
By default, the R&S ESW uses a filter with a 3-dB bandwidth. EMI measurements usually require a filter with a 6-dB bandwidth.
6. Define the dwell time for which each marker position is measured during the final measurement.
7. To obtain an overview of exceptional values in the input signal during the initial measurement, activate the "Auto Peak Search".
8. Select the measurement bandwidth.
  - a) Select the "Res BW CISPR" .  
A CISPR (6 dB) filter is configured.
  - b) Set the bandwidth to *1 MHz*.  
The R&S ESW shows the currently selected resolution bandwidth in the diagram header.
9. Configure the traces for the initial EMI measurement.
  - a) Select [TRACE] .
  - b) Select "Trace Config" to configure two traces.
  - c) Define the detectors to use for the initial measurement. Select the peak detector for trace 1 and the average detector for trace 2.  
The peak detector ensures that the detected peak levels in the frequency range covered by one pixel are displayed.  
The R&S ESW now displays two traces. Trace 1 shows the peak values, trace 2 shows the average values.
10. Increase the number of sweep points for the EMI measurement.
  - a) Select [SWEEP] on the front panel.
  - b) Select the "Sweep Config" .
  - c) Set the number of "Sweep Points" to *200000*.
11. Select [AMPT] , then select the "Amplitude Config" and, in the "Amplitude" dialog box, select V as the "Unit".

### Performing the measurement

1. Configure the EMI measurement markers. In this example, we use 6 markers.
  - a) Select the "Marker Config" .
  - b) Activate six normal markers.
  - c) Set markers 1 to 3 on trace 1. Set markers 4 to 6 on trace 2.
  - d) For each of these markers, select the "CISPR AV" detector to be used for the "Final Test", i.e. the subsequent EMI measurement at the marker positions.

2. Select a limit line to check the marker results against.
  - a) Select [Lines] and then the "Lines Config" , then select the "Lines Config" tab.
  - b) In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".

All limit lines that comply with the following conditions are displayed in the overview:

  - Stored in the `limits` subfolder of the main installation folder of the instrument
  - File extension `.LIN`
  - Compatible to the current EMI measurement settings
  - c) In the overview, click the "Check Traces" setting for the `EN55011A` limit line.
  - d) Select trace 1 to be included in the limit check. (Trace 2, which is defined as the average, is always lower than trace 1, which contains peak values.)

3. Select [RUN SINGLE] to start a new EMI measurement.

If activated, a peak search is performed. For each active marker, a final measurement is performed using the specified detector for the specified dwell time.

If activated, the signal is demodulated. During the initial measurement, demodulation is performed for the entire measurement span; during the final measurement only the detected peak marker positions are demodulated (for the defined dwell time).

The specified traces to be checked are compared with the active limit line. The status of the limit check for the final measurement is indicated in the Result Summary.

### Evaluating the measurement

Check the Result Summary to detect exceeded limit values.

Zoom into the diagram at the conspicuous frequency for more details.

If necessary, decrease the span to the area in which irregular values occurred and repeat the measurement.

## 3.12.8 Optimizing and troubleshooting EMI measurements

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

### Number of sweep points

The resolution bandwidth should cover at least one sweep point (more is better). If this condition is not met, signals or interferences could be missed during refined measurement of narrowband interferers. See [Chapter 3.12.3.3, "Frequency resolution - sweep points and scaling"](#), on page 202.

If the distance between two sweep points is larger than  $RBW/2$ , a warning is displayed in the status bar ("Increase Sweep Points" or "RBW").

### Dwell time

Consider the following when defining the dwell time:

- **Unknown signals:** select a dwell time of at least 1 second to ensure that pulses down to a frequency of 5 Hz are weighted correctly
- **Pulsed signals or signals that fluctuate slowly:** the dwell time must cover at least the time until the first signal peak is measured; can require long dwell time
- **Unmodulated signals or signals with a high modulation frequency:** the dwell time must cover at least the time until the first signal peak is measured; usually shorter than for pulsed signals



## 4 Common measurement settings

Basic measurement settings that are common to many measurement tasks, regardless of the application or operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings that may deviate from these common settings.

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### 4.1 Measurement basics

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#### 4.1.1 IF and video signal output

The measured IF signal or displayed video signal (i.e. the filtered and detected IF signal) can be provided at the IF/VIDEO/DEMODO output connector of the R&S ESW.

The **video output** is a signal of 1 V. It can be used, for example, to control demodulated audio frequencies.

The **IF output** is a signal of the measured level at a specified frequency.

#### Restrictions

Note the following restrictions for data output:

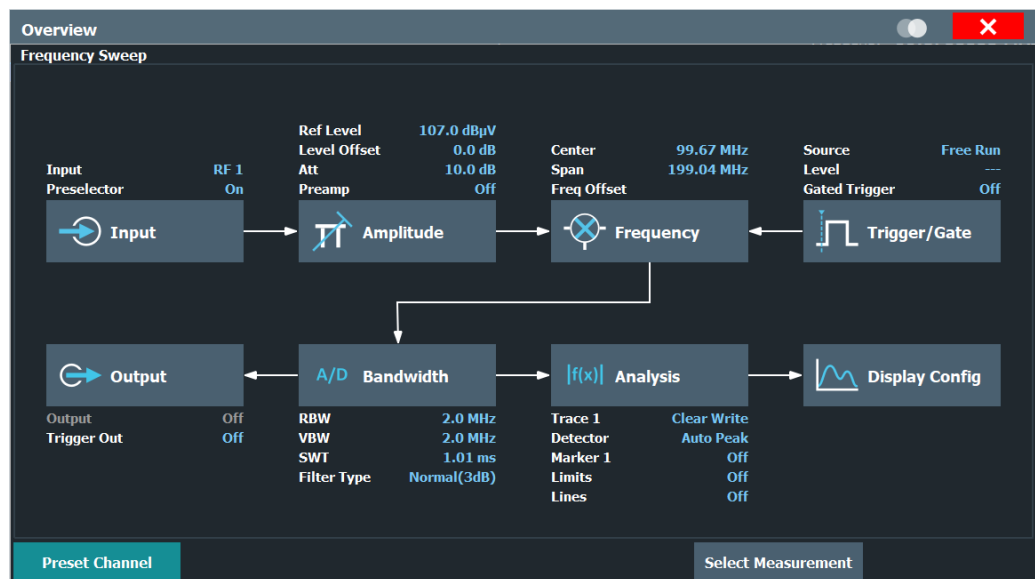
- IF and video output is only available in the time domain (zero span).
- For I/Q data, only IF output is available.

### 4.2 Configuration overview



**Access:** all menus

Each channel provides an overview of the most important currently defined settings and access to the most important configuration dialog boxes for the particular measurement. This overview is available via the "Overview" icon, which is displayed in all menus.



Using this overview, you can easily configure an entire channel from input over processing to output and analysis by stepping through the dialog boxes as indicated.

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

1. "Select Measurement"  
See [Chapter 3, "Measurements and results"](#), on page 19
2. Input  
[Chapter 4.3, "Data input and output"](#), on page 223
3. Amplitude  
[Chapter 4.5, "Amplitude and vertical axis configuration"](#), on page 289
4. Frequency  
See [Chapter 4.4, "Frequency and span configuration"](#), on page 281
5. (Optionally:) Trigger/Gate  
See [Chapter 4.7, "Trigger and gate configuration"](#), on page 312
6. Bandwidth  
See [Chapter 4.6.2, "Bandwidth, filter and sweep settings"](#), on page 303  
(For SEM measurements: SEM Setup, see [Chapter 3.5.5, "SEM configuration"](#), on page 115)  
(For Spurious measurements: Spurious Setup, see [Chapter 3.6.4, "Spurious emissions measurement configuration"](#), on page 149)
7. (Optionally:) Outputs  
See [Chapter 4.3.6, "Output settings"](#), on page 278
8. Analysis  
See [Chapter 5, "Common analysis and display functions"](#), on page 331
9. Display

See [Chapter 5.1, "Result display configuration"](#), on page 331

### To configure settings

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

### Preset Channel

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

**Note:** Do not confuse "Preset Channel" with the [Preset] key, which restores the entire instrument to its default values and thus closes *all channels* on the R&S ESW (except for the default channel)!

Remote command:

`SYSTem:PRESet:CHANnel [:EXEC]` on page 469

## 4.3 Data input and output

The R&S ESW can analyze signals from different input sources and provide various types of output (such as video or trigger signals).

- [Receiving data input and providing data output](#)..... 223
- [Input source settings](#)..... 227
- [Configuring the preselector](#)..... 229
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### 4.3.1 Receiving data input and providing data output

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

- [Increasing measurement sensitivity \(or avoiding an input mixer overload\)](#)..... 223
- [Receiving and providing trigger signals](#)..... 226

#### 4.3.1.1 Increasing measurement sensitivity (or avoiding an input mixer overload)

Measurements often confront you with unknown or unintentional signals with unknown signal levels (and often with pulse characteristics). Such signals can either have very weak signal levels, in which case you might miss them during the measurement. Or they can have very strong signal levels, in which case they can damage the input mixer.

## Protecting the input mixer

Always consider how to protect the input mixer from damage when setting up a measurement.

- ▶ **NOTICE!** EMC measurements often measure unknown signals that contain pulses with possibly strong signal levels. Strong signal levels can damage the input mixer. Read the following topics carefully before you apply a signal to learn more about protecting the input mixer and avoid an overload.

Note that pulses have different level characteristics. Refer to the specifications document for more information on the allowed maximum pulse energy.

The signal level at the input mixer is calculated as follows.

Mixer Level = Input Level - attenuation + gain



The R&S ESW is equipped with an overload protection mechanism. This mechanism becomes active as soon as the signal level at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

In this case, you must decrease the level at the RF input connector and then close the message box. Then measurements are possible again.

- [Using the RF attenuator](#).....224
- [Using the preamplifier](#).....225
- [Using the preselector](#).....225

## Using the RF attenuator

The first tool provided by the R&S ESW to control measurement sensitivity is the RF attenuator.

The RF attenuator is available in all hardware configurations of the R&S ESW.

Attenuation has the following effects on the measurement:

- High attenuation protects the input mixer: the main purpose of the attenuator is to protect the input mixer.
- High attenuation makes sure that the measurement results are reliable (signals that are stronger than allowed can distort the results)
- High attenuation helps you to avoid intermodulation
- High attenuation increases inherent noise (i.e. the noise floor) and thus decreases measurement sensitivity: if you increase attenuation by 10 dB, the sensitivity is reduced by 10 dB (in other words: the displayed noise increases by 10 dB)

Depending on the required test setup, you must find a compromise between a high sensitivity, low intermodulation and input mixer protection. We recommend to let the R&S ESW determine the ideal attenuation automatically.

You can determine the attenuation automatically with the auto ranging feature in the receiver application and the auto attenuation feature in the other applications. Determining the attenuation automatically might not necessarily utilize the maximum dynamic range, but still yields valid and reliable results.

When you select the attenuation manually and are measuring unknown signals, especially DUTs with a high RFI voltage, always select the highest possible attenuation level before you apply the signal.

If you need a better sensitivity or signal-to-noise ratio, make sure that the applied signal does not exceed the specified limits, before you lower the attenuation.

For further protection of the input mixer, the R&S ESW does not allow you to select attenuation levels of less than 10 dB unless you explicitly turn on this feature ("[10 dB Minimum Attenuation](#)").

### Protecting the input mixer

1. **NOTICE!** EMC measurements often measure unknown signals that contain pulses with possibly strong signal levels. Strong signal levels can damage the input mixer. Select an appropriate attenuation when you measure unknown signals or RFI voltage in combination with an artificial network (LISN). Do not apply a 0 dB attenuation for such measurements. During phase switching, such test setups generate very strong pulses which can damage the input mixer.
2. Make sure that the signal level at the RF input does not exceed the allowed limits when you allow attenuation of less than 10 dB in combination with auto ranging. Exceeding the limits can damage the input mixer.

### Using the preamplifier

The second tool that allows you to control measurement sensitivity is the preamplifier.

In addition to the standard preamplifier available in every R&S ESW, an additional low noise amplifier is available as an optional component (R&S ESW-B24).

Signal gain has the following effects on the measurement:

- The preamplifier allows you to detect even weak signals.
- The preamplifier reduces the noise figure of the R&S ESW and thus increases its sensitivity. Thus, it is recommended to use the preamplifier for measurements that require maximum sensitivity.
- The preamplifier reduces the dynamic range. To perform a measurement using the maximum dynamic range, turn off the preamplifier.
- The preamplifier is located after the preselection filters, reducing the risk of overloading the input mixer by strong out-of-band signals.
- The optional low noise amplifier is located in front of the preselection filters which increases the measurement sensitivity.

The gain of the preamplifier is automatically considered in the level display. The disadvantage of a lower large-signal immunity (intermodulation) is reduced by the "preselector".

### Using the preselector

The "preselector" is another tool to control measurement sensitivity.

Preselection has the following effects on the measurement:

- Preselection rejects most of the spectral energy which helps to protect the input mixer and thus makes sure that the measurement results are valid and reliable.
- Preselection filters out signals that you do not want to be displayed (selectivity) and thus allows you to analyze only the frequency range you are interested in.

The preselector of the R&S ESW consists of several filters which are automatically applied during measurements. The filter that is used depends on the frequency that is currently measured. You can see the list of filters and the progress in the "Preselector" result display. The currently applied filter is indicated by a green LED, filters that are outside the scan range are ignored.

| 2 Preselector                 |                     |                               |                       |
|-------------------------------|---------------------|-------------------------------|-----------------------|
| 0 Hz ... 0.15 MHz             | 190 MHz ... 300 MHz | 670 MHz ... 780 MHz           | 2.88 GHz ... 4.91 GHz |
| 0.15 MHz ... 2 MHz            | 270 MHz ... 380 MHz | 750 MHz ... 860 MHz           | 4.88 GHz ... 6.82 GHz |
| 0.15 MHz ... 30 MHz           | 350 MHz ... 460 MHz | 830 MHz ... 940 MHz           | 6.79 GHz ... 8.00 GHz |
| 2 MHz ... 30 MHz              | 430 MHz ... 540 MHz | 910 MHz ... 1.02 GHz          | 8.00 GHz ... 26.5 GHz |
| 30 MHz ... 140 MHz            | 510 MHz ... 620 MHz | 990 MHz ... 1.81 GHz          |                       |
| 110 MHz ... 220 MHz           | 590 MHz ... 700 MHz | 1.78 GHz ... 2.91 GHz         |                       |
| Notch 2.400 GHz ... 2.500 GHz |                     | Notch 5.725 GHz ... 5.875 GHz |                       |
| Bypass                        |                     |                               |                       |

Figure 4-1: Preselector result display. The green LED indicates the currently applied filter.

In the frequency range from 150 kHz to 30 MHz, you can preselect in a single stage (150 kHz to 30 MHz). Or, you can split the preselection into two stages, each of which applies a separate filter: one from 150 kHz to 2 MHz, and another from 2 MHz to 30 MHz.

In addition, the R&S ESW provides several notch filters to suppress certain frequency ranges completely.



### Using the preselector

Switching the filters is a mechanical process. Avoid excessive filters switches, because the hardware can wear out.

Note that results in a frequency band are only displayed if there is at least one valid measurement point in the corresponding range. If a particular measurement point is captured by more than one filter, the R&S ESW displays the combined results.



### Notch filter

The R&S ESW provides additional notch filters that suppress signals in the frequency bands from 2.4 GHz to 2.5 GHz and 5.725 GHz to 5.875 GHz.

#### 4.3.1.2 Receiving and providing trigger signals

Using one of the "trigger" connectors of the R&S ESW, the R&S ESW can use a signal from an external device as a trigger to capture data. Alternatively, the internal trigger signal used by the R&S ESW can be output for use by other connected devices. Using

the same trigger on several devices is useful to synchronize the transmitted and received signals within a measurement.

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

### External trigger as input

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

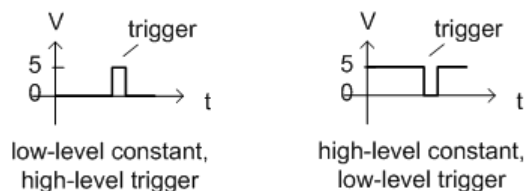
### Trigger output

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

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

### Manual triggering

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



## 4.3.2 Input source settings

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

Input settings can be configured in the "Input" dialog box.

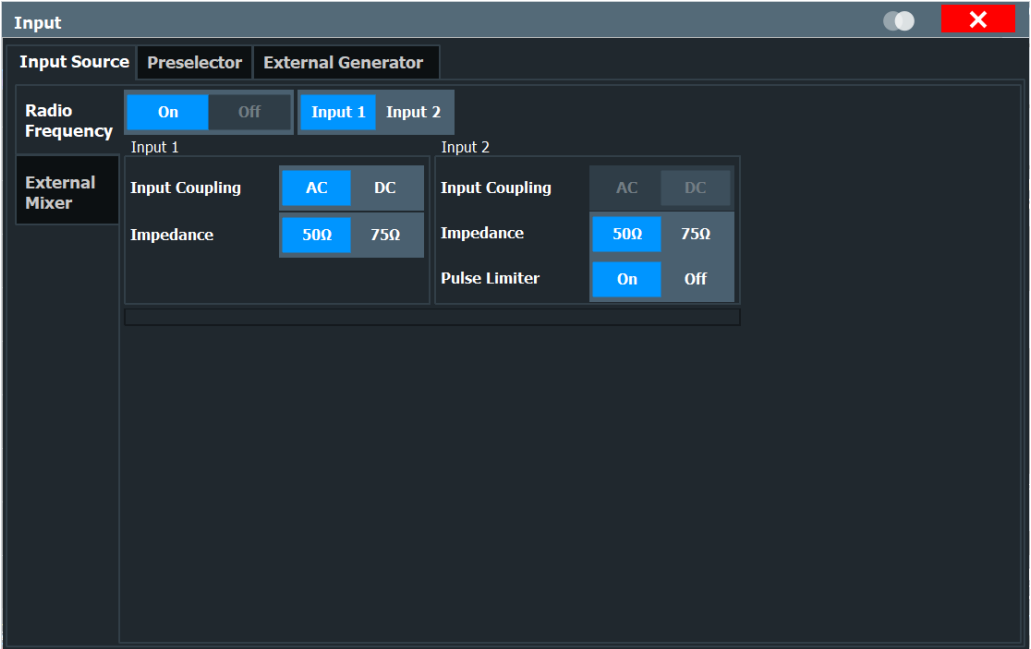
Some settings are also available in the "Amplitude" tab of the "Amplitude" dialog box.

- [Radio frequency input](#)..... 227

### 4.3.2.1 Radio frequency input

**Access:** "Overview" > "Input" > "Input Source" > "Radio Frequency"

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



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| Pulse Limiter.....         | 229 |

**Radio Frequency State**  
Activates input from the "RF Input" connector.  
Remote command:  
[INPut:SElect](#) on page 620

**Input Coupling**  
The RF input of the R&S ESW can be coupled by alternating current (AC) or direct current (DC).  
Note that the "Input Coupling" feature is only available for input 2 when the [pulse limiter](#) is turned off. When the pulse limiter is on, the input is always DC coupled.  
AC coupling blocks any DC voltage from the input signal. AC coupling is activated by default to prevent damage to the instrument. Very low frequencies in the input signal can be distorted.  
However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the specifications document.  
Remote command:  
[INPut:COUPling](#) on page 621



**Impedance**

For some measurements, the reference impedance for the measured levels of the R&S ESW can be set to 50  $\Omega$  or 75  $\Omega$ .

For GSM and Avionics measurements, the impedance is always 50  $\Omega$  and cannot be changed.

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

This value also affects the unit conversion.

Remote command:

[INPut:IMPedance](#) on page 622

**Pulse Limiter**

The pulse limiter, available for the second RF input, is a protection mechanism against high level pulses or signals (which can damage the input mixer).

When you turn on the pulse limiter, the attenuation is always at least 10 dB. Attenuation smaller than 10 dB is only available when you turn off the pulse limiter.

Remote command:

[INPut:ATTenuation:LIMiter\[:STATe\]](#) on page 621

**4.3.3 Configuring the preselector**

The preselector works the same as in the Receiver.

For more information refer to the R&S ESW User Manual.

**4.3.4 Optional external generator control**

If the R&S ESW optional External Generator Control is installed, you can operate various commercially available generators as an external generator with the R&S ESW. Thus, scalar network analysis with the R&S ESW is possible.

- [About external generator control](#).....229
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- [External generator control settings](#)..... 239
- [How to work with external generator control](#).....246
- [Measurement example: calibration with an external generator](#)..... 250

**4.3.4.1 About external generator control**

A common measurement setup includes a signal generator, a device under test (DUT), and a signal and spectrum analyzer, for example the R&S ESW. In this setup, the signal analyzer can control which signal the generator is to send, which is in turn measured by the analyzer. This process is referred to as *external generator control*. The generator in this setup is referred to as a *tracking generator*.

A measurement with a tracking generator is useful to measure any effects on the power level caused by the cables and connectors from the signal generator and the signal analyzer in advance. The known effects can then be removed from the measurement results to obtain accurate information on the DUT.

#### 4.3.4.2 Basics on external generator control

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



External generator control is only available in the following applications.

- Receiver
- Spectrum Analyzer
- I/Q Analyzer
- Analog Demodulation

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| • <a href="#">Reference trace, reference line and reference level</a> ..... | 235 |
| • <a href="#">Coupling the frequencies</a> .....                            | 236 |
| • <a href="#">Displayed information and errors</a> .....                    | 238 |

#### External generator connections

The external generator is controlled either via a LAN connection or via the EXT. GEN. CONTROL GPIB interface of the R&S ESW supplied with the option.

For more information on configuring interfaces, see the R&S ESW user manual.

#### TTL synchronization

In addition, TTL synchronization can be used with some Rohde & Schwarz generators connected via GPIB. The TTL interface is included in the AUX control connector of the External Generator Control option.



Using the TTL interface allows for considerably higher measurement rates than pure GPIB control, because the frequency stepping of the R&S ESW is directly coupled with the frequency stepping of the generator. For details see "[Coupling the frequencies](#)" on page 236.

In [Figure 4-2](#) the TTL connection is illustrated using an R&S SMU generator, for example.

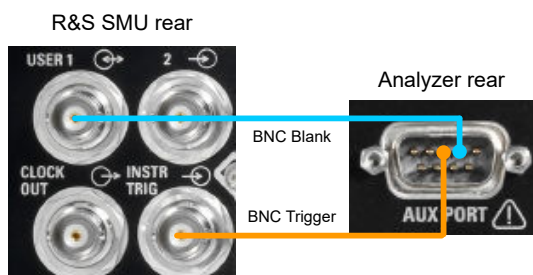


Figure 4-2: TTL connection for an R&S SMU generator

In Figure 4-3, the connection for an R&S SMW is shown.

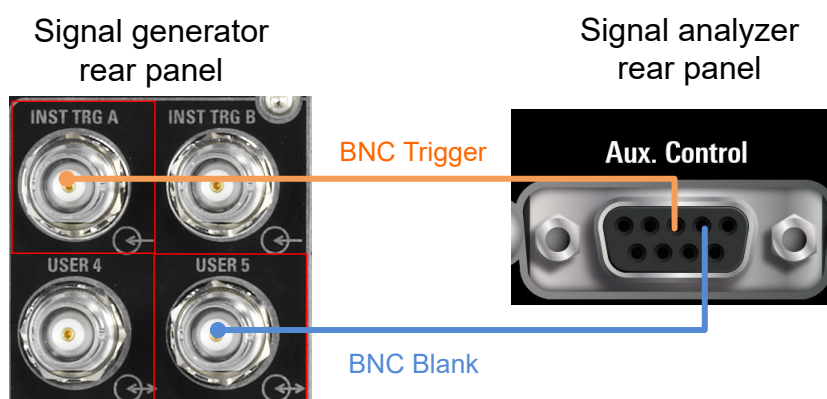


Figure 4-3: TTL connection for an R&S SMW generator

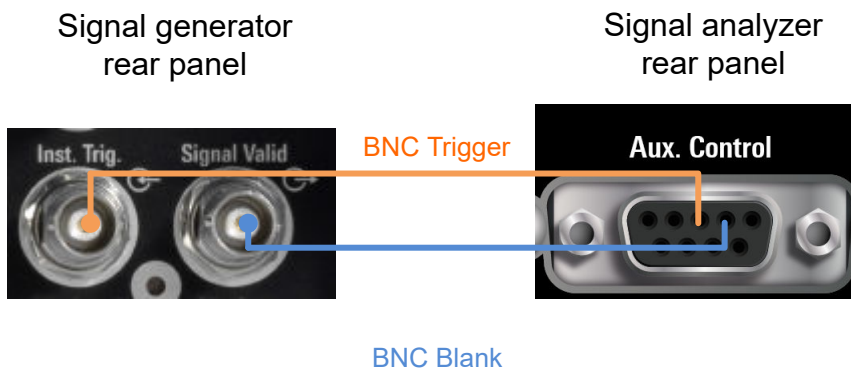


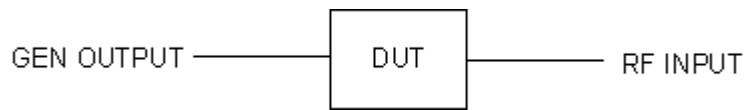
Figure 4-4: TTL connection for an R&S SMA100B generator

The external generator can be used to calibrate the data source by performing either transmission or reflection measurements.

### Transmission Measurement

This measurement yields the transmission characteristics of a two-port network. The external generator is used as a signal source. It is connected to the input connector of the DUT. The input of the R&S ESW is fed from the output of the DUT. A calibration

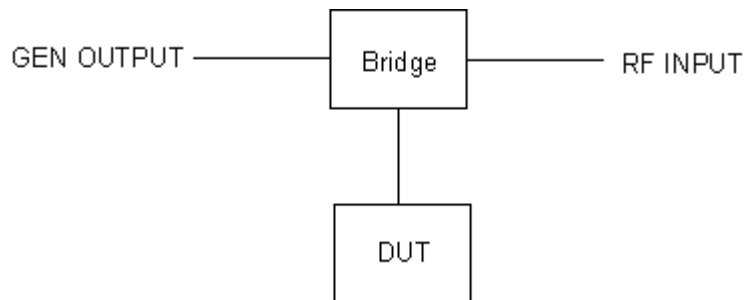
can be carried out to compensate for the effects of the test setup (e.g. frequency response of connecting cables).



*Figure 4-5: Test setup for transmission measurement*

### Reflection Measurement

Scalar reflection measurements can be carried out using a reflection-coefficient measurement bridge.



*Figure 4-6: Test setup for reflection measurement*

### Generated signal input

To use the functions of the external generator, an appropriate generator must be connected and configured correctly. In particular, the generator output must be connected to the RF input of the R&S ESW.

### External reference frequency

To enhance measurement accuracy, use a common reference frequency for both the R&S ESW and the generator. If no independent 10 MHz reference frequency is available, connect the reference output of the generator with the reference input of the R&S ESW. Enable usage of the external reference on the R&S ESW via "SETUP" > "Reference" > "External Reference".

For more information on external references, see the R&S ESW user manual.

### Connection errors

If no external generator is connected, if the connection address is not correct, or the generator is not ready for operation, an error message is displayed (e.g. "Ext. Generator TCP/IP Handshake Error!", see ["Displayed information and errors"](#) on page 238).

### Generator setup files

For each signal generator type to be controlled by the R&S ESW, configure a generator setup file and store it on the R&S ESW. The setup file defines the frequency and power ranges supported by the generator, and information required for communication.

For the signal generators listed in the specifications document, default setup files are provided. If necessary, you can edit or duplicate these files for varying measurement setups or other instruments.

You can display the existing setup files in an editor in read-only mode directly from the "External Generator" configuration dialog box. From there, you can edit them and store them under a different name. Then they are available on the R&S ESW.

(For details see ["How to define a new generator setup file"](#) on page 247).

### Calibration mechanism

A common measurement setup includes a signal generator, a device under test (DUT), and a signal and spectrum analyzer. Therefore, it is useful to measure the attenuation or gain caused by the cables and connectors from the signal generator and the signal analyzer in advance. The known level offsets can then be removed from the measurement results to obtain accurate information on the DUT.

Calculating the difference between the currently measured power and a reference trace is referred to as *calibration*. Thus, the measurement results from the controlled external generator - including the inherent distortions - can be used as a reference trace to calibrate the measurement setup.

The inherent frequency and power level distortions can be determined by connecting the R&S ESW to the signal generator. The R&S ESW sends a predefined list of frequencies to the signal generator (see also ["Coupling the frequencies"](#) on page 236). The signal generator then sends a signal with the specified level at each frequency in the predefined list. The R&S ESW measures the signal and determines the level offsets to the expected values.

### Saving calibration results

A reference dataset for the calibration results is stored internally as a table of value pairs (frequency/level), one for each sweep point. The measured offsets can then be used as calibration factors for subsequent measurement results. The calibration data can also be stored permanently with the instrument settings using the "Save" function in the toolbar.

The calibration can be performed using either transmission or reflection measurements. The selected type of measurement used to determine the reference trace is included in the reference dataset.

### Normalization

Once the measurement setup has been calibrated and the reference trace is available, subsequent measurement results can be corrected according to the calibration factors, if necessary. Results are corrected by subtracting the reference trace from the measurement results. This process is referred to as *normalization* and can be activated or deactivated as required. If normalization is activated, "NOR" is displayed in the channel bar, next to the indication that an external generator is being used ("Ext.Gen"). The normalized trace from the calibration sweep is a constant 0 dB line, as  $\text{<calibration trace>} - \text{<reference trace>} = 0$ .

*As long as the same settings are used for measurement as for calibration, the normalized measurement results should not contain any inherent frequency or power distortions. Thus, the measured DUT values are very accurate.*

### Approximate normalization

As soon as any of the calibration measurement settings are changed, the stored reference trace is longer identical to the new measurement results. However, if the measurement settings do not deviate too much, the measurement results can still be normalized *approximately* using the stored reference trace. An "APX" label in the channel bar (instead of "NOR") indicates the approximated normalization.

Approximation is necessary if one or more of the following values deviate from the calibration settings:

- Coupling (RBW, VBW, SWT)
- Reference level, RF attenuation
- Start or stop frequency
- Output level of external generator
- Detector (max. peak, min. peak, sample, etc.)
- Frequency deviation at a maximum of 1001 points within the set sweep limits (corresponds to a doubling of the span)

Differences in level settings between the reference trace and the current instrument settings are considered automatically. If the span is reduced, a linear interpolation of the intermediate values is applied. If the span increases, the values at the left or right border of the reference dataset are extrapolated to the current start or stop frequency. The reference dataset is extended by constant values.

Thus, you can change various instrument settings without giving up normalization. The necessity to carry out a new normalization is reduced to a minimum.

### The normalized trace in the display

The normalized reference trace is also displayed in the spectrum diagram, by default at the top of the diagram (= 100% of the window height). It is indicated by a red line labeled "NOR", followed by the current reference value. However, it can be shifted vertically to reflect an attenuation or gain caused by the measured DUT (see also ["Shifting the reference line \(and normalized trace\)"](#) on page 235).

### Restoring the calibration settings

If the measurement settings no longer match the instrument settings with which the calibration was performed (indicated by the "APX" or no label next to "Ext.TG" in the channel bar), you can restore the calibration settings, which are stored with the reference dataset on the R&S ESW.

### Storing the normalized reference trace as a transducer factor

The (inverse) normalized reference trace can also be stored as a *transducer factor* for use in other R&S ESW applications that do not support external generator control. The normalized trace data is converted to a transducer with unit dB and stored in a file with

the specified name and the suffix `.trd` under `c:\r_s\instr\trd`. The frequency points are allocated in equidistant steps between the start and stop frequency.

Transducer factors are useful, for example, to determine the effects of a particular device component and then remove these effects from a subsequent measurement which includes this component.

For an example, see ["How to remove the effects of a particular component from measurement results using calibration"](#) on page 249.



Note that the *normalized* measurement data is stored, not the original *reference* trace. Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor is 0 dB for the entire span (by definition of the normalized trace).

## Reference trace, reference line and reference level

### Reference trace

The calibration results are stored internally on the R&S ESW as a *reference trace*. For each measured sweep point, the offset to the expected values is determined. If normalization is activated, the offsets in the reference trace are removed from the current measurement results to compensate for the inherent distortions.

### Reference line

The reference line is defined by the [Reference Value](#) and [Reference Position](#) in the "External Generator" > "Source Calibration" settings. It is similar to the [Reference Level](#) defined in the "Amplitude" settings. However, as opposed to the reference *level*, this reference *line* only affects the y-axis scaling in the diagram. It has no effect on the expected input power level or the hardware settings.

The reference line determines the range and the scaling of the y-axis, just as the reference level does.

The normalized reference trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. By default, the reference line is displayed at the top of the diagram. If you shift the reference line, the normalized trace is shifted, as well.

### Shifting the reference line (and normalized trace)

You can shift the reference line - and thus the normalized trace - in the result display by changing the [Reference Position](#) or the [Reference Value](#).

If the DUT inserts a gain or an attenuation in the measurement, this effect can be reflected in the result display on the R&S ESW. To reflect a power offset in the measurement trace, change the [Reference Value](#).

For a detailed example, see [Chapter 4.3.4.5, "Measurement example: calibration with an external generator"](#), on page 250.

### Coupling the frequencies

As described in ["Normalization"](#) on page 233, normalized measurement results are very accurate *as long as the same settings are used as for calibration*. Although approximate normalization is possible, it is important to consider the required frequencies for calibration in advance. The frequencies and levels supported by the connected signal generator are provided for reference with the interface configuration.

Frequency coupling means that the generator frequency and the frequency of the R&S ESW are the same.

- **Manual coupling:** a single frequency is defined
- **Automatic coupling:** a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S ESW. The RF frequency range covers the currently defined span of the R&S ESW (unless limited by the range of the signal generator).

### Automatic coupling

If automatic coupling is used, the output frequency of the generator (source frequency) is calculated as follows:

$$F_{\text{Generator}} = \left| F_{\text{Analyzer}} * \frac{\text{Numerator}}{\text{Denominator}} + F_{\text{Offset}} \right|$$

**Equation 4-1: Output frequency of the generator**

Where:

$F_{\text{Generator}}$  = output frequency of the generator

$F_{\text{Analyzer}}$  = current frequency at the RF input of the R&S ESW

Numerator = multiplication factor for  $F_{\text{Analyzer}}$

Denominator = division factor for  $F_{\text{Analyzer}}$

$F_{\text{Offset}}$  = frequency offset for  $F_{\text{Analyzer}}$ , for example for frequency-converting measurements or harmonics measurements

The value range for the offset depends on the selected generator. The default setting is 0 Hz. Offsets other than 0 Hz are indicated by the "FRQ" label in the channel bar (see also ["Displayed information and errors"](#) on page 238).

### Swept frequency range

The  $F_{\text{Analyzer}}$  values for the calibration sweep start with the start frequency and end with the stop frequency defined in the "Frequency" settings of the R&S ESW. The resulting output frequencies ([Result Frequency Start](#) and [Result Frequency Stop](#)) are displayed in "External Generator" > "Measurement Configuration" for reference.

If the resulting frequency range exceeds the allowed ranges of the signal generator, an error message is displayed (see ["Displayed information and errors"](#) on page 238). The [Result Frequency Start](#) and [Result Frequency Stop](#) values are corrected to comply with the range limits.





The calibration sweep nevertheless covers the entire span defined by the R&S ESW. However, no input is received from the generator outside the generator's defined limits.

### TTL synchronization

Some Rohde & Schwarz signal generators support TTL synchronization when connected via GPIB. The TTL interface is included in the AUX control connector of the External Generator Control option.

When pure GPIB connections are used between the R&S ESW and the signal generator, the R&S ESW sets the generator frequency for each frequency point individually via GPIB. Only when the setting procedure is finished, the R&S ESW can measure the next sweep point.

For generators with a TTL interface, the R&S ESW sends a list of the frequencies to be set to the generator before the beginning of the first sweep. Then the R&S ESW starts the sweep and the next frequency point is selected by both the R&S ESW and the generator using the TTL handshake line "TRIGGER". The R&S ESW can only measure a value when the generator signals the end of the setting procedure via the "BLANK" signal.

Using the TTL interface allows for considerably higher measurement rates, because the frequency stepping of the R&S ESW is directly coupled with the frequency stepping of the generator.

### Reverse sweep

The frequency offset for automatic coupling can be used to sweep in the reverse direction. To do so, define a negative offset in the external generator measurement configuration. (Note that the frequency is defined as the unsigned value of the equation, thus a negative frequency is not possible.)

#### Example: Example for reverse sweep

$$F_{\text{AnalyzerStart}} = 100 \text{ MHz}$$

$$F_{\text{AnalyzerStop}} = 200 \text{ MHz}$$

$$F_{\text{Offset}} = -300 \text{ MHz}$$

$$\text{Numerator} = \text{Denominator} = 1$$

$$\rightarrow F_{\text{GeneratorStart}} = 200 \text{ MHz}$$

$$\rightarrow F_{\text{GeneratorStop}} = 100 \text{ MHz}$$

If the offset is adjusted so that the sweep of the generator crosses the minimum generator frequency, a message is displayed in the status bar ("Reverse Sweep via min. Ext. Generator Frequency!").

**Example: Example for reverse sweep via minimum frequency**
 $F_{\text{AnalyzerStart}} = 100 \text{ MHz}$ 
 $F_{\text{AnalyzerStop}} = 200 \text{ MHz}$ 
 $F_{\text{Offset}} = -150 \text{ MHz}$ 
 $F_{\text{min}} = 20 \text{ MHz}$ 

Numerator = Denominator = 1

 $\rightarrow F_{\text{GeneratorStart}} = 50 \text{ MHz}$ 
 $\rightarrow F_{\text{GeneratorStop}} = 50 \text{ MHz via } F_{\text{min}}$ 
**Displayed information and errors****Channel bar**

If external generator control is active, some additional information is displayed in the channel bar.

| Label                  | Description  |
|------------------------|--|
| EXT TG: <source power> | External generator active; signal sent with <source power> level   |
| LVL                    | Power Offset (see <a href="#">"Source Offset"</a> on page 242)   |
| FRQ                    | Frequency Offset (see <a href="#">"(Automatic) Source Frequency (Numerator/Denominator/Offset)"</a> on page 243) |
| NOR                    | Normalization on;<br>No difference between reference setting and measurement                                     |
| APX (approximation)    | Normalization on;<br>Deviation from the reference setting occurs   |
| -                      | Aborted normalization or no calibration performed yet  |

**Error and status messages**

The following status and error messages can occur during external generator control.

| Message  | Description  |
|--|--|
| "Ext. Generator GPIB Handshake Error!" /<br>"Ext. Generator TCPIP Handshake Error!" /<br>"Ext. Generator TTL Handshake Error!" | Connection to the generator is not possible, e.g. due to a cable damage or loose connection or wrong address.  |
| "Ext. Generator Limits Exceeded!"  | The allowed frequency or power ranges for the generator were exceeded.   |
| "Reverse Sweep via min. Ext. Generator Frequency!"   | Reverse sweep is performed; frequencies are reduced to the minimum frequency, then increased again; see <a href="#">"Reverse sweep"</a> on page 237. |
| "Ext. Generator File Syntax Error!"  | Syntax error in the generator setup file (see <a href="#">"Generator setup files"</a> on page 232)   |

| Message                         | Description  |
|---------------------------------|--|
| "Ext. Generator Command Error!" | Missing or wrong command in the generator setup file (see <a href="#">"Generator setup files"</a> on page 232) |
| "Ext. Generator Visa Error!"    | Error with Visa driver provided with installation (very unlikely)  |

## NOTICE

### Overloading

At a reference level of -10 dBm and at an external generator output level of the same value, the R&S ESW operates without overrange reserve. That means the R&S ESW is in danger of being overloaded if a signal is applied whose amplitude is higher than the reference line. In this case, either the message "RF OVLD" for overload or "IF OVLD" for exceeded display range (clipping of the trace at the upper diagram border = overrange) is displayed in the status line.

Overloading can be avoided as follows:

- Reducing the output level of the external generator ("[Source Power](#)" on page 242 in "External Generator > Measurement Configuration")
- Increasing the reference level ([Reference Level](#) in the "Amplitude" menu)

#### 4.3.4.3 External generator control settings

**Access:** [INPUT/OUTPUT] > "External Generator Config"

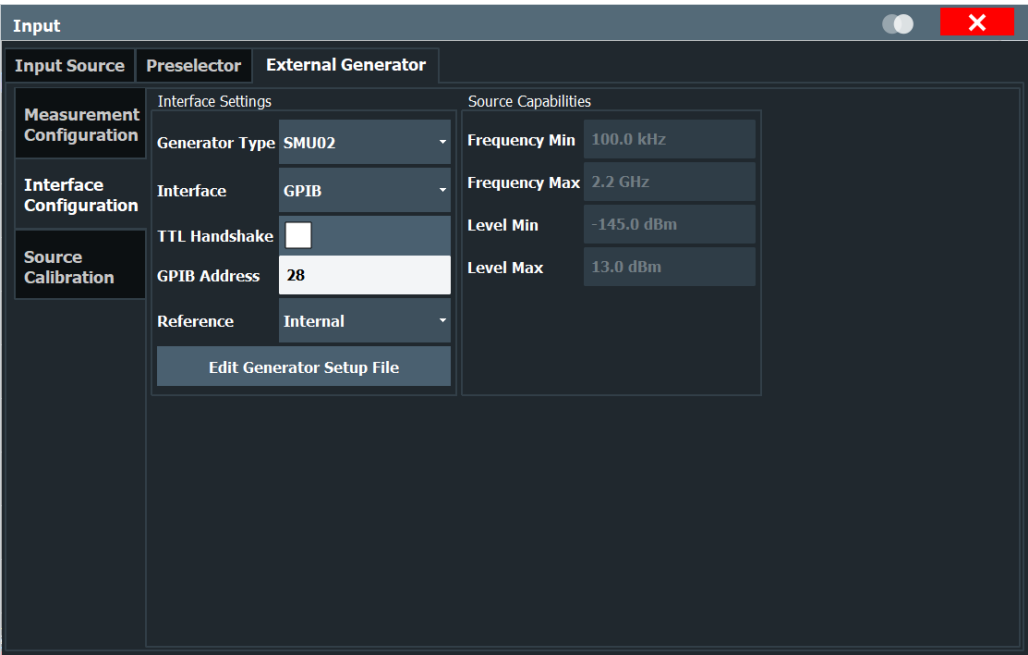
The "External Generator" settings are available if the R&S ESW External Generator Control option is installed. For each measurement channel, you can configure one external generator. To switch between different configurations, define multiple measurement channels.

For more information on external generator control, see [Chapter 4.3.4.2, "Basics on external generator control"](#), on page 230.

- [Interface configuration settings](#)..... 239
- [Measurement settings](#)..... 241
- [Source calibration functions](#)..... 244

### Interface configuration settings

**Access:** [INPUT/OUTPUT] > "External Generator Config" > "Interface Configuration" tab



|   |     |
|---|-----|
| Generator Type.....                             | 240 |
| Interface.....                                  | 240 |
| TTL Handshake.....                              | 240 |
| GPIB Address/TCPIP Address / Computer Name..... | 241 |
| Reference.....                                  | 241 |
| Edit Generator Setup File.....                  | 241 |
| Frequency Min/ Frequency Max.....               | 241 |
| Level Min/ Level Max.....                       | 241 |

**Generator Type**

Selects the generator type and thus defines the generator setup file to use.

For an overview of supported generators, see the specifications document. For information on generator setup files, see ["Generator setup files"](#) on page 232.

Remote command:

[SYSTem:COMMunicate:RDEvice:GENerator<gen>:TYPE](#) on page 631

**Interface**

Type of interface connection used.

For details on which signal generators support which interfaces, see the documentation of the corresponding signal generator.

- GPIB
- TCP/IP

Remote command:

[SYSTem:COMMunicate:RDEvice:GENerator<gen>:INTERface](#) on page 630

**TTL Handshake**

If available for the specified generator type, this option activates TTL synchronization via handshake.

Using the TTL interface allows for considerably higher measurement rates, because the frequency stepping of the R&S ESW is directly coupled with the frequency stepping of the generator.

For more information on TTL synchronization, see ["TTL synchronization"](#) on page 237.

Remote command:

[SYSTem:COMMunicate:RDEvice:GENerator<gen>:LINK](#) on page 630

### GPIO Address/TCP/IP Address / Computer Name

For LAN connections: TCP/IP address of the signal generator

For GPIB connections: GPIB address of the signal generator.

Remote command:

[SYSTem:COMMunicate:GPIO:RDEvice:GENerator<gen>:ADDRESS](#) on page 630

[SYSTem:COMMunicate:TCPIp:RDEvice:GENerator<gen>:ADDRESS](#)  
on page 631

### Reference

Selects the internal R&S ESW or an external frequency reference to synchronize the R&S ESW with the generator (default: internal).

Remote command:

[SOURce<si>:EXTernal<gen>:ROSCillator\[:SOURce\]](#) on page 629

### Edit Generator Setup File

Displays the setup file for the currently selected [Generator Type](#) in read-only mode in an editor.

Although the existing setup files are displayed in read-only mode in the editor, they can be saved under a different name (using "File > SaveAs").

Be careful, however, to adhere to the required syntax and commands. Errors are only detected and displayed when you try to use the new generator (see also ["Displayed information and errors"](#) on page 238).

For details, see ["Generator setup files"](#) on page 232.

### Frequency Min/ Frequency Max

For reference only: Lower and upper frequency limit for the generator.

### Level Min/ Level Max

For reference only: Lower and upper power limit for the generator.

### Measurement settings

**Access:** [INPUT/OUTPUT] > "External Generator Config" > "Measurement Configuration" tab

Input

Input Source

Preselector

External Generator

Measurement Configuration

Source State

On Off

Interface Configuration

Source Power

87.0 dBµV

Source Calibration

Source Offset

0.0 dB

Frequency Coupling

Coupling State

Auto Manual

Numerator

1

Source Freq. = RF \*

+ Offset

0 Hz

Denominator

1

Result

Frequency Start

150.0 kHz

Frequency Stop

199.19 MHz

|  |     |
|--|-----|
| Source State.....  | 242 |
| Source Power.....  | 242 |
| Source Offset.....   | 242 |
| Source Frequency Coupling.....                                   | 243 |
| (Manual) Source Frequency.....                                   | 243 |
| (Automatic) Source Frequency (Numerator/Denominator/Offset)..... | 243 |
| Result Frequency Start.....                                      | 244 |
| Result Frequency Stop.....                                       | 244 |

Source State

Activates or deactivates control of an external generator.

Remote command:

SOURce<si>:EXTernal<gen>[:STATe] on page 629

Source Power

The output power of the external generator. The default output power is -20 dBm. The range is specified in the specifications document.

Remote command:

SOURce<si>:EXTernal<gen>:POWer[:LEVel] on page 628

Source Offset

Constant level offset for the external generator. Values from -200 dB to +200 dB in 1 dB steps are allowed. The default setting is 0 dB. Offsets are indicated by the "LVL" label in the channel bar (see also "Displayed information and errors" on page 238).

Using this offset, attenuators or amplifiers at the output connector of the external generator can be considered. This is useful, for example, for the displayed output power values on screen or during data entry. Positive offsets apply to an amplifier, while negative offsets apply to an attenuator after the external generator.

Remote command:

`SOURce<si>:POWER[:LEVEL][:IMMEDIATE]:OFFSET` on page 629

### Source Frequency Coupling

Defines the frequency coupling mode between the R&S ESW and the generator.

For more information on coupling frequencies, see ["Coupling the frequencies"](#) on page 236.

- |          |   |
|----------|---|
| "Auto"   | Default setting: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S ESW (see <a href="#">"(Automatic) Source Frequency (Numerator/Denominator/Offset)"</a> on page 243). The RF frequency range covers the currently defined span of the R&S ESW (unless limited by the range of the signal generator). |
| "Manual" | The generator uses a single fixed frequency, defined by <a href="#">(Manual) Source Frequency</a> which is displayed when you select "Manual" coupling.   |

Remote command:

`SOURce<si>:EXTERNAL<gen>:FREQUENCY:COUPLING[:STATE]` on page 626

### (Manual) Source Frequency

Defines the fixed frequency to be used by the generator.

Remote command:

`SOURce<si>:EXTERNAL<gen>:FREQUENCY` on page 626

### (Automatic) Source Frequency (Numerator/Denominator/Offset)

With automatic frequency coupling, a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S ESW.

However, the frequency used by the generator can differ from the input from the R&S ESW. The RF frequency can be multiplied by a specified factor, or a frequency offset can be added, or both.

**Note:** The input for the generator frequency is not validated, i.e. you can enter any values. However, if the allowed frequency ranges of the generator are exceeded, an error message is displayed on the R&S ESW. The values for [Result Frequency Start](#) and [Result Frequency Stop](#) are corrected to comply with the range limits.

The value range for the offset depends on the selected generator. The default setting is 0 Hz. Offsets  $\neq$  0 Hz are indicated by the "FRQ" label in the channel bar. Negative offsets can be used to define reverse sweeps.

For more information on coupling frequencies and reverse sweeps, see ["Coupling the frequencies"](#) on page 236. For more information on error messages and the channel bar, see ["Displayed information and errors"](#) on page 238.

Remote command:

`SOURce<si>:EXTERNAL<gen>:FREQUENCY[:FACTOR]:DENOMINATOR` on page 626

`SOURce<si>:EXTERNAL<gen>:FREQUENCY[:FACTOR]:NUMERATOR` on page 627

`SOURce<si>:EXTERNAL<gen>:FREQUENCY:OFFSET` on page 628

Result Frequency Start

For reference only: The start frequency for the generator, calculated from the configured generator frequency and the start value defined for the R&S ESW.

Result Frequency Stop

For reference only: The stop frequency for the generator, calculated from the configured generator frequency and the stop value defined for the R&S ESW.

Source calibration functions

Access: [INPUT/OUTPUT] > "External Generator Config" > "Source Calibration" tab

The calibration functions of the external generator are available *only if external generator control is active* (see "Source State" on page 242).

Input Source

Measurement Configuration

Interface Configuration

Source Calibration

Preselector

Source Calibration Type

Source Calibration Normalize

Source Calibration Settings

External Generator

Reference

Position

Value

Transmission

Reflection Short

Reflection Open

On

Off

Recall

Save as Trd Factor

100.0 %

0.0 dB

|                                 |     |
|---------------------------------|-----|
| Calibrate Transmission.....     | 244 |
| Calibrate Reflection Short..... | 245 |
| Calibrate Reflection Open.....  | 245 |
| Normalization state.....        | 245 |
| Recall Cal. Settings.....       | 245 |
| Save as Trd Factor.....         | 245 |
| Reference Position.....         | 246 |
| Reference Value.....            | 246 |

Calibrate Transmission

Starts a transmission type measurement to determine a reference trace. This trace is used to calculate the difference for the normalized values.

Remote command:

[SENSe:]CORRection:METhod on page 624



**Calibrate Reflection Short**

Starts a short-circuit reflection type measurement to determine a reference trace for calibration.

If both calibrations (open circuit, short circuit) are carried out, the calibration trace is calculated by averaging the two measurements. The order of the two calibration measurements is irrelevant.

Remote command:

`[SENSe:]CORRection:METHod` on page 624

Selects the reflection method.

`[SENSe:]CORRection:COLLect[:ACQuire]` on page 624

Starts the sweep for short-circuit calibration.

**Calibrate Reflection Open**

Starts an open-circuit reflection type measurement to determine a reference trace for calibration.

If both reflection-type calibrations (open circuit, short circuit) are carried out, the reference trace is calculated by averaging the two measurements. The order of the two calibration measurements is irrelevant.

Remote command:

`[SENSe:]CORRection:METHod` on page 624

Selects the reflection method.

`[SENSe:]CORRection:COLLect[:ACQuire]` on page 624

Starts the sweep for open-circuit calibration.

**Normalization state**

Switches the normalization of measurement results on or off. This function is only available if the memory contains a reference trace, that is, after a calibration has been performed.

For details on normalization, see "[Normalization](#)" on page 233.

Remote command:

`[SENSe:]CORRection[:STATe]` on page 625

**Recall Cal. Settings**

Restores the settings that were used during source calibration. This can be useful if instrument settings were changed after calibration (e.g. center frequency, frequency deviation, reference level, etc.).

Remote command:

`[SENSe:]CORRection:RECall` on page 625

**Save as Trd Factor**

Uses the normalized measurement data to generate a transducer factor. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.trd` under

`C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\trd`. The frequency points are allocated in equidistant steps between start and stop frequency.

The generated transducer factor can be further adapted using the "Transducer" function in the [Setup] menu.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

For more information on transducers, see the R&S ESW User Manual.

**Note:** Note that the *normalized* measurement data is used, not the *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor is 0 dB for the entire span (by definition of the normalized trace).

Remote command:

`[SENSe:]CORRection:TRANsducer:GENerate` on page 625

### Reference Position

Defines the position of the reference line in percent of the total y-axis range.

The top of the diagram is 100%, the bottom is 0%. By default, the 0 dB line is displayed at the top of the diagram (100%).

This setting is only available if normalization is on (see "[Normalization state](#)" on page 245).

The reference line defined by the reference value and reference position is similar to the [Reference Level](#) defined in the "Amplitude" settings. However, this reference line only affects the y-axis scaling in the diagram, it has no effect on the expected input power level or the hardware settings.

The normalized trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. If you shift the reference line, the normalized trace is shifted, as well.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RPOSition` on page 663

### Reference Value

Defines an offset for the position of the reference line.

This setting can be used to shift the reference line and thus the normalized trace, similar to the [Shifting the Display \(Offset\)](#) defined in the "Amplitude" settings shifts the reference level *in the display*.

Shifting the normalized trace is useful, for example, to reflect an attenuation or gain caused by the measured DUT. If you then zoom into the diagram around the normalized trace, the measured trace still remains fully visible.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RVALue` on page 663

#### 4.3.4.4 How to work with external generator control

The following step-by-step instructions demonstrate how to work with the optional external generator control.



For remote operation, see [Chapter 6.8.1.6, "Programming example for external generator control"](#), on page 648.

- [How to configure an external generator connection via GPIB](#)..... 247
- [How to define a new generator setup file](#).....247
- [How to calibrate a measurement setup using an external generator](#).....248
- [How to remove the effects of a particular component from measurement results using calibration](#)..... 249
- [How to compensate for additional gain or attenuation after calibration](#)..... 249

### How to configure an external generator connection via GPIB

1. Connect the signal generator's GPIB interface connector to the "Ext. Gen.Control GPIB" connector on the rear panel of the R&S ESW.
2. If the signal generator supports TTL synchronization, connect the signal generator to the optional "Aux.Control" port.
3. Press [INPUT/OUTPUT] and select "External Generator Config".
4. In the "Interface Configuration" subtab, select the "Generator Type" connected to the R&S ESW.  
If the required generator type is not available, define a new setup file as described in ["How to define a new generator setup file"](#) on page 247.
5. Select the type of interface and the address used to connect the generator to the R&S ESW.
6. If the generator supports "TTL Synchronization", activate this function.

### How to define a new generator setup file

1. Press [INPUT/OUTPUT] and select "External Generator Config".
2. In the "Interface Configuration" subtab, select a generator type that has similar characteristics (frequency and power ranges).
3. Select "Edit Generator Setup File".  
The configuration file for the selected generator type is displayed (read-only) in an editor.
4. Edit the configuration values according to your generator. Be sure not to change the syntax of the file - only change the *values* of the parameters.  
Errors are only detected and displayed when you try to use the new generator (see also ["Displayed information and errors"](#) on page 238).
5. Save the file under a different name with the extension `.gen`:
  - a) In the editor, select "File > SaveAs".
  - b) Select "Save as type: All Files (\*.\*)".
  - c) Specify a name with the extension `.gen`.

6. In the R&S ESW firmware, close the "External Generator Config" dialog and re-open it.

Now you can select the new generator type from the selection list on the "Interface Configuration" tab.

#### How to calibrate a measurement setup using an external generator

1. Connect the signal generator output to the "RF input" connector of the R&S ESW.
2. If the measurement setup does not require the full span of the R&S ESW, change the "Frequency Start" and "Frequency Stop" values ([FREQ] > "Frequency Config").
3. Press [INPUT/OUTPUT] and select "External Generator Config".
4. In the "Interface Configuration" subtab, select "Reference: External" to synchronize the analyzer with the generator.
5. Switch to the "Measurement Configuration" subtab.
6. Set the "Source State" to "On".
7. Define the generator output level as the "Source Power".
8. Optionally, to define a constant level offset for the external generator, define a "Source Offset".
9. The default frequency list for the calibration sweep contains 1001 values, divided in equidistant frequencies between the R&S ESW's start and stop frequency. Usually, this automatic coupling is correct. Check the "Result Frequency Start" and "Result Frequency Stop" values to make sure that the required measurement span is covered. If necessary, change the frequency settings on the R&S ESW ([FREQ] > "Frequency Config"), or use a different generator type.
10. Switch to the "Source Calibration" subtab.
11. Select the "Source Calibration Type": "Transmission" to perform a calibration sweep and store a reference trace for the measurement setup.
12. Select "Source Calibration Normalize": "On".
13. Optionally, shift the reference line further down in the result display by decreasing the "Reference": "Position".

The measurement setup is now calibrated. Subsequent measurement results are normalized, so that any unwanted effects from the cables and connectors are removed.

### How to remove the effects of a particular component from measurement results using calibration

1. Set up the measurement, including the component, and perform a calibration as described in ["How to calibrate a measurement setup using an external generator"](#) on page 248.
2. After setting "Source Calibration Normalize": "On", select "Save as Trd Factor" to store the normalized reference trace as a transducer factor.
3. If necessary, switch to another measurement channel for a different R&S ESW application.
4. Press [Setup], then select "Transducer".
5. Select the stored transducer in the list of available transducers and select the "Active" setting for it.
6. Perform any measurement with the setup that contains the calibrated component.  
The measurement results do not include the effects from the component.

### How to compensate for additional gain or attenuation after calibration

If a gain or an attenuation is inserted in the measurement after calibration, this effect can be reflected in the display of the normalized trace on the R&S ESW. Thus, the measured trace and the normalized trace are not so far apart in the display, so that you can zoom into the normalized trace without cropping the measurement trace.

Prerequisite: a calibration has been performed for the original measurement setup, except for the component causing an additional gain or attenuation (as described in ["How to calibrate a measurement setup using an external generator"](#) on page 248)

1. Insert the additional component in the calibrated measurement setup and perform a new measurement.
2. Press [INPUT/OUTPUT] and select "External Generator Config".
3. Switch to the "Source Calibration" subtab.
4. With active normalization, set the "Reference": "Value" to the same value as the gain or attenuation the inserted component causes.
5. Optionally, shift the reference line further down in the result display by decreasing the "Reference": "Position".

The normalized reference trace moves to the position of the measured trace.

6. Optionally, zoom into the measured trace by changing the y-axis scaling (or the range: "AMPT > Scale Config > Range").

The measured trace is still fully visible, and the absolute values are still valid.

#### 4.3.4.5 Measurement example: calibration with an external generator

The following measurement example demonstrates the most common functions using an external generator. This example requires the External Generator Control option.

The example assumes an SMW100A generator is connected to the R&S ESW. A band elimination filter is the device under test. After calibration, an additional attenuator is inserted between the DUT and the R&S ESW.

The following procedures are described:

- ["Calibrating the measurement setup"](#) on page 250
- ["Measuring the effects of the DUT"](#) on page 251
- ["Compensating the effects of additional attenuation after calibration"](#) on page 253

##### Calibrating the measurement setup

1. Connect the signal generator's GPIB interface connector to the [Ext. Gen.Control GPIB] connector on the rear panel of the R&S ESW.
2. Connect the signal generator output to the [RF input] connector of the R&S ESW.
3. Adapt the measurement range of the R&S ESW to the filter to be tested. In this measurement, define the following settings:
  - a) Press [FREQ], select "Frequency Config" and enter "Frequency Start":  
*100 MHz.*
  - b) Enter "Frequency Stop": *300 MHz*
4. Press [INPUT/OUTPUT] and select "External Generator Config".
5. In the "Interface Configuration" sub-tab, select "Generator Type": "SMW06".
6. Select "Reference: External" to synchronize the analyzer with the generator.
7. Switch to the "Measurement Configuration" sub-tab.
8. Set the "Source State" to "On".
9. Define the generator output level as the "Source Power": *-20 dBm*.
10. Set the "Coupling State" to "Auto".

The "Result Frequency Start" value for the generator is indicated as *100.0 MHz*.  
The "Result Frequency Stop" value is indicated as *300.0 MHz*.
11. Switch to the "Source Calibration" sub-tab.
12. Select the "Source Calibration Type": "Transmission" to perform a calibration sweep and store a reference trace for the measurement setup.

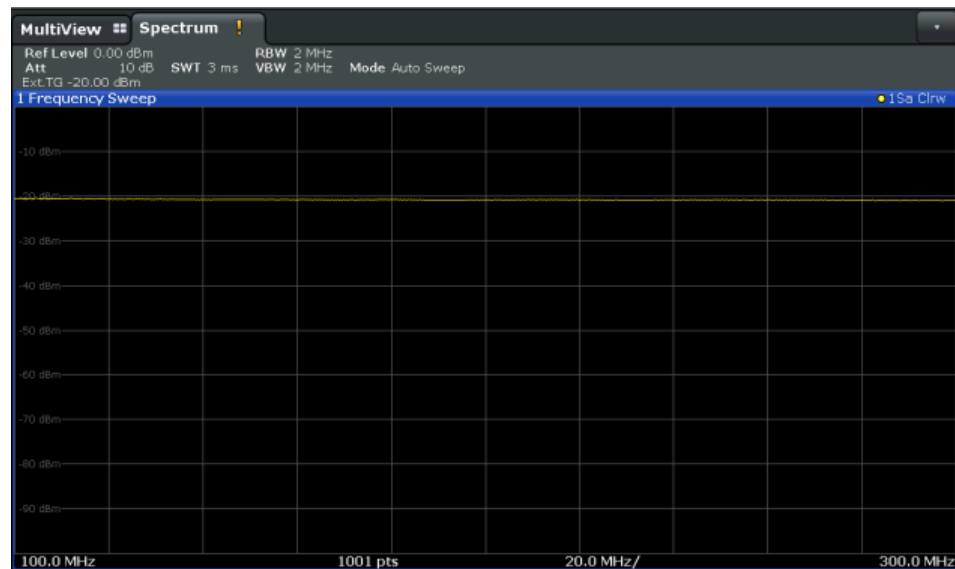


Figure 4-7: Measurement results from generator, analyzer and connecting cables

13. Select "Source Calibration Normalize": "On" to set the measurement results for the current setup to 0, thus eliminating all effects from the generator, the analyzer and the connecting cables from subsequent measurements with the band elimination filter.

The reference line is displayed at 0 dB at the top of the diagram (100%).

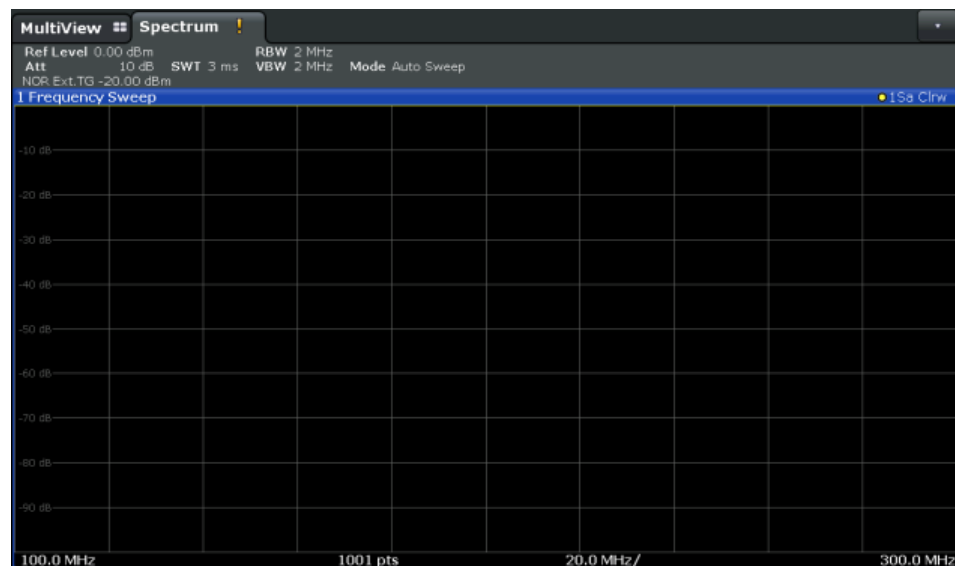


Figure 4-8: Normalized measurement results after calibration

### Measuring the effects of the DUT

After calibration we can insert the band elimination filter (our DUT) in the measurement setup.

1. Connect the signal generator output to the band elimination filter.

2. Connect the band elimination filter output to the [RF input] connector of the R&S ESW.

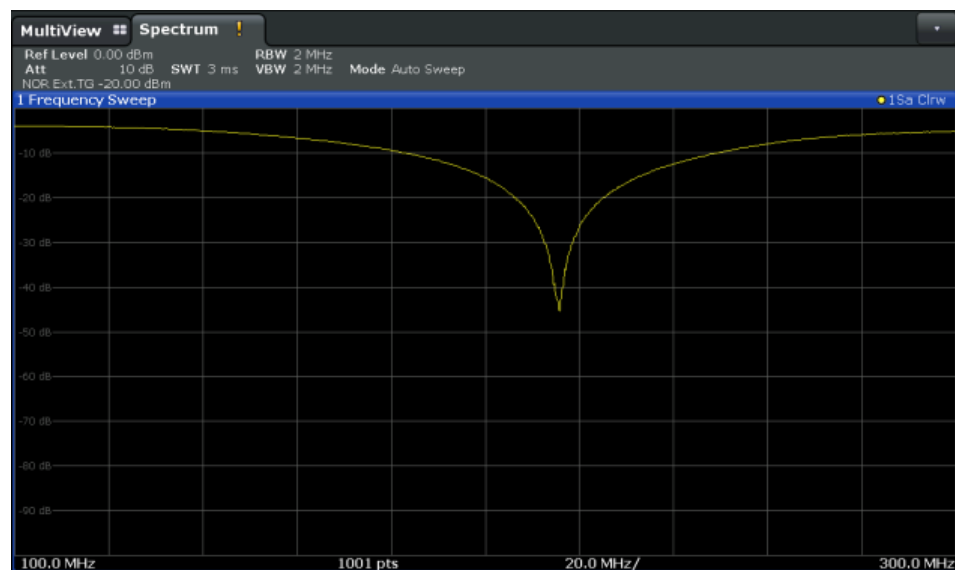


Figure 4-9: Band elimination filter results

3. Shift the reference line from the top of the diagram to the middle of the diagram by changing the position of the reference point 0.0 dB to 50 %.
- In the "Source Calibration" tab, enter "Position": 50 %.
- At the same time, the range of the displayed y-axis moves from [-100.0 dB to 0 dB] to [-50 dB to +50 dB].

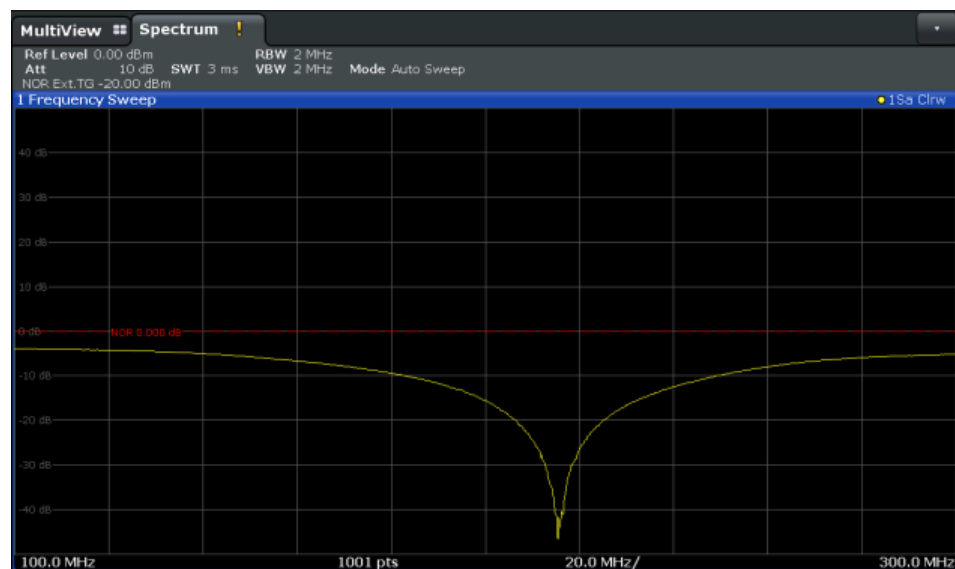


Figure 4-10: Reference line shifted to middle of diagram (50%)



### Compensating the effects of additional attenuation after calibration

After calibration, an additional attenuator is inserted between the DUT and the R&S ESW. This may be necessary, for example, to protect the analyzer's input connector. Nevertheless, we are only interested in the effects of the DUT, not those of the additional protective attenuator. Thus, we will compensate these effects in the result display on the R&S ESW by moving the reference line.

1. Connect a 3 dB attenuator between the band elimination filter output and the [RF input] connector on the R&S ESW.

The measurement results are now 3 dB lower.

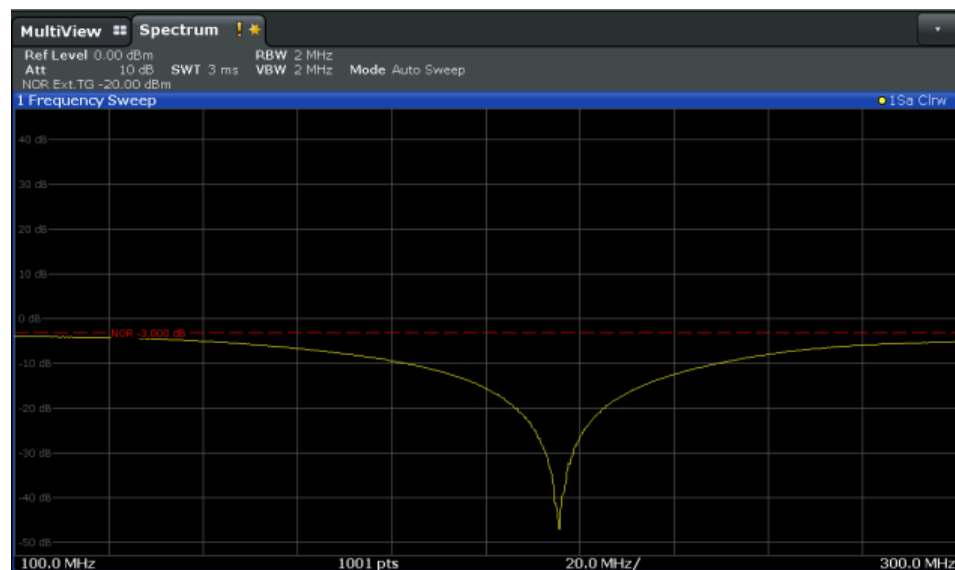


Figure 4-11: Measurement results with additional attenuator

2. In the "Source Calibration" tab, enter "Reference Value": -3 dB.

The reference line is shifted down by 3 dB so that the measurement trace is displayed on the reference line again.

At the same time, the scaling of the y-axis is changed: -3 dB are now shown at 50% of the diagram; the range is [-53 dB to +47 dB].

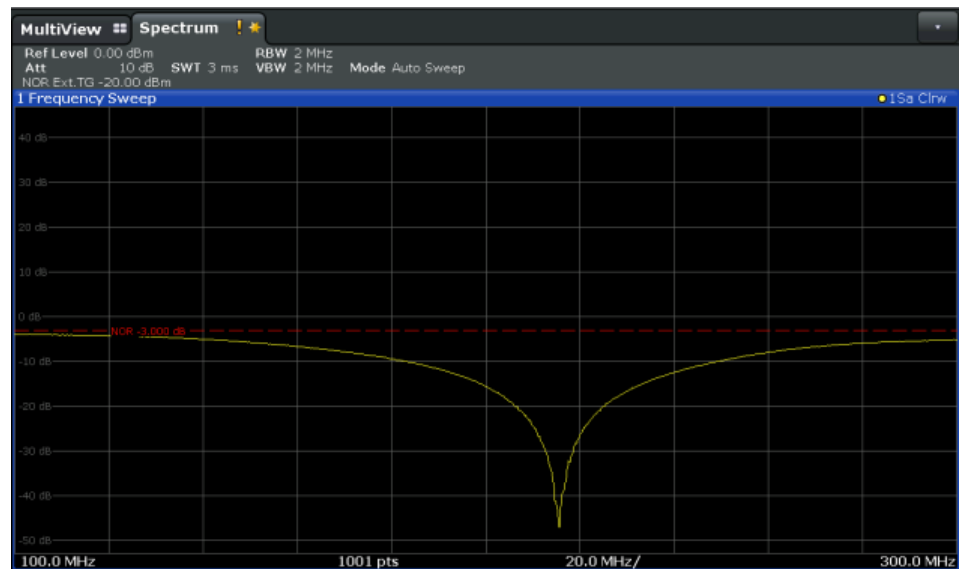


Figure 4-12: Reference line with an offset of -3 dB and shifted to middle of diagram (50%)

3. After the reference trace has been shifted, you can zoom into the measured trace to determine the offsets to the reference line, which represent the effects of the band elimination filter in the measurement setup.

Change the y-axis scaling to 1 dB/div (or the range to 10 dB).

- a) Press [AMPT], then select "Scale Config" > "Range".
- b) Enter 10 dB.

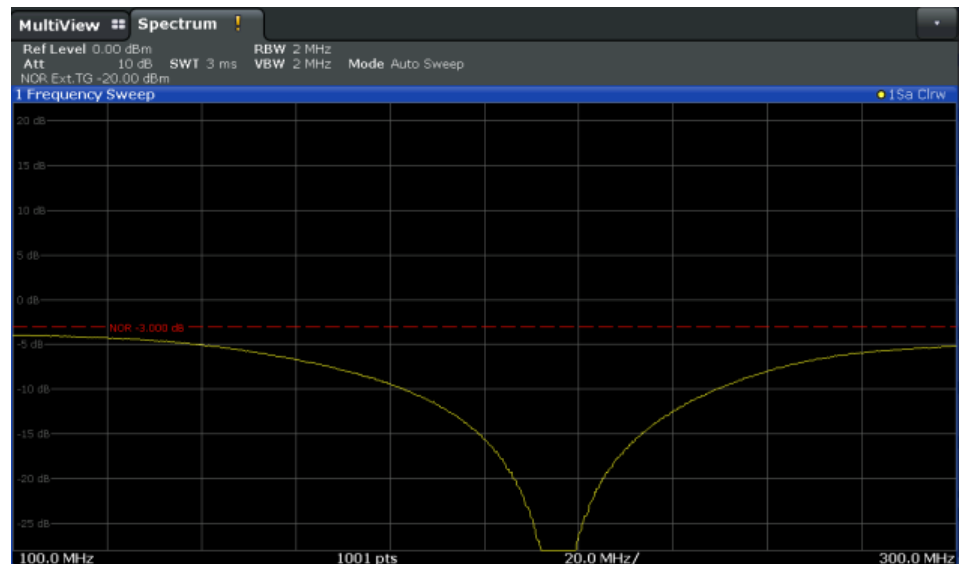


Figure 4-13: Reference line with measurement results using larger scale

### 4.3.5 Optional external mixers

If the R&S ESW External Mixer option is installed, an external mixer can be connected to the R&S ESW to increase the available frequency range. In this case, the input to measure is not taken from the RF input connector, but from the [Ext Mixer] connector(s).

- [Basics on external mixers](#).....255
- [External mixer settings](#).....264
- [How to work with external mixers](#).....274
- [Measurement examples: using an external mixer](#).....277

#### 4.3.5.1 Basics on external mixers

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

- [Frequency ranges](#).....255
- [Two-port and three-port mixers](#).....256
- [Bias current](#).....257
- [Conversion loss tables](#).....258
- [Automatic signal identification](#).....259

#### Frequency ranges

In a common spectrum analyzer, rather than providing one large (and thus inaccurate) filter, or providing several filters to cover the required frequency range of the input signal (at a high cost), a single, very accurate filter is used. Therefore, the input signal must be converted to the frequencies covered by the single accurate filter. This is done by a mixer, which converts and multiplies the frequency of the input signal with the help of the local oscillator (LO). The result is a higher and lower intermediate frequency (IF). The local oscillator can be tuned within the supported frequency range of the input signal.

In order to extend the supported frequency range of the input signal, an external mixer can be used. In this case, the LO frequency is output to the external mixer, where it is mixed with the RF input from the original input signal. In addition, the *harmonics* of the LO are mixed with the input signal, and converted to new intermediate frequencies. Thus, a wider range of frequencies can be obtained. The IF from the external mixer is then returned to the spectrum analyzer.

The frequency of the input signal can be expressed as a function of the LO frequency and the selected harmonic of the first LO as follows:

$$f_{in} = n * f_{LO} + f_{IF}$$

Where:

$f_{in}$ : Frequency of input signal

$n$ : Order of harmonic used for conversion

$f_{IF}$ : Intermediate frequency (variable; defined internally depending on RBW and span)

Thus, depending on the required frequency band, the appropriate order of harmonic must be selected. For commonly required frequency ranges, predefined bands with the appropriate harmonic order setting are provided. By default, the lowest harmonic order is selected that allows conversion of input signals in the whole band.

The frequency ranges for pre-defined bands are described in [Table 6-4](#).



Changes to the band and mixer settings are maintained even after using the [PRESET] function. A "Preset band" function allows you to restore the original band settings.

### Extending predefined ranges

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

### Additional ranges

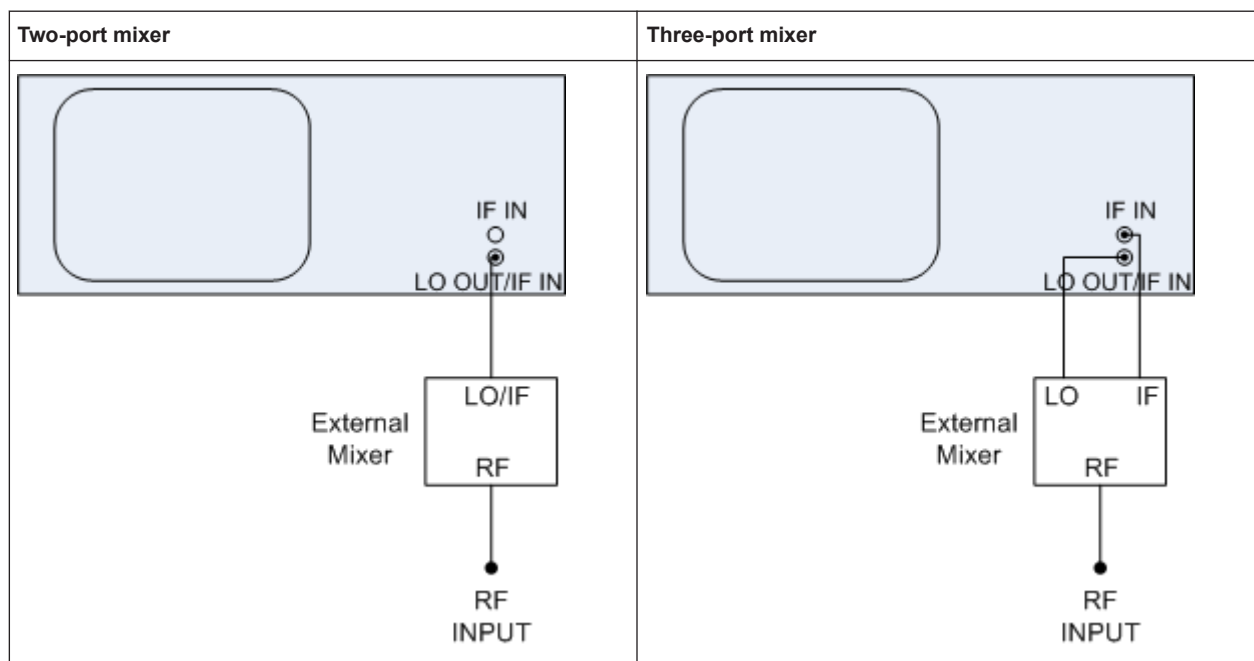
If due to the LO frequency the conversion of the input signal is not possible using one harmonic, the band must be split. An adjacent, partially overlapping frequency range can be defined using different harmonics. In this case, the sweep begins using the harmonic defined for the first range, and at a specified frequency in the overlapping range ("handover frequency"), switches to the harmonic for the second range.

Which harmonics are supported depends on the mixer type.

### Two-port and three-port mixers

External mixers are connected to the R&S ESW at the LO OUT/IF IN and IF IN connectors.

When using three-port mixers, the LO signal output from the R&S ESW and the IF input from the mixer are transmitted on separate connectors, whereas for two-port mixers, both signals are exchanged via the same connector (LO OUT/IF IN). Because of the diplexer contained in the R&S ESW, the IF signal can be tapped from the line which is used to feed the LO signal to the mixer.



In both cases, the nominal LO level is 15.5 dBm.

### Bias current

Single-diode mixers generally require a DC voltage which is applied via the LO line. This DC voltage is to be tuned to the minimum conversion loss versus frequency. Such a DC voltage can be set via the "BIAS" function using the D/A converter of the R&S ESW. The value to be entered is not the voltage but the short-circuit current. The current is defined in the "Bias Settings" or set to the value of the conversion loss table.

See "Bias Value" on page 269 and "Bias" on page 272.

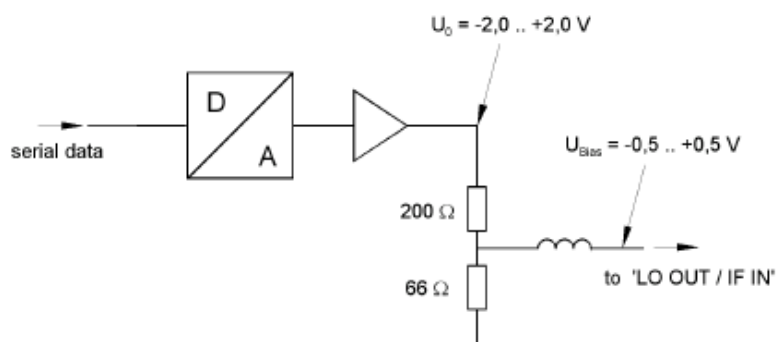


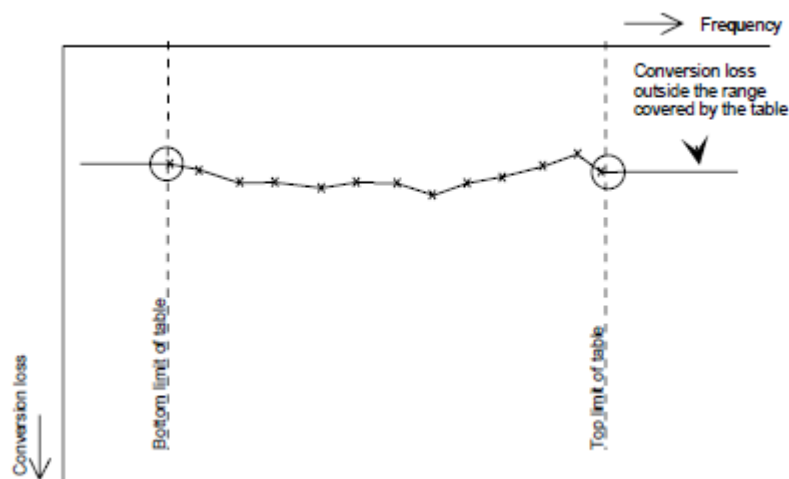
Figure 4-14: Bias circuit of the R&S ESW

The voltage  $U_0$  at the output of the operational amplifier can be set in the range  $-2.0$  V to  $+2.0$  V. An open-circuit voltage  $U_{\text{bias}}$  of  $-0.5$  V to  $+0.5$  V is obtained accordingly at the output of the voltage divider. A short-circuit current of  $I_{\text{short}} = U_0 / 200 \, \Omega = 10$  mA to

+10 mA is obtained for a short circuit at the output of the voltage divider. In order to use biasing it is not important to know the exact current flowing through the diode since the conversion loss must be set to a minimum with the frequency. Therefore, it makes no difference whether the setting is performed by an open-circuit voltage or by a short-circuit current. A DC return path is ensured via the 66  $\Omega$  resistor, which is an advantage in some mixers.

### Conversion loss tables

Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. Correction values for frequencies between the reference values are obtained by interpolation. Linear interpolation is performed if the table contains only two values. If it contains more than two reference values, spline interpolation is carried out. Outside the frequency range covered by the table the conversion loss is assumed to be the same as that for the first and last reference value (see [Figure 4-15](#)).



**Figure 4-15: Conversion loss outside the band's frequency range**

Predefined conversion loss tables are often provided with the external mixer and can be imported to the R&S ESW.

Alternatively, you can define your own conversion loss tables. Conversion loss tables are configured and managed in the "Conversion loss Table Settings" tab of the "External Mixer Configuration" dialog box.

See ["Managing conversion loss tables"](#) on page 270 for more information about conversion loss tables.

### Importing CVL tables

The conversion loss table to be used for a particular measurement range is also defined in the "External Mixer Configuration" dialog box.

The frequency range that the cvl table must cover depends on the used IF, which varies depending on the instrument and installed bandwidth extension options. Thus,

external mixers from Rohde & Schwarz provide multiple conversion loss table files. When you select a storage path containing cvl files, or a particular cvl file from a Rohde & Schwarz mixer for import, all available files are copied to the `C:\R_S\Instr\User\cvl\` directory on the R&S ESW. Provided `.acl` files are renamed according to the following syntax:

`<serial_number>_<harmonic_order>_<IF>.acl`,

e.g. `12345_2_1330M.acl`

To select a conversion loss table for use in a measurement, you merely have to select the serial number for the external mixer in use. The R&S ESW automatically selects the correct cvl file for the current IF. As an alternative, you can also select a user-defined conversion loss table (`.acl` file).



Before copying any files to the `C:\R_S\Instr\User\cvl\` directory, the R&S ESW firmware moves any existing user-defined cvl tables to a `backup` subdirectory. To use a user-defined cvl table later, select the file in the `C:\R_S\Instr\User\cvl\backup` directory.

A validation check is then performed on the selected table to ensure that it complies with the settings. In particular, the following is checked:

- The assigned band name
- The harmonic order
- The mixer type
- The table must contain at least one frequency that lies within the frequency range for the band

### Reference level

The maximum possible reference level depends on the maximum used conversion loss value. Thus, the reference level can be adjusted for each range according to the used conversion loss table or average conversion loss value. If a conversion loss value is used which exceeds the maximum reference level, the reference level is adjusted to the maximum value permitted by the firmware.

### Automatic signal identification

Automatic signal identification allows you to compare the upper and lower band results of the mixer, thus detecting unwanted mixer products due to conversion.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

### Signal ID function

Two sweeps are performed alternately. Trace 1 shows the trace measured on the upper side band (USB) of the LO (the test sweep), trace 2 shows the trace measured on the lower side band (LSB), i.e. the reference sweep.

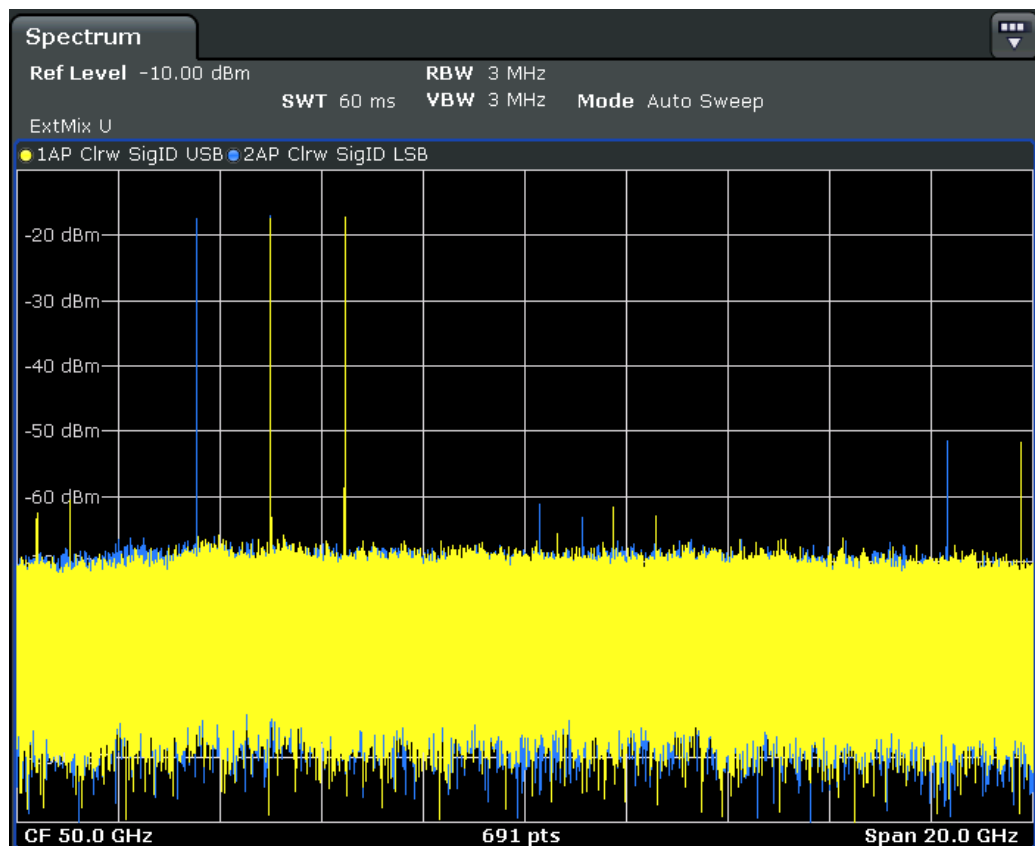


Figure 4-16: Signal identification function (Signal ID) with optional external mixer

The reference sweep is performed using an LO setting shifted downwards by  $2 \cdot \text{IF} / \langle \text{Harmonic order} \rangle$ . Input signals in the desired sideband that are converted using the specified harmonic are displayed in both traces at the same position on the frequency axis. Image signals and mixer products caused by other harmonics are displayed at different positions in both traces. The user identifies the signals visually by comparing the two traces.

Since the LO frequency is displaced downwards in the reference sweep, the conversion loss of the mixer may differ from the test sweep. Therefore the signal level should only be measured in the test sweep (trace 1).

#### Auto ID function

The Auto ID function basically functions like [Signal ID function](#). However, the test and reference sweeps are converted into a single trace by a comparison of maximum peak values of each sweep point. The result of this comparison is displayed in trace 3 if "Signal ID" is active at the same time. If "Signal ID" is not active, the result can be displayed in any of the traces 1 to 3. Unwanted mixer products are suppressed in this calculated trace.



### Test sweep and reference sweep traces

Depending on which of the automatic signal identification functions are used, the traces are used to display either the test sweep (the upper side-band sweep) or the reference sweep (lower side-band sweep).

| Function            | Trace 1                   | Trace 2                   | Trace 3 |
|---------------------|---------------------------|---------------------------|---------|
| Signal ID           | Signal ID upper side-band | Signal ID lower side-band | -       |
| Auto ID             | Auto ID                   | -                         | -       |
| Signal ID + Auto ID | Signal ID upper side-band | Signal ID lower side-band | Auto ID |

### Tolerance for the comparison of test sweep and reference

Since the LO frequency is displaced downwards in the reference sweep, the conversion loss of the mixer may differ from that of the test sweep. This is due to the fact that the LO output power of the R&S ESW varies with the frequency, and also due to the non-ideal characteristics of the mixer. A certain tolerance should therefore be permitted for the comparison of the signal levels in the test sweep and reference sweep. A user-defined threshold is used to determine deviations.

### Auto ID detection threshold

Real input signals are displayed at the same frequency in the test and reference sweeps, i.e. theoretically, identical signal levels are expected at the frequency of the real mixer product in both sweeps. If the level difference is lower than the user-defined threshold, the signal obtained in the test sweep is displayed. If a signal occurs only in the test sweep or reference sweep, it is an unwanted mixer product. The level of this signal is compared to the noise floor in the other sweep. If the S/N ratio is sufficiently large, the threshold is exceeded. This means that the signal with the lower level, i.e. noise in this case, is displayed.

Note that the Auto ID method operates according to the fail-safe principle, i.e. unwanted mixer products may not be detected as such but signals which are in fact real input signals are not blanked out.

### Time-constant spectrum

The automatic comparison of the test sweep and reference sweep with the Auto ID function can only be applied usefully for signals with a time-constant spectrum since the two sweeps are always required to determine the actual spectrum.

### Mixer products with low S/N ratio

If the S/N ratio of a mixer product is lower than the user-defined threshold, the level difference between the test sweep and reference sweep at the frequency of this mixer product is always within limits, even if the signal occurs in one of the sweeps only. Such mixer products cannot be identified by the Auto ID function. It is therefore recommended that you perform a visual comparison of the test sweep and reference sweep using the Signal ID function.

**Examining unwanted mixer products with small span**

With large spans in which non-modulated sine-wave signals are represented as single lines, unwanted mixer products are generally completely blanked out. However, if you examine the frequency range containing a blanked signal in detail using a small span, e.g. an image-frequency response, part of the signal may nevertheless be displayed. This happens when the displayed components of a blanked signal have a level difference which is smaller than the user-defined threshold when compared with the noise floor. These components are therefore not blanked out.

An unwanted signal with an S/N ratio that corresponds approximately to the user-defined threshold may not be blanked out permanently. Due to the fact that the noise display varies from one sweep to another, the S/N ratio changes and thus the level difference between the test sweep and reference sweep measured at a frequency changes as well. As a result, the criterion for detecting unwanted signals is not fulfilled. To blank out unwanted signals permanently, an almost constant noise indication is therefore required. This can be achieved by reducing the video bandwidth. Since the average noise indication lies well below the generated noise peak values, the minimum level diminishes. For identification using the Auto ID function, signals should have this minimum noise level.

**Display of mixer products at the same frequency**

If the input signal consists of a very large number of spectral components, it will become more and more probable that two different unwanted mixer products will be displayed at the same frequency in the test sweep and reference sweep.

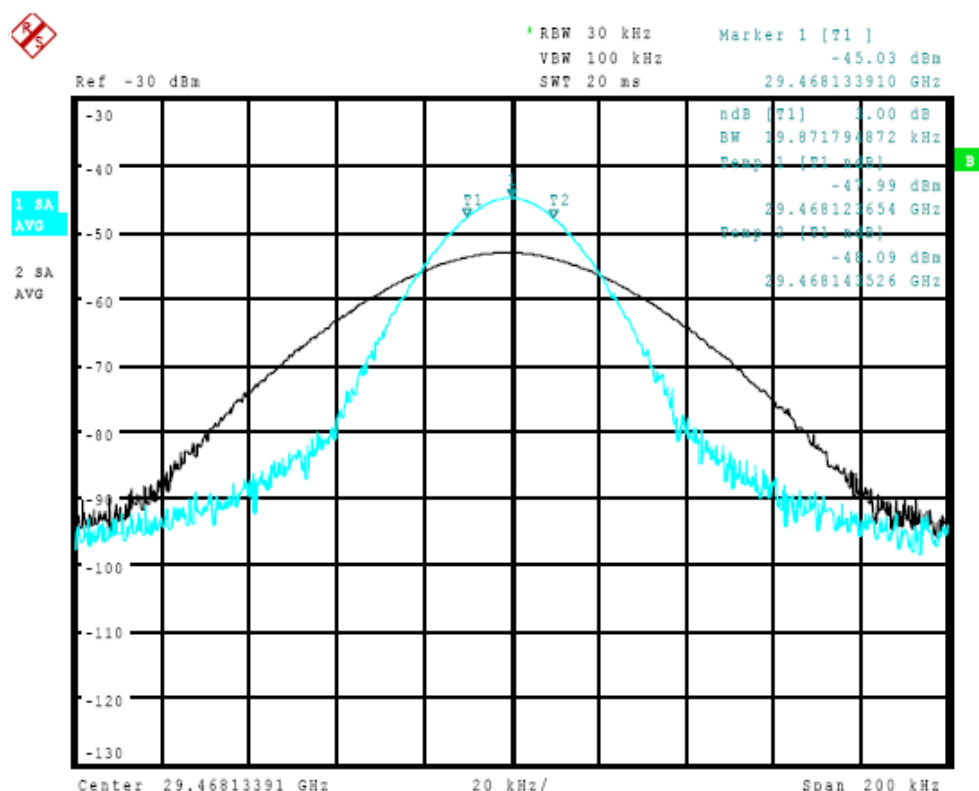


Figure 4-17: Different mixer products displayed at the same frequency in the test sweep and reference sweep (large span)

#### Example:

The external mixer is set to use the 2nd order harmonic. The signal recorded in the test sweep is displayed by trace 1. The IF filter of the R&S ESW is represented at a 3 dB bandwidth of 20 kHz, the real IF bandwidth being 30 kHz. If, however, the 3 dB bandwidth of the signal recorded in the reference sweep is examined (trace 2), it will be found to be larger exactly by a factor of 2. This shows that the two products were generated by mixing with LO harmonics of different orders. The signal recorded in the test sweep was generated by mixing with the 3rd order harmonic. Since the frequency axis scaling is based on the 2nd order, the mixer product or the resulting diagram of the IF filter is compressed by a factor of 2/3. The signal recorded in the reference sweep was generated by mixing with the fundamental of the LO signal. Since the frequency axis scaling is based on the 2nd order, the mixer product or the resulting diagram of the IF filter is expanded by a factor of 2.

Automatic identification with a large span is not possible since the two mixer products are displayed at the same frequency. The diagram shown in Figure 4-18 is obtained when examining products with a narrow span using the Auto ID function. You can easily recognize unwanted mixer products in the diagram obtained using one of the automatic detection functions.

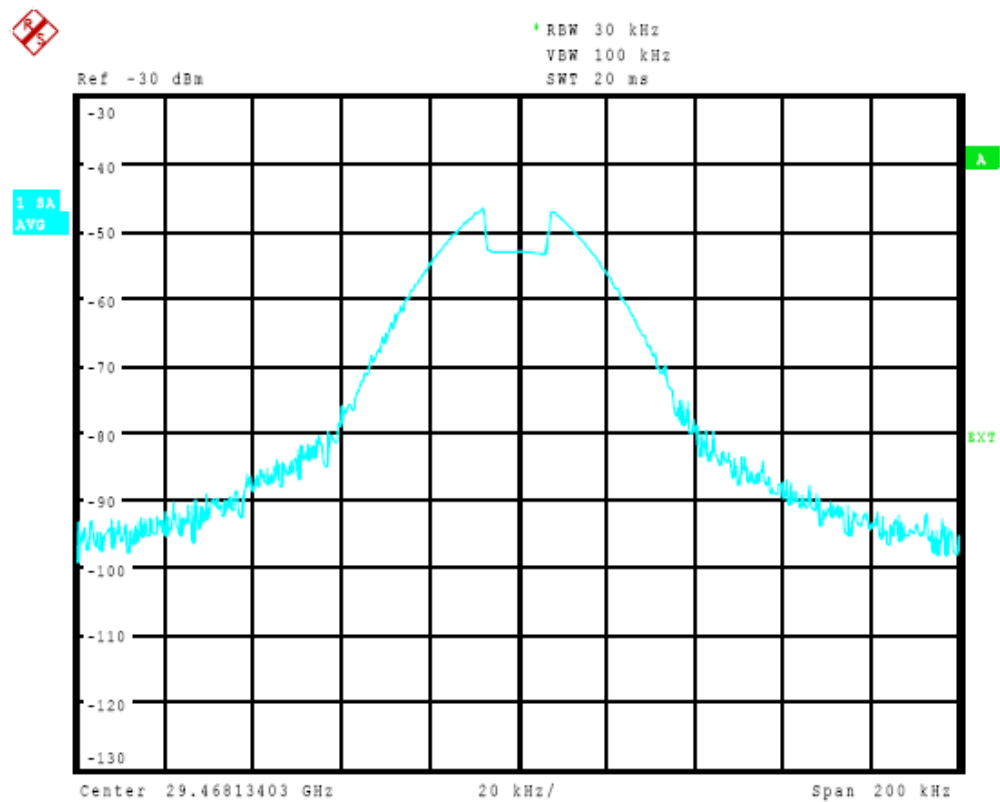


Figure 4-18: Unwanted mixer products displayed for small span

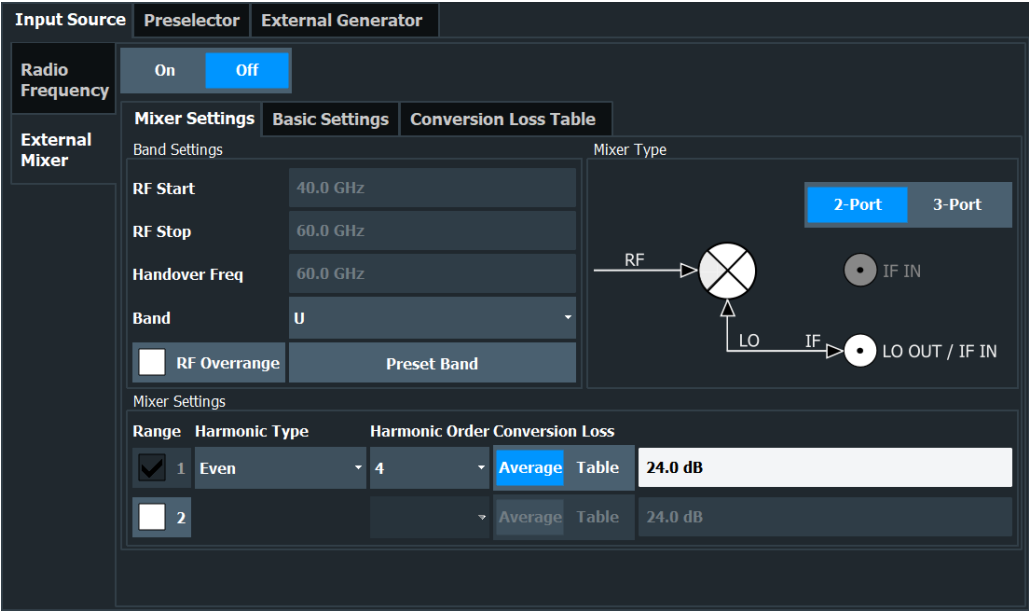
#### 4.3.5.2 External mixer settings

Access: [INPUT/OUTPUT] > "External Mixer Config"

- [Mixer settings](#).....264
- [Basic settings](#).....268
- [Managing conversion loss tables](#).....270
- [Creating and editing conversion loss tables](#).....271

##### Mixer settings

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



External Mixer (State)..... 265

RF Start / RF Stop..... 265

Handover Freq..... 266

Band..... 266

RF Overrange..... 266

Preset Band..... 266

Mixer Type..... 266

Mixer Settings (Harmonics Configuration)..... 267

L Range 1/Range 2..... 267

L Harmonic Type..... 267

L Harmonic Order..... 267

L Conversion Loss..... 267

**External Mixer (State)**  
Activates or deactivates the external mixer for input. If activated, "ExtMix" is indicated in the channel bar of the application, together with the used band (see "Band" on page 266).

Remote command:  
[SENSe:]MIXer<x>[:STATe] on page 643

**RF Start / RF Stop**  
Displays the start and stop frequency of the selected band (read-only).  
The frequency range for the user-defined band is defined via the harmonics configuration (see "Range 1/Range 2" on page 267).  
For details on available frequency ranges, see table 6-4 on page 639.

Remote command:  
[SENSe:]MIXer<x>:FREQuency:START on page 637  
[SENSe:]MIXer<x>:FREQuency:STOP on page 638

**Handover Freq**

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

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

Remote command:

[\[SENSe:\]MIXer<x>:FREQuency:HANDoVer](#) on page 637

**Band**

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

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

For a definition of the frequency range for the pre-defined bands, see [table 6-4 on page 639](#).

The mixer settings for the user-defined band can be selected freely. The frequency range for the user-defined band is defined via the harmonics configuration (see ["Range 1/Range 2"](#) on page 267).

Remote command:

[\[SENSe:\]MIXer<x>:HARMonic:BAND](#) on page 638

**RF Overrange**

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

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

Remote command:

[\[SENSe:\]MIXer<x>:RFOVerrange\[:STATe\]](#) on page 642

**Preset Band**

Restores the presettings for the selected band.

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

Remote command:

[\[SENSe:\]MIXer<x>:HARMonic:BAND:PRESet](#) on page 638

**Mixer Type**

The External Mixer option supports the following external mixer types:

- |          |                                   |
|----------|-----------------------------------|
| "2 Port" | LO and IF data use the same port  |
| "3 Port" | LO and IF data use separate ports |

Remote command:

`[SENSe:]MIXer<x>:PORTs` on page 641

### Mixer Settings (Harmonics Configuration)

The harmonics configuration determines the frequency range for user-defined bands (see ["Band"](#) on page 266).

#### Range 1/Range 2 ← Mixer Settings (Harmonics Configuration)

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

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

Remote command:

`[SENSe:]MIXer<x>:HARMonic:HIGH:STATe` on page 643

#### Harmonic Type ← Mixer Settings (Harmonics Configuration)

Defines if only even, only odd, or even and odd harmonics can be used for conversion. Depending on this selection, the order of harmonic to be used for conversion changes (see ["Harmonic Order"](#) on page 267). Which harmonics are supported depends on the mixer type.

Remote command:

`[SENSe:]MIXer<x>:HARMonic:TYPE` on page 639

#### Harmonic Order ← Mixer Settings (Harmonics Configuration)

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

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

Remote command:

`[SENSe:]MIXer<x>:HARMonic[:LOW]` on page 640

`[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue]` on page 639

#### Conversion Loss ← Mixer Settings (Harmonics Configuration)

Defines how the conversion loss is handled. The following methods are available:

- |           |   |
|-----------|---|
| "Average" | Defines the average conversion loss for the entire frequency range in dB.   |
| "Table"   | Defines the conversion loss via the table selected from the list. Pre-defined conversion loss tables are often provided with the external mixer and can be imported to the R&S ESW. Alternatively, you can define your own conversion loss tables. Imported tables are checked for compatibility with the current settings before being assigned. For details on conversion loss tables, see <a href="#">"Conversion loss tables"</a> on page 258. For details on importing tables, see <a href="#">"Import Table"</a> on page 271. |

Remote command:  
Average for range 1:  
[SENSe:]MIXer<x>:LOSS[:LOW] on page 641  
Table for range 1:  
[SENSe:]MIXer<x>:LOSS:TABLE[:LOW] on page 641  
Average for range 2:  
[SENSe:]MIXer<x>:LOSS:HIGH on page 640  
Table for range 2:  
[SENSe:]MIXer<x>:LOSS:TABLE:HIGH on page 640

Basic settings

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

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

Input Source

Preselector

External Generator

Radio Frequency

On

Off

External Mixer

Mixer Settings

Basic Settings

Conversion Loss Table

Signal Identification Settings

Signal ID

On

Off

Auto ID

On

Off

Auto ID Threshold

10.0 dB

LO Level

15.5 dBm

Bias Settings Range 1

Bias Value

0 A

CVL Table not selected

Bias Settings Range 2

Bias Value

0 A

CVL Table not selected

|                           |     |
|---------------------------|-----|
| LO Level.....             | 268 |
| Signal ID.....            | 269 |
| Auto ID.....              | 269 |
| Auto ID Threshold.....    | 269 |
| Bias Value.....           | 269 |
| L Write to CVL table..... | 270 |

**LO Level**  
Defines the LO level of the external mixer's LO port. Possible values are from 13.0 dBm to 17.0 dBm in 0.1 dB steps. Default value is 15.5 dB.  
Remote command:  
[SENSe:]MIXer<x>:LOPower on page 644



### Signal ID

Activates or deactivates visual signal identification. Two sweeps are performed alternately. Trace 1 shows the trace measured on the upper side band (USB) of the LO (the test sweep). Trace 2 shows the trace measured on the lower side band (LSB), i.e. the reference sweep.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in the VSA or the I/Q Analyzer, for instance).

(See also ["Automatic signal identification"](#) on page 259).

Mathematical functions with traces and trace copy cannot be used with the Signal ID function.

Remote command:

`[SENSe:]MIXer<x>:SIGNal` on page 642

### Auto ID

Activates or deactivates automatic signal identification.

Auto ID basically functions like [Signal ID](#). However, the test and reference sweeps are converted into a single trace by a comparison of maximum peak values of each sweep point. The result of this comparison is displayed in trace 3 if "Signal ID" is active at the same time. If "Signal ID" is not active, the result can be displayed in any of the traces 1 to 3. Unwanted mixer products are suppressed in this calculated trace.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

(See also ["Automatic signal identification"](#) on page 259).

Remote command:

`[SENSe:]MIXer<x>:SIGNal` on page 642

### Auto ID Threshold

Defines the maximum permissible level difference between test sweep and reference sweep to be corrected during automatic comparison (["Auto ID"](#) on page 269 function). The input range is between 0.1 dB and 100 dB. Values of about 10 dB (i.e. default setting) generally yield satisfactory results.

(See also ["Automatic signal identification"](#) on page 259).

Remote command:

`[SENSe:]MIXer<x>:THReshold` on page 643

### Bias Value

Define the bias current for each range, which is required to set the mixer to its optimum operating point. It corresponds to the short-circuit current. The bias current can range from -10 mA to 10 mA. The actual bias current is lower because of the forward voltage of the mixer diode(s).

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

To store the bias setting in the currently selected conversion loss table, select [Write to CVL table](#).

Remote command:  
[SENSe:]MIXer<x>:BIAS[:LOW] on page 637  
[SENSe:]MIXer<x>:BIAS:HIGH on page 636

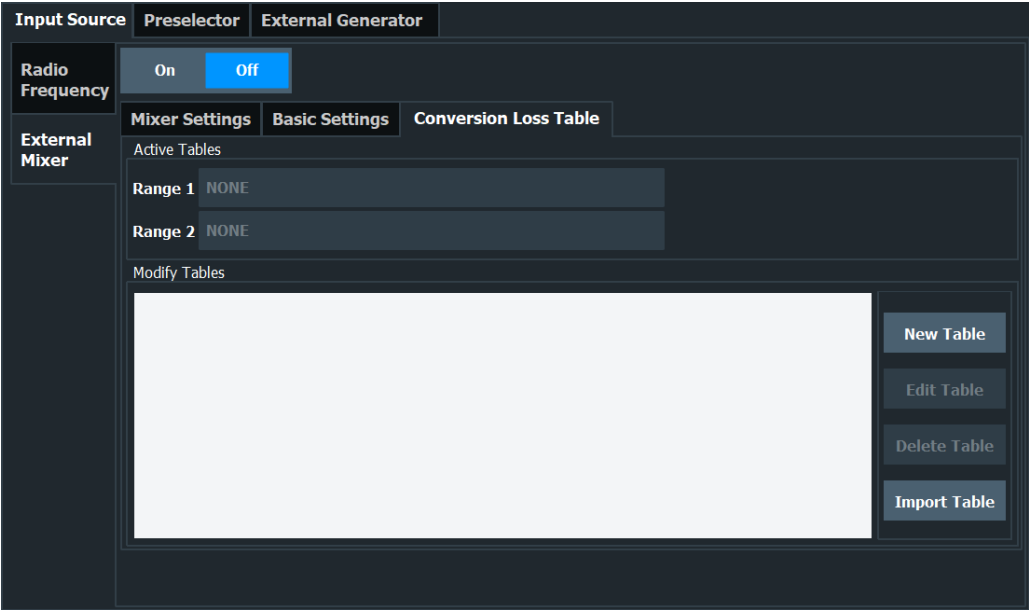
**Write to CVL table ← Bias Value**  
Stores the bias setting in the currently selected "Conversion Loss Table" for the range. If no conversion loss table is selected yet, this function is not available ("CVL Table not selected").  
(See "Conversion Loss" on page 267).

Remote command:  
[SENSe:]CORRection:CVL:BIAS on page 633

Managing conversion loss tables

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

In this tab, you configure and manage conversion loss tables. Conversion loss tables consist of value pairs that describe the correction values for conversion loss at certain frequencies. The correction values for frequencies between the reference points are obtained via interpolation.  
The currently selected table for each range is displayed at the top of the dialog box. All conversion loss tables found in the instrument's C:\R\_S\Instr\User\cvl\ directory are listed in the "Modify Tables" list.



New Table..... 271  
Edit Table..... 271  
Delete Table..... 271  
Import Table..... 271

**New Table**

Opens the "Edit conversion loss table" dialog box to configure a new conversion loss table.

For details on table configuration, see ["Creating and editing conversion loss tables"](#) on page 271.

Remote command:

[\[SENSe:\]CORRection:CVL:SElect](#) on page 636

**Edit Table**

Opens the "Edit conversion loss table" dialog box to edit the selected conversion loss table.

For details on table configuration, see ["Creating and editing conversion loss tables"](#) on page 271.

Remote command:

[\[SENSe:\]CORRection:CVL:SElect](#) on page 636

**Delete Table**

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

Remote command:

[\[SENSe:\]CORRection:CVL:CLEar](#) on page 634

**Import Table**

Imports one or more stored conversion loss tables from any directory and copies them to the instrument's C:\R\_S\Instr\User\cvl\ directory. They can then be assigned for use for a specific frequency range (see ["Conversion Loss"](#) on page 267).

**Note:**

Before copying any files to the C:\R\_S\Instr\User\cvl\ directory, the R&S ESW firmware moves any existing user-defined cvl tables to a backup subdirectory. To use a user-defined cvl table later, select the file in the C:\R\_S\Instr\User\cvl\backup directory.

Remote command:

MMEM:COPY '<conversionlosstable>',C:\R\_S\Instr\User\cvl\  
See [MMEMory:COpy](#) on page 785

**Creating and editing conversion loss tables**

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

Conversion loss tables can be newly defined and edited.

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

|                                      |     |
|--------------------------------------|-----|
| <a href="#">File Name</a> .....      | 272 |
| <a href="#">Comment</a> .....        | 272 |
| <a href="#">Band</a> .....           | 272 |
| <a href="#">Harmonic Order</a> ..... | 272 |
| <a href="#">Bias</a> .....           | 272 |

|                     |     |
|---------------------|-----|
| Mixer Name.....     | 273 |
| Mixer S/N.....      | 273 |
| Mixer Type.....     | 273 |
| Position/Value..... | 273 |
| Insert Value.....   | 273 |
| Delete Value.....   | 273 |
| Shift x.....        | 274 |
| Shift y.....        | 274 |
| Save.....           | 274 |

### File Name

Defines the name under which the table is stored in the C:\R\_S\Instr\User\cvl\ directory on the instrument. The name of the table is identical to the name of the file (without extension) in which the table is stored. This setting is mandatory. The .ACL extension is automatically appended during storage.

Remote command:

[SENSe:]CORRection:CVL:SElect on page 636

### Comment

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

Remote command:

[SENSe:]CORRection:CVL:COMMeNt on page 634

### Band

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

For a definition of the frequency range for the pre-defined bands, see [table 6-4 on page 639](#).

Remote command:

[SENSe:]CORRection:CVL:BAND on page 632

### Harmonic Order

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

Remote command:

[SENSe:]CORRection:CVL:HARMOinic on page 635

### Bias

The bias current which is required to set the mixer to its optimum operating point. It corresponds to the short-circuit current. The bias current can range from -10 mA to 10 mA. The actual bias current is lower because of the forward voltage of the mixer diode(s).

**Tip:** You can also define the bias interactively while a preview of the trace with the changed setting is displayed, see ["Bias Value" on page 269](#).

Remote command:

[SENSe:]CORRection:CVL:BIAS on page 633

**Mixer Name**

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

Remote command:

[\[SENSe:\]CORRection:CVL:MIXer](#) on page 635

**Mixer S/N**

Specifies the serial number of the external mixer to which the table applies.

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

Remote command:

[\[SENSe:\]CORRection:CVL:SNUMber](#) on page 636

**Mixer Type**

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

Remote command:

[\[SENSe:\]CORRection:CVL:PORTs](#) on page 635

**Position/Value**

Each position/value pair defines the conversion loss value in dB for a specific frequency. Enter the reference values in order of increasing frequencies. You can define a maximum of 500 reference values. To enter a new value pair, select an empty space in the "Position"/"Value" table, or select [Insert Value](#).

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

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

Remote command:

[\[SENSe:\]CORRection:CVL:DATA](#) on page 634

**Insert Value**

Inserts a new position/value entry in the table.

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

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

**Delete Value**

Deletes the currently selected position/value entry.

**Shift x**

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

**Shift y**

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

**Save**

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

**4.3.5.3 How to work with external mixers**

The required tasks to work with external mixers are described step-by-step:

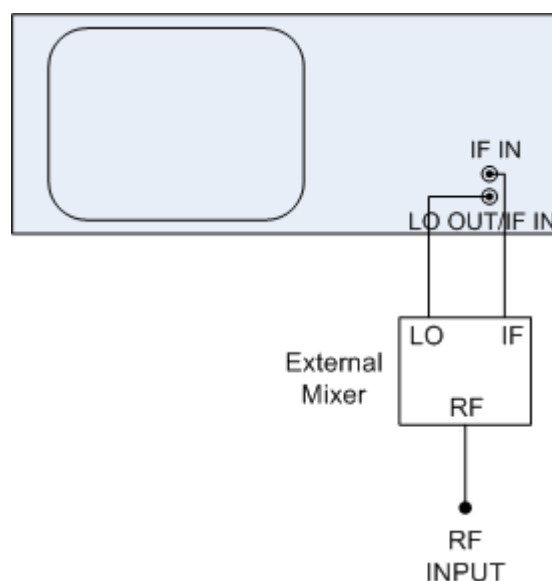
- ["To connect a three-port mixer"](#) on page 274
- ["To connect a two-port mixer"](#) on page 275
- ["To activate and configure the external mixer"](#) on page 275
- ["To define a new conversion loss table"](#) on page 276
- ["To shift the conversion loss values"](#) on page 276



For remote operation, see [Chapter 6.8.1.7, "Programming example: working with an external mixer"](#), on page 650.

**To connect a three-port mixer**

External mixers can be connected at the LO OUT/IF IN and IF IN female connectors (if option is installed). Both two-port and three-port mixers can be used. Connect the mixer as follows:

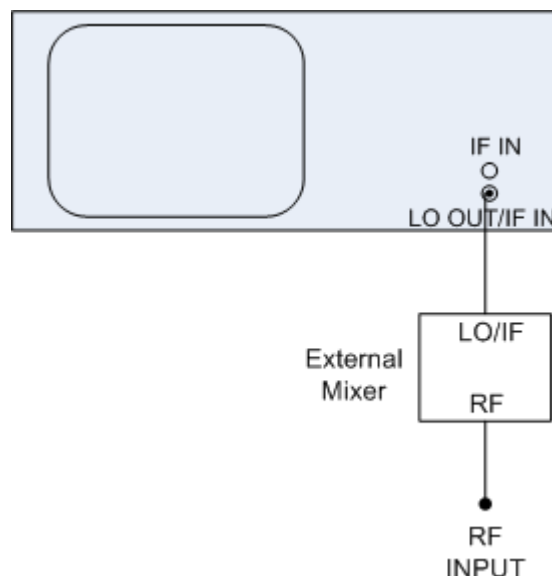




Use the supplied coaxial cable to feed in the LO signal. If no external mixers are connected to the R&S ESW, cover the two front connectors [LO OUT / IF IN] and [IF IN] with the SMA caps supplied.

1. Connect the LO OUT / IF IN output of the R&S ESW to the LO port of the external mixer.
2. Connect the IF IN input of the R&S ESW to the IF port of the external mixer.
3. Feed the signal to be measured to the RF input of the external mixer.

#### To connect a two-port mixer



1. Connect the LO OUT / IF IN output of the R&S ESW to the LO/IF port of the external mixer. The nominal LO level is 15.5 dBm.  
Because of the diplexer contained in the R&S ESW, the IF signal can be tapped from the line which is used to feed the LO signal to the mixer.
2. Feed the signal to be measured to the RF input of the external mixer.

#### To activate and configure the external mixer

1. Select "INPUT > Input Source Config > External Mixer: ON" to activate the external mixer for the current application.
2. Select "Mixer Settings > Band" to define the required frequency range.
3. From the "Band" selection list, select the required band.
4. In the Mixer Settings, select "Conversion Loss: Table" for Range 1 to define frequency-dependent level correction.
5. From the selection list, select a conversion loss table stored on the instrument. No further settings are necessary since the selected file contains all required parameters.

ters. If the selected table is not valid for the selected band, an error message is displayed.

If no conversion loss table is available yet, create a new table first (as described in ["To define a new conversion loss table"](#) on page 276).

6. Optionally, select "Basic Settings> Auto ID: On" to activate automatic signal identification.
7. If necessary, adapt the tolerance limit by selecting "Basic Settings> Auto ID Threshold".

#### To define a new conversion loss table

1. Select "INPUT > Input Source Config > External Mixer > Conversion Loss Table".
2. Select "New Table".
3. Define a file name and, optionally, a comment for the new table.
4. Define the band and mixer settings for which the conversion loss table is to be used. These settings will be compared to the current mixer settings during the validation check when the table is imported.
5. Define the reference values for the frequency-dependant conversion loss:
  - a) Select "Insert Value" to add a new row in the table.
  - b) Enter the first reference frequency.
  - c) Enter the corresponding conversion loss value.  
The conversion loss function is updated and displayed in the preview diagram in the dialog box.
  - d) Repeat these steps to define up to 500 reference values. Remember to define the values in ascending order of frequencies.
6. Select "Save".

The table is stored and is then available for import and assignment to a specific frequency range.

#### To shift the conversion loss values

In order to increase each reference value in the conversion-loss table a constant value ( $a_0$ ), the values can be shifted either in x-direction or in y-direction.

1. Select "INPUT > Input Source Config > External Mixer > Conversion Loss Table".
2. Select the assigned conversion loss table.
3. Select "Edit Table".
4. Select "Shift y" and enter the constant value  $<a_0>$  to shift all y-values in the table by this value.  
Or:  
Select "Shift x" and enter the constant value  $<a_0>$  to shift all x-values in the table by this value.



5. Select "Save".

#### 4.3.5.4 Measurement examples: using an external mixer

##### Measurement example 1: two-port mixer

The following example demonstrates the basic operation of an external two-port mixer as well as the required settings. A sine wave signal with  $f = 14.5$  GHz is applied to the input of a multiplier. The spectrum at the multiplier output is to be recorded in the range of 52 GHz to 60 GHz using a 2-port mixer for the V band. The mixer used is a double-diode mixer. The example of operation is described in the following steps:

- ["To set up the measurement"](#) on page 277
- ["To activate and configure the external mixer"](#) on page 278
- ["To take into account the cable loss in the IF path"](#) on page 278

##### To set up the measurement

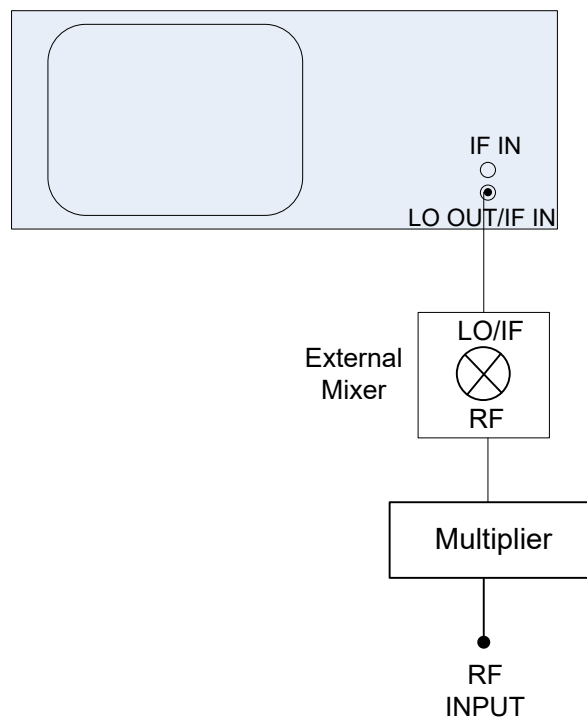


Figure 4-19: External Mixer test setup

1. Connect the [LO OUT / IF IN] output of the R&S ESW to the [LO/IF] port of the external mixer.
2. Connect the multiplier to the RF input of the external mixer.
3. Apply a sine wave signal with  $f = 14.5$  GHz to the input of the multiplier.

**To activate and configure the external mixer**

1. Select "INPUT > Input Source Config > External Mixer: ON" to activate the external mixer for the current application.
2. Select "Mixer Settings > Band" to define the required frequency range.
3. From the "Band" selection list, select the band "V".
4. In the Mixer Settings, select "Conversion Loss: Table" for Range 1 to define frequency-dependent level correction.
5. From the selection list, select a conversion loss table stored on the instrument. No further settings are necessary since the selected file contains all required parameters. If the selected table is not valid for the selected band, an error message is displayed.  
If no conversion loss table is available yet, create a new table first (as described in ["To define a new conversion loss table"](#) on page 276).
6. A span is automatically set which covers the whole V band (50 GHz to 75 GHz).
7. Reduce the video bandwidth by selecting "BW > Video Bandwidth Manual": 1 MHz. This allows for correct signal identification using the Auto ID function (see also ["Automatic signal identification"](#) on page 259).
8. Select "Basic Settings> Auto ID: On" to activate automatic signal identification.
9. Adapt the tolerance limit by selecting "Basic Settings> Auto ID Threshold". The tolerance limit is set to 5 dB in this example.

**To take into account the cable loss in the IF path**

On performing level correction, the conversion loss of the mixer and also the insertion loss  $a_0$  of the cable used to tap off the IF signal are to be taken into account. This additional loss is frequency-dependent.

1. Determine the insertion of the cable at the used intermediate frequency.
2. Increase each reference value in the conversion-loss table by the insertion loss ( $a_0$ ).
  - a) Select "INPUT > Input Source Config > External Mixer > Conversion Loss Table".
  - b) Select the assigned conversion loss table.
  - c) Select "Edit Table".
  - d) Select "Shift y" and enter the insertion loss value  $<a_0>$  to shift all y-values in the table by this value.
3. Select "Save".

**4.3.6 Output settings**

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

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

- [Configuring outputs \(IF / video / demodulation\)](#).....279
- [Configuring line impedance stabilization networks \(LISN\)](#).....279
- [Configuring additional outputs](#).....279

4.3.6.1    **Configuring outputs (IF / video / demodulation)**

The R&S ESW provides several outputs that you can use to transfer a signal to other devices. The R&S ESW allows you to configure the output as required.

The output functionality is similar to that in Receiver application.

For more information refer to the R&S ESW User Manual.

Note that audio output in the Spectrum application is only possible in zero span mode.

4.3.6.2    **Configuring line impedance stabilization networks (LISN)**

The R&S ESW supports several LISN models and provides functionality to control these devices. The functionality is the same as in the Receiver application.

For more information refer to the R&S ESW User Manual.

4.3.6.3    **Configuring additional outputs**

**Access:** "Overview" > "Output" > "Additional Outputs"

The R&S ESW provides additional outputs that you can use for various tasks.

| Output Config      | LISN | Additional Outputs |               |
|--------------------|------|--------------------|---------------|
| Probe Power Supply |      | Probe1             | Probe2    Off |
| Trigger 2          |      | Input              | Output        |
| Trigger 3          |      | Input              | Output        |

|  |     |
|--|-----|
| <a href="#">Probe Power Supply</a> ..... | 279 |
| <a href="#">Trigger 2/3</a> .....        | 280 |
| L <a href="#">Output Type</a> .....      | 280 |
| L <a href="#">Level</a> .....            | 281 |
| L <a href="#">Pulse Length</a> .....     | 281 |
| L <a href="#">Send Trigger</a> .....     | 281 |

**Probe Power Supply**

Selects the probe connector that is supplied with power.

The probe power supply is a global setting - when you change it in one measurement channel, it is also changed in the others.

"Probe 1" Supplies the 3-pin probe connector with power.


"Probe 2" Supplies the 5-pin probe connector with power.

"Off" Turns off the power supply for the probe connectors.

Remote command:

`OUTPut<ou>:PROBe<pb>[:POWer]` on page 645

### Trigger 2/3

| Trigger Source | Trigger In/Out |  |
|----------------|----------------|--|
| Trigger 2      | <b>Input</b>   | Output   |
| Trigger 3      | Input          | <b>Output</b>  |
| Output Type    | User Defined   | Level <b>Low</b> High  |
| Pulse Length   | 100.0 µs       | Send Trigger  |

The trigger input and output functionality depends on how the variable "Trigger Input/Output" connectors are used.

"Trigger 1" "Trigger 1" is input only.

"Trigger 2" Defines the usage of the variable "Trigger Input/Output" connector on the front panel

"Trigger 3" Defines the usage of the variable "Trigger 3 Input/Output" connector on the rear panel

"Input" The signal at the connector is used as an external trigger source by the R&S ESW. Trigger input parameters are available in the "Trigger" dialog box.

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

Remote command:

`OUTPut:TRIGger<tp>:DIRection` on page 645

### Output Type ← Trigger 2/3

Type of signal to be sent to the output

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

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

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

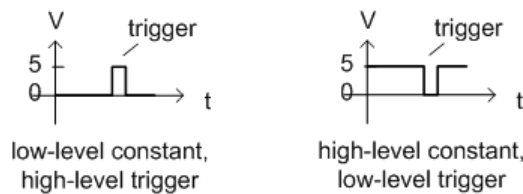
Remote command:

`OUTPut:TRIGger<tp>:OTYPe` on page 646

#### Level ← Output Type ← Trigger 2/3

Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector (for "Output Type": "User Defined").

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



Remote command:

`OUTPut:TRIGger<tp>:LEVel` on page 646

#### Pulse Length ← Output Type ← Trigger 2/3

Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:

`OUTPut:TRIGger<tp>:PULSe:LENGth` on page 647

#### Send Trigger ← Output Type ← Trigger 2/3

Sends a user-defined trigger to the output connector immediately.

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

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

Remote command:

`OUTPut:TRIGger<tp>:PULSe:IMMediate` on page 647

## 4.4 Frequency and span configuration

The frequency and span settings define the scope of the signal and spectrum to be analyzed with the R&S ESW.

- [Impact of the frequency and span settings](#)..... 282
- [Frequency and span settings](#)..... 283
- [Keeping the center frequency stable - signal tracking](#)..... 287
- [How to define the frequency range](#)..... 288
- [How to move the center frequency through the frequency range](#)..... 289

### 4.4.1 Impact of the frequency and span settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- [Defining the scope of the measurement - frequency range](#).....282
- [Stepping through the frequency range - center frequency stepsize](#)..... 282
- [Coping with large frequency ranges - logarithmic scaling](#).....282

#### 4.4.1.1 Defining the scope of the measurement - frequency range

The frequency range defines the scope of the signal and spectrum to be analyzed. It can either be defined as a span around a center frequency, or as a range from a start to a stop frequency. Furthermore, the full span comprising the entire possible frequency range can be selected, or a zero span. The full span option allows you to perform an overview measurement over the entire span. Using the "Last Span" function you can easily switch back to the detailed measurement of a specific frequency range.

For sinusoidal signals, the center frequency can be defined automatically by the R&S ESW as the highest frequency level in the frequency span (see ["Adjusting the Center Frequency Automatically \(Auto Frequency\)"](#) on page 329).

#### 4.4.1.2 Stepping through the frequency range - center frequency stepsize

Using the arrow keys you can move the center frequency in discrete steps through the available frequency range. The step size by which the center frequency is increased or decreased is defined by the "Center Frequency Stepsize".



The "Center Frequency Stepsize" also defines the step size by which the value is increased or decreased when you use the rotary knob to change the center frequency; however, the **rotary knob** moves in steps of only **1/10 of the "Center Frequency Stepsize"** to allow for a more precise setting.

By default, the step size is set in relation to the selected span or resolution bandwidth (for zero span measurements). In some cases, however, it may be useful to set the step size to other values.



For example, to analyze signal harmonics, you can define the step size to be equal to the center frequency. In this case, each stroke of the arrow key selects the center frequency of another harmonic. Similarly, you can define the step size to be equal to the current marker frequency.

#### 4.4.1.3 Coping with large frequency ranges - logarithmic scaling

In a linear display, the frequencies are distributed linearly across the x-axis. That means the entire frequency range is divided by the number of sweep points, and the distance between sweep points is equal. Linear scaling is useful to determine precise frequencies within a small range.



**Figure 4-20: Linear x-axis scaling: the distance between the sweep points is equal, e.g. 200 kHz**

However, if high and low frequencies appear in the same display, it is difficult to determine individual frequencies precisely or to distinguish frequencies that are close together.

In a logarithmic display, lower frequencies are distributed among a much larger area of the display, while high frequencies are condensed to a smaller area. Now it is much easier to distinguish several lower frequencies, as they are spread over a wider area. Logarithmic scaling is useful for overview measurements when a large frequency range must be displayed in one diagram.

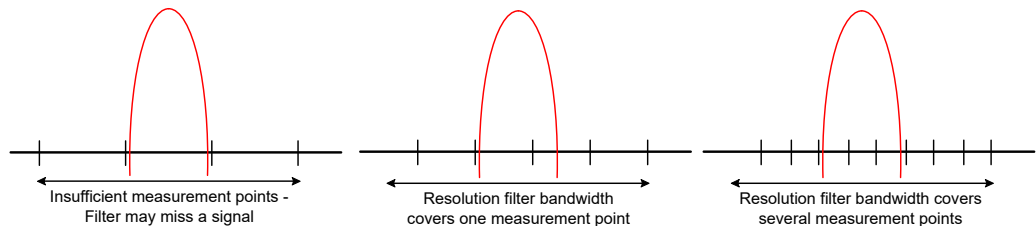
However, with logarithmic scaling, the frequency resolution between two sweep points deteriorates with higher frequencies.



**Figure 4-21: Logarithmic x-axis scaling: the distance between sweep points is variable**

In the spectrum from 10 Hz to 100 Hz, the distance is a few Hz. Between 100 MHz and 1 GHz, the distance is several MHz.

Thus, for logarithmic x-axis scaling, the number of sweep points must be sufficiently high in order to distinguish high frequencies precisely. The resolution bandwidth should cover at least one sweep point (that means: the distance between two sweep points should not exceed the RBW). If this condition is not met, signals or interferers could be missed, especially narrowband interferers.



#### 4.4.2 Frequency and span settings

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

For more information see [Chapter 4.4.4, "How to define the frequency range"](#), on page 288.

**Frequency**

**Frequency** **Signal Tracking**

Frequency/Span

|        |           |           |
|--------|-----------|-----------|
| Center | 13.25 GHz | Full Span |
| Span   | 26.5 GHz  | Zero Span |
| Start  | 0.0 Hz    | Last Span |
| Stop   | 26.5 GHz  |           |
| Axis   | Lin       | Log       |

Center Frequency Stepsize

Stepsize 0.1 \* Span X-Factor 10.0 %

Frequency Offset

Value 0.0 Hz

**Frequency**

**Frequency** **Signal Tracking**

State On Off

Tracking Bandwidth 2.65 GHz

Tracking Threshold -120.0 dBm

Signal Track Trace 1

|                                |     |
|--------------------------------|-----|
| Center Frequency.....          | 285 |
| Span.....                      | 285 |
| Start / Stop.....              | 285 |
| Frequency Axis Scaling.....    | 285 |
| Full Span.....                 | 286 |
| Zero Span.....                 | 286 |
| Last Span.....                 | 286 |
| Center Frequency Stepsize..... | 286 |
| Frequency Offset.....          | 287 |



**Center Frequency**

Defines the center frequency of the signal in Hertz.

The allowed range of values for the center frequency depends on the frequency span.

span > 0:  $\text{span}_{\min}/2 \leq f_{\text{center}} \leq f_{\max} - \text{span}_{\min}/2$

zero span:  $0 \text{ Hz} \leq f_{\text{center}} \leq f_{\max}$

$f_{\max}$  and  $\text{span}_{\min}$  depend on the instrument and are specified in the specifications document.

Remote command:

[\[SENSe:\] FREQuency: CENTer](#) on page 652

**Span**

Defines the frequency span. The center frequency is kept constant. The following range is allowed:

span = 0: 0 Hz

span > 0:

$\text{span}_{\min} \leq f_{\text{span}} \leq f_{\max}$

$f_{\max}$  and  $\text{span}_{\min}$  are specified in the specifications document.

For more information, see [Chapter 4.4.1.1, "Defining the scope of the measurement - frequency range"](#), on page 282.

Remote command:

[\[SENSe:\] FREQuency: SPAN](#) on page 654

**Start / Stop**

Defines the start and stop frequencies.

The following range of values is allowed:

$f_{\min} \leq f_{\text{start}} \leq f_{\max} - \text{span}_{\min}$

$f_{\min} + \text{span}_{\min} \leq f_{\text{stop}} \leq f_{\max}$

$f_{\min}$ ,  $f_{\max}$  and  $\text{span}_{\min}$  are specified in the specifications document.

Remote command:

[\[SENSe:\] FREQuency: START](#) on page 655

[\[SENSe:\] FREQuency: STOP](#) on page 655

**Frequency Axis Scaling**

Switches between linear and logarithmic scaling for the frequency axis.

Logarithmic scaling is only available for  $f_{\text{stop}} \geq 1.4 * f_{\text{start}}$ .

By default, the frequency axis has linear scaling. Logarithmic scaling of the frequency axis, however, is common for measurements over large frequency ranges as it enhances the resolution of the lower frequencies. On the other hand, high frequencies get more crowded and become harder to distinguish.

For more information see [Chapter 4.4.1.3, "Coping with large frequency ranges - logarithmic scaling"](#), on page 282.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing` on page 696

### Full Span

Sets the span to the full frequency range of the R&S ESW specified in the specifications document. This setting is useful for overview measurements.

Remote command:

`[SENSe:]FREQuency:SPAN:FULL` on page 655

### Zero Span

Sets the span to 0 Hz (zero span). The x-axis becomes the time axis with the grid lines corresponding to 1/10 of the current sweep time ("SWT").

For details see [Chapter 3.1, "Basic measurements"](#), on page 20.

Remote command:

`FREQ:SPAN 0Hz`, see `[SENSe:]FREQuency:SPAN` on page 654

### Last Span

Sets the span to the previous value. With this function you can switch between an overview measurement and a detailed measurement quickly.

Remote command:

`[SENSe:]FREQuency:SPAN` on page 654

### Center Frequency Stepsize

Defines the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob the center frequency changes in much smaller steps (1/10 the size as for the arrow keys).

The step size can be coupled to the span or the resolution bandwidth, or it can be manually set to a fixed value.

For more details see [Chapter 4.4.1.2, "Stepping through the frequency range - center frequency stepsize"](#), on page 282.

"0.1 \* Span" / "0.1 \* RBW"      Sets the step size for the center frequency to 10 % of the span / RBW.

This is the default setting.

"0.5 \* Span" / "0.5 \* RBW"      Sets the step size for the center frequency to 50 % of the span / RBW.

"x \* Span" / "x \* RBW"      Sets the step size for the center frequency to a manually defined factor of the span / RBW. The "X-Factor" defines the percentage of the span / RBW.

Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.

"= Center"      Sets the step size to the value of the center frequency and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.

- "= Marker" This setting is only available if a marker is active. Sets the step size to the value of the current marker and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.
- "Manual" Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:

[SENSe:] FREQuency:CENTer:STEP:LINK on page 653

[SENSe:] FREQuency:CENTer:STEP:LINK:FACTOR on page 654

[SENSe:] FREQuency:CENTer:STEP on page 653

### Frequency Offset

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

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

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

The allowed values range from -1 THz to 1 THz. The default setting is 0 Hz.

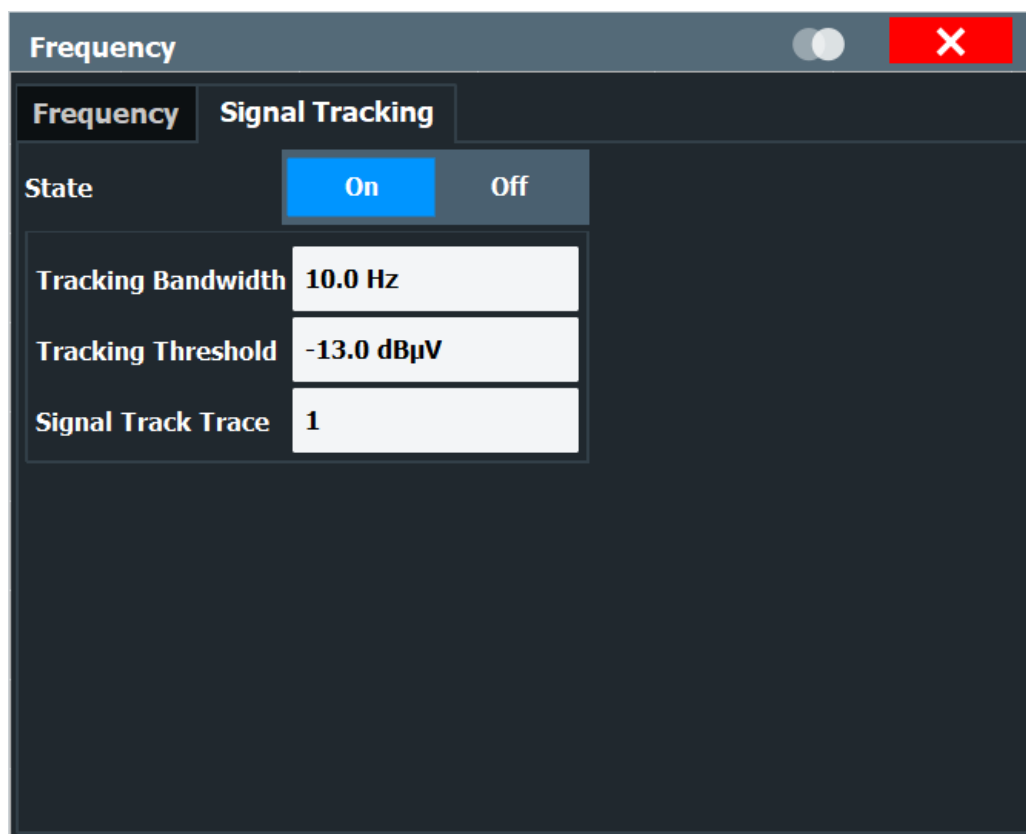
Remote command:

[SENSe:] FREQuency:OFFSet on page 654

## 4.4.3 Keeping the center frequency stable - signal tracking

Note: in the Receiver application, signal tracking is available for the IF analysis.

If the signal drifts on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**. In this case, the signal trace is surveyed in a specified bandwidth around the expected center frequency. After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above a defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".



### Signal Tracking

**Access:** "Overview" > "Frequency" > "Signal Tracking" tab

Defines the settings for signal tracking. These settings are only available for spans > 0.

For more details see [Chapter 4.4.3, "Keeping the center frequency stable - signal tracking"](#), on page 287.

If activated, after each sweep, the center frequency is set to the maximum level of the specified "Signal Track Trace" found within the searched "Tracking Bandwidth".

If the signal level does not pass the "Tracking Threshold", the center frequency is not changed.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:STRack[:STATe]` on page 656

`CALCulate<n>:MARKer<m>:FUNCTION:STRack:BANDwidth` on page 656

`CALCulate<n>:MARKer<m>:FUNCTION:STRack:THReshold` on page 657

`CALCulate<n>:MARKer<m>:FUNCTION:STRack:TRACe` on page 657

## 4.4.4 How to define the frequency range

The following step-by-step instructions demonstrate how to configure the frequency and span settings. For details on individual functions and settings see [Chapter 4.4.2, "Frequency and span settings"](#), on page 283.

The remote commands required to perform these tasks are described in [Chapter 6.8.2, "Frequency configuration"](#), on page 652.

### To configure the frequency and span

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box.

1. To display the "Frequency" dialog box, do one of the following:
  - Select "Frequency" from the "Overview".
  - Select [FREQ] and then "Frequency Config".
  - Select [SPAN] and then "Frequency Config".
2. Define the frequency range using one of the following methods:
  - Define the "Center Frequency" and "Span".
  - Define the "Start Frequency" and "Stop Frequency".
  - To perform a measurement in the time domain, define the "Center Frequency" and select "Zero Span".
  - To perform a measurement over the entire available frequency range, select "Full Span".
  - To return to the previously set frequency range, select "Last Span".

### 4.4.5 How to move the center frequency through the frequency range

In some cases it may be useful to move the center frequency through a larger frequency range, for example from one harmonic to another.

1. In the "Frequency" dialog box, define the "Center Frequency Stepsize". This is the size by which the center frequency is to be increased or decreased in each step. Enter a manual or relative value, or set the step size to the current center frequency or marker value. To move from one harmonic to the next, use the center frequency or marker value.
2. Select the "Center Frequency" dialog field.
3. Use the arrow keys to move the center frequency in discrete steps through the available frequency range.

## 4.5 Amplitude and vertical axis configuration

In the Spectrum application, measurement results usually consist of the measured signal levels (amplitudes) displayed on the vertical (y-)axis for the determined frequency spectrum or for the measurement time (horizontal, x-axis). The settings for the vertical axis, regarding amplitude and scaling, are described here.

- [Impact of the vertical axis settings](#)..... 290
- [Amplitude settings](#)..... 292
- [Scaling the y-axis](#)..... 295
- [How to optimize the amplitude display](#)..... 296

### 4.5.1 Impact of the vertical axis settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- [Reference level](#)..... 290
- [Scaling](#)..... 291

#### 4.5.1.1 Reference level

The reference level value is the maximum value the AD converter can handle without distortion of the measured value. Signal levels above this value will not be measured correctly, which is indicated by the "IF Overload" status display.

Internally, the reference level is also used to determine the optimum hardware settings for the R&S ESW. The defined reference level should correspond with the maximum expected RF input level.



When determining the expected input level, consider that the power from *all* input signals contribute to the total power. The reference level must be higher than the total power from all signals.

The optimum reference level for the current measurement settings can be set automatically by the R&S ESW (see "[Reference Level](#)" on page 292).

The reference level determines the amplitude represented by the topmost grid line in the display. When you change the reference level, the measurement is not restarted; the results are merely shifted in the display. Only if the reference level changes due to a coupled RF attenuation (see "[Attenuation](#)" on page 294), the measurement is restarted.

In general, the R&S ESW measures the signal voltage at the RF input. The level display is calibrated in RMS values of an unmodulated sine wave signal. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance, conversion to other units is possible.

See "[Impedance](#)" on page 229.

#### Reference level offset

If the signal is attenuated or amplified before it is fed into the R&S ESW, you can define an (arithmetic) offset to the reference level so the application shows correct power results. All displayed power level results are shifted by this value, and the scaling of the y-axis is changed accordingly.

To determine the required offset, consider the external attenuation or gain applied to the input signal. For attenuation, define a positive offset so the R&S ESW increases the displayed power values.

If an external gain is applied, define a negative offset so the R&S ESW decreases the displayed power values.

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

internal reference level = displayed reference level - offset

### Example

1. The initial reference level is 2 dBm with no offset.

Both the displayed reference level and the internal reference level are 2 dBm.

2. An offset of 3 dB is defined.

The displayed reference level is adjusted to 5 dBm.

The internal reference level remains at 2 dBm.

$(5 \text{ dBm (displayed ref level)} - 3 \text{ dB (offset)}) = 2 \text{ dBm}$

3. Now the user decreases the reference level to 1 dBm.

The displayed reference level is adjusted to 1 dBm.

The internal reference level is adjusted to:

$1 \text{ dBm (displayed ref level)} - 3 \text{ dB (offset)} = -2 \text{ dBm}$ .

#### 4.5.1.2 Scaling

In a linear display, the measurement values are distributed linearly throughout the grid. That means the entire range of measured values is divided by the number of rows in the grid (10) and each row corresponds to 1/10 of the total range. Linear scaling is useful to determine precise levels for a small range of values. However, if large and small values appear in the same display, it is difficult to determine individual values precisely or to distinguish values that are close together.

In a logarithmic display, smaller values are distributed among a much larger area of the display, while large values are condensed to a smaller area. Now it is much easier to distinguish several lower values, as they are spread over a wider area. Logarithmic scaling is useful when large ranges of values must be combined in one display. Logarithmic scaling is best applied to measurement values in logarithmic units (dB, dBm etc.).

In addition to linear or logarithmic scaling, the vertical axis can be set to display either absolute or relative values. Absolute values show the measured levels, while relative values show the difference between the measured level and the defined reference level. Relative values are indicated in percent for linear scaling, and in dB for logarithmic scaling.

4.5.2 Amplitude settings

**Access:** "Overview" > "Amplitude" > "Amplitude"

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

The dialog box also contain settings to scale the diagrams, which are described in [Chapter 4.5.3, "Scaling the y-axis"](#), on page 295.

Amplitude

Scale

Preselector

Reference Level

Input Settings

Value

107.0 dBµV

Offset

0.0 dB

Unit

dBµV

Auto Level

Preamplifier

Off

LN Amplifier

Preamp

Input Coupling

AC

DC

Impedance

50Ω

75Ω

Attenuation

Mode

Auto

Manual

Value

10.0 dB

10 dB Min

On

Off

The remote commands required to define these settings are described in [Chapter 6.8.3, "Amplitude configuration"](#), on page 658.

Functions in the "Amplitude" dialog box described elsewhere:

- ["Input Coupling"](#) on page 228
- ["Impedance"](#) on page 229

|  |     |
|--|-----|
| Reference Level.....   | 292 |
| L <a href="#">Shifting the Display (Offset)</a> .....                          | 293 |
| L <a href="#">Unit</a> .....   | 293 |
| L <a href="#">Setting the Reference Level Automatically (Auto Level)</a> ..... | 293 |
| 10 dB Minimum Attenuation.....   | 294 |
| Attenuation.....   | 294 |
| Preamplifier.....  | 294 |

**Reference Level**

Defines the expected maximum reference level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IF Overload" or "OVLD" status display.

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



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

For details, see [Chapter 4.5.1.1, "Reference level"](#), on page 290.

Note that for input from the External Mixer (R&S ESW-B21) the maximum reference level also depends on the conversion loss, see ["Reference level"](#) on page 259.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel`  
on page 659

### 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 ESW so the application shows correct power results. All displayed power level results are shifted by this value.

The setting range is  $\pm 200$  dB in 0.01 dB steps.

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

For details, see ["Reference level offset"](#) on page 290.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:`  
`OFFSet` on page 660

### Unit ← Reference Level

The R&S ESW measures the signal voltage at the RF input.

In the default state, the level is displayed at a power level of 1 mW (= dBm). Via the known input impedance (50  $\Omega$  or 75  $\Omega$ , see ["Impedance"](#) on page 229), conversion to other units is possible.

Remote command:

`INPut:IMPedance` on page 622  
`CALCulate<n>:UNIT:POWer` on page 659

### Setting the Reference Level Automatically (Auto Level) ← Reference Level

Automatically determines a reference level which ensures that no overload occurs at the R&S ESW for the current input data. At the same time, the internal attenuators are adjusted. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S ESW.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

You can change the measurement time for the level measurement if necessary (see ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 330).

Remote command:

`[SENSe:]ADJust:LEVel` on page 685

### 10 dB Minimum Attenuation

Turns the availability of attenuation levels of less than 10 dB on and off.

When you turn on this feature, the attenuation is always at least 10 dB. This minimum attenuation protects the input mixer and avoids accidental setting of 0 dB, especially if you measure EUTs with high RFI voltage.

When you turn it off, you can also select attenuation levels of less than 10 dB.

The setting applies to a manual selection of the attenuation as well as the automatic selection of the attenuation.

Remote command:

`INPut:ATTenuation:PROTection[:STATe]` on page 661

### Attenuation

Defines the attenuation of the signal.

You can attenuate the signal in 1 dB steps. The range is specified in the datasheet. Attenuation of less than 10 dB is only possible if you turn off [10 dB Minimum Attenuation](#).

If you are using the preamplifier in frequency ranges above 8 GHz, the available attenuation can be reduced.

The auto ranging feature in the receiver remains active even if you change the attenuation and preamplifier properties in other measurement channels and then return to the receiver application.

The R&S ESW also allows you to determine the best attenuation automatically.

- In the receiver application, turn on the "Auto Ranging" feature.
- In the other applications, select attenuation "Mode" → "Auto"

Remote command:

Global: `INPut:ATTenuation[:VALue]` on page 660

Attenuation mode: `INPut:ATTenuation:AUTO` on page 660

### Preamplifier

Configures the preamplifier.

In addition to the standard preamplifier, a low noise amplifier is available as an optional hardware component.

- **"Off"**  
Turns off the preamplifier.
- **"LN Amplifier"**  
Turns on the optional low noise amplifier.
- **"Auto Preamp"**  
Turns on the preamplifier (only possible when the preselector is "On").  
Using both preamplifiers at the same time is not possible.

Note that if you want to use the standard preamplifier, you have to route the signal through the preselector.

[More information.](#)

Remote command:

**Preamplifier:**

State (global): `INPut:GAIN:STATe` on page 661

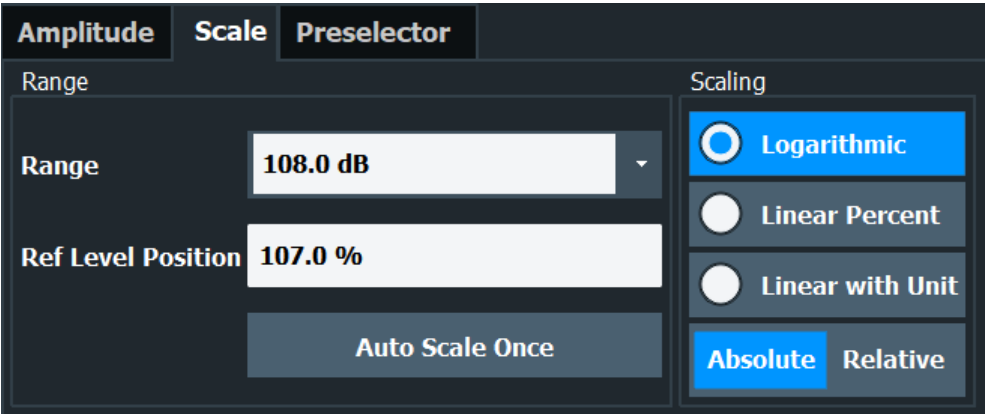
**Low noise preamplifier:**

State (global): `INPut:GAIN:LNA:STATe` on page 661

4.5.3    **Scaling the y-axis**

**Access:** "Overview" > "Amplitude" > "Scale"

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



The remote commands required to define these settings are described in [Chapter 6.8.4, "Y-Axis scaling"](#), on page 661.

|  |     |
|--|-----|
| <a href="#">Range</a> .....              | 295 |
| <a href="#">Ref Level Position</a> ..... | 295 |
| <a href="#">Auto Scale Once</a> .....    | 296 |
| <a href="#">Scaling</a> .....            | 296 |

**Range**  
Defines the displayed y-axis range in dB.  
The default value is 100 dB.

Remote command:  
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 662

**Ref Level Position**  
Defines the reference level position, i.e. the position of the maximum AD converter value on the level axis in %.  
0 % corresponds to the lower and 100 % to the upper limit of the diagram.  
Values from -120 % to +280 % are available.

Larger values are useful for small scales, such as a power range of 10 dB or 20 dB, and low signal levels, for example 60 dB below the reference level. In this case, large reference level position values allow you to see the trace again.

For spectrograms, this value defines the position of the reference level value within the span covered by the color map. In this case, the value is given in %, where 0 % corresponds to the maximum (right end) and 100 % to the minimum (left end) of the color map.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RPOSition`  
on page 663

#### Auto Scale Once

Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:AUTO ONCE`  
on page 662

#### Scaling

Defines the scaling method for the y-axis.

For more information, see [Chapter 4.5.1.2, "Scaling"](#), on page 291.

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

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 664  
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:MODE`  
on page 662

### 4.5.4 How to optimize the amplitude display

This section gives you some advice on how to optimize the display of the measured signal amplitudes depending on the required evaluation.

1. Perform a measurement with the default settings to get an impression of the values to be expected.
2. Use the "Auto Level" function ([AUTO] menu) to optimize the reference level.
3. Use the "Auto Scale Once" function ([AUTO] menu) to optimize the scaling.
4. **To determine a precise level at a specific point in the signal:**
  - Reduce the "Range" of the y-axis to a small area around the required level. If necessary, change the "Ref Level Position" so the required range remains visible.
  - Select "Linear with Unit" scaling.

Now you can set a marker at the point in question and read the result.
5. **To detect a spurious signal close to the noise floor:**
  - Set the "RF Attenuation" to "Manual" mode and reduce the "Value" to lower the noise floor.
  - Select "Relative" - "Logarithmic" scaling.

Now you can determine if any spurious levels of a certain size are visible.

## 4.6 Bandwidth, filter and sweep configuration

The basic bandwidth, filter and sweep settings that apply to most measurements are described here. These parameters define how the data is measured: how much data is collected internally and which filters are used.

- [Impact of the bandwidth, filter and sweep settings](#)..... 297
- [Bandwidth, filter and sweep settings](#).....303

### 4.6.1 Impact of the bandwidth, filter and sweep settings

The bandwidth, filter and sweep settings are closely related and interdependent. The values available for resolution bandwidth and video bandwidth depend on the selected filter type. In addition, these settings have an impact on other measurement parameters. The following equation shows the interdependency of these settings:

$$T_{\min} = K \cdot \text{Span} / \text{RBW}^2$$

where K = Filter constant

By default, a Gaussian filter is used. The resolution bandwidth, the video bandwidth and the Sweep Time are set automatically according to the set span, and default coupling is used. Thus, the following settings are applied:

$$\text{RBW} = \text{Span} / 100$$

$$\text{VBW} = \text{RBW}$$

$$\text{Sweep Time} = T_{\min} \text{ for set Span, RBW, VBW}$$

When defining the bandwidth and filter settings, consider the impact of the individual settings on the other settings and the measurement result, as described in more detail in the following sections.

|  |     |
|--|-----|
| • Separating signals by selecting an appropriate resolution bandwidth..... | 298 |
| • Smoothing the trace using the video bandwidth.....                       | 299 |
| • Coupling VBW and RBW.....  | 299 |
| • Coupling span and RBW.....   | 300 |
| • How data is measured: the sweep type.....                                | 300 |
| • Which data may pass: filter types.....                                   | 301 |
| • How long the data is measured: Sweep Time.....                           | 302 |
| • How much data is measured: sweep points and sweep count.....             | 303 |
| • How often data is measured: sweep mode.....                              | 303 |

#### 4.6.1.1 Separating signals by selecting an appropriate resolution bandwidth

The resolution bandwidth defines the 3 dB bandwidth of the resolution filter to be used. An RF sinusoidal signal is displayed according to the passband characteristic of the resolution filter (RBW), i.e. the signal display reflects the shape of the filter.

A basic feature of a signal analyzer is being able to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component. Smaller resolution bandwidths, however, increase the required Sweep Time.

Two signals with the same amplitude can be resolved if the resolution bandwidth is smaller than or equal to the frequency spacing of the signal. If the resolution bandwidth is equal to the frequency spacing, the spectrum display screen shows a level drop of 3 dB precisely in the center of the two signals. Decreasing the resolution bandwidth makes the level drop larger, which thus makes the individual signals clearer.

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77 dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

If there are large level differences between signals, the resolution is determined by selectivity as well as by the resolution bandwidth that has been selected. The measure of selectivity used for signal analyzers is the ratio of the 60 dB bandwidth to the 3 dB bandwidth (= shape factor).

For the R&S ESW, the shape factor for bandwidths is < 5, i.e. the 60 dB bandwidth of the 30 kHz filter is <150 kHz.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are very far away (e.g. from a different signal) are considered in the measurement and distort the results. The noise increases.

If the RBW is too small, parts of the signal are lost. As the displayed signal always reflects the shape of the filter, select a bandwidth large enough so the displayed signal reflects the entire shape of the filter.

#### 4.6.1.2 Smoothing the trace using the video bandwidth

The video filters are responsible for smoothing the displayed trace. Using video bandwidths that are small compared to the resolution bandwidth, only the signal average is displayed and noise peaks and pulsed signals are repressed. If pulsed signals are to be measured, it is advisable to use a video bandwidth that is large compared to the resolution bandwidth ( $VBW = 10 \times RBW$ ) for the amplitudes of pulses to be measured correctly.

The level of a sine wave signal is not influenced by the video bandwidth. A sine wave signal can therefore be freed from noise by using a video bandwidth that is small compared with the resolution bandwidth, and thus be measured more accurately.



#### RMS/Average detector and VBW

If an RMS detector is used, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS or average detector no longer occurs. However, the VBW is still considered when calculating the Sweep Time. This leads to a longer Sweep Time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if the RMS detector is used, the Sweep Time should be increased to get more stable traces.

If an average detector is used, the video bandwidth in the hardware is only bypassed if the video filter is set to "Auto" mode. Use this mode to avoid duplicate trace averaging with small VBWs.

#### 4.6.1.3 Coupling VBW and RBW

The video bandwidth can be coupled to the resolution bandwidth automatically. In this case, if the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

Coupling is recommended if a minimum Sweep Time is required for a selected resolution bandwidth. Narrow video bandwidths require longer Sweep Times due to the longer settling time. Wide bandwidths reduce the signal/noise ratio.

**Table 4-1: Overview of RBW/VBW ratios and recommendations for use**

| Ratio RBW/VBW | Recommendation for use   |
|---------------|--|
| 1/1           | Recommended for sinusoidal signals<br>This is the default setting for automatic coupling.  |
| 0.1           | Recommended when the amplitudes of pulsed signals are to be measured correctly. The IF filter is exclusively responsible for the pulse shape. No additional evaluation is performed by the video filter. |

| Ratio RBW/VBW                | Recommendation for use  |
|------------------------------|---|
| 10                           | Recommended to suppress noise and pulsed signals in the video domain. |
| Manually set (0.001 to 1000) | Recommended for other measurement requirements                        |

#### 4.6.1.4 Coupling span and RBW

The resolution bandwidth can be coupled to the span setting, either by a manually defined factor or automatically. If the span is changed, the resolution bandwidth is automatically adjusted. The automatic coupling adapts the resolution bandwidth to the currently set frequency span/100.

With a span/RBW ratio of 100 and a screen resolution of 1000 pixels, each frequency in the spectrum is displayed by 10 pixels. A span/RBW ratio of 1000 provides the highest resolution.

#### 4.6.1.5 How data is measured: the sweep type

In a standard analog **frequency sweep**, the local oscillator of the analyzer sweeps the applied signal quasi analog from the start to the stop frequency to determine the frequency spectrum.

Alternatively, the analyzer can sample signal levels over time at a defined frequency and transform the data to a spectrum by Fast Fourier Transformation (**FFT**). Although this measurement method requires additional calculations, it can provide results much faster than the frequency sweep, in particular for small RBWs.

Which sweep mode is appropriate for the current measurement depends on the span, RBW, VBW and Sweep Time settings. By default ("Auto" sweep type), the R&S ESW automatically uses the sweep type with the highest sweep rate depending on these measurement settings.



#### Restrictions for FFT mode

FFT mode is not available when using 5-pole filters, channel filters or RRC filters, or the quasi peak detector. In this case, sweep mode is used.

The same applies when an external generator is active (with the optional External Generator Control).

#### Optimization

In FFT mode, FFT analysis is performed to determine a spectrum of frequencies. Several analysis steps are required to cover the entire span. The subspan which is covered by one FFT analysis depends on the RBW. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

Narrow subspans provide a higher dynamic range, and also allow you to perform measurements near a carrier with a reduced reference level. With a wide subspan, the carrier and the useful signal are likely to be measured at the same time, in which case the powers of both signals are summarized, so the reference level must be high enough to



consider this factor. With a narrow subspan, this is less likely to happen, so the reference level can be reduced.

**For an optimal dynamic range**, the narrowest possible subspan (depending on the RBW) is used. Furthermore, the autorange function for the internal IF gain calculation is activated to obtain the best control range of the A/D converter.

On the other hand, the narrower the subspan, the more steps are required to cover the entire span, thus increasing analysis and calculation time. To **optimize the sweep rate**, the widest possible subspan (depending on the RBW) is used.



For an optimal sweep rate, it is recommended that you set the Sweep Time to "Auto", as well.

For general purpose measurements, an "Auto" mode is available, which provides a **compromise between a large dynamic range and a fast sweep**. In this case, a medium-sized subspan is used.



#### FFT mode and external mixers (R&S ESW-B21)

The subspan optimization modes "Dynamic" and "Auto" include automatic suppression of unwanted mixing products. Thus, when using external mixers (R&S ESW-B21), use the "Speed" mode to obtain similar results in FFT mode as in normal sweep mode.



#### FFT mode and EMI measurements

For EMI measurements, the subspan optimization mode "Dynamic" is not supported. "Auto" mode always uses "Speed" optimization.

#### Optimization for zero span sweeps

For normal sweeps in the time domain (zero span), the optimization mode determines the selection of the A/D converter prefilter, which depends on the RBW.

In **"Dynamic" mode**, the narrowest possible prefilter is used.

In **"Speed" mode**, the widest possible prefilter is used.

In **"Auto" mode**, a medium-sized prefilter is used.

#### 4.6.1.6 Which data may pass: filter types

While the filter is irrelevant when measuring individual narrowband signals (as long as the signal remains within the RBW), the measurement result for broadband signals is very dependant on the selected filter type and its shape. If the filter is too narrow, the signal is distorted by the filter. If the filter is too wide, multiple signals can no longer be distinguished. Generally, the smaller the filter width and the steeper its edges, the longer the settling time and thus the longer the Sweep Time must be.

All resolution bandwidths are realized with digital filters. Normal (3dB) Gaussian filters are set by default. Some communication standards require different filters.

For a list of available filter types, see the specifications document.

### Normal (3 dB) Gaussian filters

Gaussian filters provide a good compromise between steep edges and a short settling time. This filter is suitable for most measurement tasks and is used by default.

The available Gaussian (3 dB) filters are listed in the R&S ESW specifications document.

### 6 dB Gaussian filters

6 dB Gaussian filters are required for Receiver tests and measurements. The R&S ESW provides bandwidths that comply to commercial and military standards. For details refer to the data sheet.

### Channel filters

Channel filters are fairly steep but require a long settling time; they are useful for pulse measurements in the time domain.

### RRC filters

Root raised cosine filters are similar in shape to channel filters and are required by some measurement standards.

### 5-Pole filters

5-Pole filters are very broad and allow for a large bandwidth to pass.

#### 4.6.1.7 How long the data is measured: Sweep Time

Each filter has a settling time that must be awaited in order to obtain correct results. Since the resolution bandwidth and video bandwidth define the filter, the smaller of the two determines the minimum Sweep Time required for the measurement. Allowed values depend on the ratio of span to RBW and RBW to VBW.

If the selected Sweep Time is too short for the selected bandwidth and span, level measurement errors will occur. In this case, the R&S ESW displays the error message "Sweep time too low" and marks the indicated Sweep Time with a red bullet. Furthermore, a status bit indicates an error.

The Sweep Time can be coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW) automatically. If the span, resolution bandwidth or video bandwidth is changed, the Sweep Time is automatically adjusted.



Note that the Sweep Time only indicates how long data is captured; the time required to process the captured data may be considerably longer, in particular for FFT mode. For FFT mode, an estimated duration is indicated behind the Sweep Time in the channel bar (for RF measurements only).

#### 4.6.1.8 How much data is measured: sweep points and sweep count

By default, 1001 data points are determined in a single sweep. During the next sweep, 1001 new data points are collected, and so on. The number of **sweep points** defines how much of the entire span is covered by a single data point. By increasing the number of sweep points you can increase the reliability of the individual data points and thus the accuracy of the analyzed results. However, these data points are all stored on the instrument, occupying a large amount of memory, and each sweep point increases the overall measurement time.

The number of sweeps to be performed in single sweep mode is defined by the "Sweep Count". Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in a diagram.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, the "Sweep/Average Count" also determines the number of averaging or maximum search procedures (see [Chapter 5.3.1.2, "Analyzing several traces - trace mode"](#), on page 352).

#### 4.6.1.9 How often data is measured: sweep mode

How often the spectrum is swept depends on the sweep mode. Either a certain number of sweeps can be defined ("Sweep Count") which are performed in "Single Sweep" mode, or the sweep is repeated continuously ("Continuous Sweep" mode).

By default, the data is collected for the specified number of sweeps and the corresponding trace is displayed. When the next sweep is started, the previous trace is deleted.

However, the data from a single sweep run can also be retained and displayed together with the new data ("Continue Single Sweep" mode). This is particularly of interest when using the trace configurations "Average" or "Max Hold" to take previously recorded measurements into account for averaging/maximum search (see [Chapter 5.3.1.2, "Analyzing several traces - trace mode"](#), on page 352).

### 4.6.2 Bandwidth, filter and sweep settings

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

The remote commands required to define these settings are described in [Chapter 6.8.5, "Bandwidth configuration"](#), on page 664.

How to perform a basic sweep measurement is described in [Chapter 3.1.2, "How to perform a basic sweep measurement"](#), on page 21.

| Bandwidth        |           | Sweep       |        |
|------------------|-----------|-------------|--------|
| RBW              |           | VBW         |        |
| Auto             | Manual    | Auto        | Manual |
| 100.0 kHz        |           | 100.0 kHz   |        |
| Span/RBW         |           | RBW/VBW     |        |
| Auto[100]        | Sine[1.0] | Filter Type |        |
| 100.0            | 1.0       | Normal(3dB) |        |
| Coupling Default |           |             |        |

Figure 4-22: Bandwidth dialog box for RF measurements

| Bandwidth          |         | Sweep               |  |
|--------------------|---------|---------------------|--|
| Sweep Time         |         | Sweep/Average Count |  |
| Auto               | Manual  | 0                   |  |
| 41.87 $\mu$ s      |         |                     |  |
| Sweep Type         |         | Sweep Points        |  |
| Auto               | Sweep   | 1001                |  |
| FFT                |         |                     |  |
| Optimization       |         |                     |  |
| Auto               | Dynamic | Speed               |  |
| Spectrogram Frames |         |                     |  |
| Select Frame       | 0       |                     |  |
| Continue Frame     | On      | Off                 |  |
| Frame Count        | 1       |                     |  |
| Spectrogram Clear  |         |                     |  |

Figure 4-23: Sweep dialog box for spectrogram display

|                                  |     |
|----------------------------------|-----|
| RBW.....                         | 305 |
| VBW.....                         | 305 |
| Sweep Time.....                  | 306 |
| Span/RBW.....                    | 306 |
| RBW/VBW.....                     | 306 |
| Filter Type.....                 | 307 |
| Default Coupling.....            | 307 |
| Sweep/Average Count.....         | 307 |
| Sweep Points.....                | 308 |
| Optimization.....                | 308 |
| Sweep Type.....                  | 309 |
| Single Sweep / Run Single.....   | 309 |
| Continuous Sweep / Run Cont..... | 310 |
| Continue Single Sweep.....       | 310 |
| Spectrogram Frames.....          | 310 |
| L Select Frame.....              | 311 |
| L Continue Frame.....            | 311 |
| L Frame Count.....               | 311 |
| L Clear Spectrogram.....         | 311 |

## RBW

Defines the resolution bandwidth. The available resolution bandwidths are specified in the specifications document. Numeric input is always rounded to the nearest possible bandwidth.

If "Auto" is selected, the resolution bandwidth is coupled to the selected span (for span > 0). If the span is changed, the resolution bandwidth is automatically adjusted.

If the resolution bandwidth is defined manually, a green bullet is displayed next to the "RBW" display in the channel bar.

For a list of supported filters, see the specifications document.

For more information see [Chapter 4.6.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 298.

**Note:** Restrictions.

- For EMI measurements using the quasipeak detector, the 1 MHz RBW filter is not available (see [Chapter 3.12.3.1, "Resolution bandwidth and filter types"](#), on page 200).

Remote command:

`[SENSe:]BANDwidth[:RESolution]` on page 665

`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 664

## VBW

Defines the video bandwidth automatically or manually.

For more information see [Chapter 4.6.1.2, "Smoothing the trace using the video bandwidth"](#), on page 299.

"Auto"                      The video bandwidth is coupled to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

"Manual" For manual mode, define the bandwidth value. The available video bandwidths are specified in the specifications document. Numeric input is always rounded to the nearest possible bandwidth. If the video bandwidth is defined manually, a green bullet is displayed next to the "VBW" display in the channel bar.

Remote command:

[SENSe:]BANDwidth:VIDeo:AUTO on page 667

[SENSe:]BANDwidth:VIDeo on page 666

[SENSe:]BANDwidth:VIDeo:TYPE on page 667

### Sweep Time

Defines the duration of a single sweep, during which the defined number of sweep points are measured. The Sweep Time can be defined automatically or manually.

The allowed Sweep Time depends on the device model; refer to the specifications document.

For more information see [Chapter 4.6.1.7, "How long the data is measured: Sweep Time"](#), on page 302.

**Note:** The Sweep Time only indicates how long data is captured; the time required to process the captured data may be considerably longer, in particular for FFT mode. For FFT mode, an estimated duration is indicated behind the Sweep Time in the channel bar (for RF measurements only).

"Auto" The Sweep Time is coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW). If the span, resolution bandwidth or video bandwidth is changed, the Sweep Time is automatically adjusted.

"Manual" For manual mode, define the Sweep Time. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the specifications document. Numeric input is always rounded to the nearest possible Sweep Time.

Remote command:

[SENSe:]SWEep:TIME:AUTO on page 672

### Span/RBW

Sets the coupling ratio if **RBW** is set to auto mode.

For more information see [Chapter 4.6.1.4, "Coupling span and RBW"](#), on page 300.

"Auto[100]" "Resolution Bandwidth" = "Span/100"  
This coupling ratio is the default setting of the R&S ESW.

"Manual" The coupling ratio is defined manually.  
The span/resolution bandwidth ratio can be set in the range from 1 to 10000.

Remote command:

[SENSe:]BANDwidth[:RESolution]:RATio on page 665

### RBW/VBW

Sets the coupling ratio between the resolution bandwidth and the video bandwidth.

This setting is only effective if **VBW** is set to auto mode.

For more information see [Chapter 4.6.1.3, "Coupling VBW and RBW"](#), on page 299.

|              |   |
|--------------|---|
| "Sine[1/1]"  | "Video Bandwidth" = "Resolution Bandwidth"<br>This is the default setting for the coupling ratio RBW/VBW and is recommended if sinusoidal signals are to be measured. |
| "Pulse[0.1]" | "Video Bandwidth" = 10 x "Resolution Bandwidth"<br>or<br>"Video Bandwidth" = "10 MHz" (= max. VBW)<br>Recommended for pulse signals                                   |
| "Noise[10]"  | "Video Bandwidth" = "Resolution Bandwidth/10"<br>Recommended for noise measurements   |
| "Manual"     | The coupling ratio is defined manually.<br>The RBW/VBW ratio can be set in the range of 0.001 to 1000.  |

Remote command:

[\[SENSe:\]BANDwidth:VIDeo:AUTO](#) on page 667

[\[SENSe:\]BANDwidth:VIDeo:RATio](#) on page 667

### Filter Type

Defines the filter type.

The following filter types are available:

- Normal (3dB)
- Gauss (6 dB)
- CISPR (6 dB)
- MIL Std (6 dB)
- Channel
- RRC (not available for sweep type "FFT")
- 5-Pole (not available for sweep type "FFT")

For more information, see [Chapter 4.6.1.6, "Which data may pass: filter types"](#), on page 301.

**Note:** The RBW filter configured in the bandwidth settings is identical to the filter configured in the EMI configuration.

Remote command:

[\[SENSe:\]BANDwidth\[:RESolution\]:TYPE](#) on page 665

### Default Coupling

Sets all coupled functions to the default state ("Auto"). In addition, the ratio "RBW/VBW" is set to "Sine[1/1]" and the ratio "Span/RBW" to 100.

For more information see [Chapter 4.6.1.3, "Coupling VBW and RBW"](#), on page 299.

Remote command:

[\[SENSe:\]BANDwidth\[:RESolution\]:AUTO](#) on page 664

[\[SENSe:\]BANDwidth:VIDeo:AUTO](#) on page 667

[\[SENSe:\]SWEep:TIME:AUTO](#) on page 672

### Sweep/Average Count

Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed.

The sweep count is applied to all the traces in all diagrams.

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

In continuous sweep mode, if "Sweep Count" = 0 (default), averaging is performed over 10 sweeps. For "Sweep Count" = 1, no averaging, maxhold or minhold operations are performed.

For more information, see [Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count"](#), on page 303.

For spectrogram displays, the sweep count determines how many sweeps are combined in one frame in the spectrogram; that is: how many sweeps the R&S ESW performs to plot one trace in the spectrogram result display. For more details, see ["Time frames"](#) on page 359.

Remote command:

[\[SENSe:\] SWEep:COUNT](#) on page 670

### Sweep Points

Defines the number of measured values to be collected during one sweep.

For details see [Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count"](#), on page 303.

All values from 101 to 100001 can be set. The default value is 1001 sweep points.

The R&S ESW supports values between 101 and 100001. Zero span measurements support up to 1,000,001 sweep points (multiple traces) or 10,000,001 (one trace).

For EMI measurements, 512001 sweep points are available.

Remote command:

[\[SENSe:\] SWEep\[:WINDow<n>\]:POINTs](#) on page 672

### Optimization

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *subspan*. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

**Table 4-2: Optimization parameters in FFT mode**

| Optimization mode | Description  |
|-------------------|--|
| "Dynamic"         | Optimizes the dynamic range by using the narrowest possible subspan (depending on the RBW).<br><br>The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.  |
| "Speed"           | Optimizes the sweep rate by using the widest possible subspan (depending on the RBW).<br><br>The autorange function for the internal IF gain calculation is deactivated. (Note: set the reference level accordingly to optimize the control range for the A/D converter).<br><br>It is recommended that you set the <a href="#">Sweep Time</a> to "Auto" to optimize the sweep rate. |
| "Auto"            | Uses a medium-sized subspan to obtain a compromise between a large dynamic range and a fast sweep rate.<br><br>The autorange function for the internal IF gain calculation is deactivated. (Note: set the reference level accordingly to optimize the control range for the A/D converter).  |



**Note: FFT mode and external mixers (R&S ESW-B21)**

The subspan optimization modes "Dynamic" and "Auto" include automatic suppression of unwanted mixing products. Thus, when using external mixers (R&S ESW-B21), use the "Speed" mode to obtain similar results in FFT mode as in frequency sweep mode.

**Zero span mode**

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

**Table 4-3: Optimization parameters in zero span mode**

| Optimization mode | Description   |
|-------------------|---|
| Dynamic           | The narrowest filter possible (depending on the RBW) is used. |
| Speed             | The widest filter possible (depending on the RBW) is used.    |
| Auto              | A medium-sized prefilter is used.                             |

**Note: EMI measurements**

For EMI measurements, "Dynamic" mode is not supported. "Auto" mode always uses "Speed" optimization.

Remote command:

[\[SENSe:\]SWEep:OPTimize](#) on page 671

**Sweep Type**

Defines the sweep type.

- |         |   |
|---------|---|
| "Sweep" | In the standard sweep mode, the local oscillator is set to provide the spectrum quasi analog from the start to the stop frequency.  |
| "Auto"  | Automatically sets the fastest available sweep type for the current measurement (Frequency or FFT). Auto mode is set by default.  |
| "FFT"   | <p>The FFT sweep samples on a defined frequency value and transforms it to the spectrum by fast Fourier transformation (FFT) (see also <a href="#">Chapter 4.6.1.5, "How data is measured: the sweep type"</a>, on page 300).</p> <p>FFT is not available in the following cases:</p> <ul style="list-style-type: none"> <li>• When using 5-Pole filters or RRC filters</li> <li>• When using one of the CISPR detectors</li> <li>• When an external generator is active (via hardware option)</li> <li>• When the preselector is on and the span covers frequencies below 8 GHz</li> </ul> <p>In these cases, frequency sweep is used.</p> |

Remote command:

[\[SENSe:\]SWEep:TYPE](#) on page 673

**Single Sweep / Run Single**

After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

**Note:** Sequencer. If the Sequencer is active, "Single Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.

Furthermore, [RUN SINGLE] controls the Sequencer, not individual sweeps. [RUN SINGLE] starts the Sequencer in single mode.

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

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

Remote command:

Measurement mode: [INITiate<n>:CONTInuous](#) on page 471

Run measurement: [INITiate<mt>\[:IMMediate\]](#) on page 470

[CALCulate<n>:SPECTrogram:CONTInuous](#) on page 705

### Continuous Sweep / Run Cont

After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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

**Note:** Sequencer. If the Sequencer is active, "Continuous Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.

Furthermore, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

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

Remote command:

Measurement mode: [INITiate<n>:CONTInuous](#) on page 471

Run measurement: [INITiate<mt>\[:IMMediate\]](#) on page 470

### Continue Single Sweep

After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

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

Remote command:

[INITiate<n>:CONMeas](#) on page 470

### Spectrogram Frames

These settings are only available if spectrogram display is active.

For more information see [Chapter 5.3.3.4, "How to display and configure a spectrogram"](#), on page 384.

#### **Select Frame ← Spectrogram Frames**

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details, see ["Time frames"](#) on page 359.

Remote command:

[CALCulate<n>:SPECTrogram:FRAMe:SElect](#) on page 706

#### **Continue Frame ← Spectrogram Frames**

Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold", "Min Hold", and "Average".

This function is available in single sweep mode only.

- **On**  
When the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also considered.
- **Off**  
The average or peak values are determined from the results of the newly swept frames only.

Remote command:

[CALCulate<n>:SPECTrogram:CONTinuous](#) on page 705

#### **Frame Count ← Spectrogram Frames**

Determines how many frames are plotted during a single sweep (as opposed to a continuous sweep). The maximum number of possible frames depends on the history depth (see ["History Depth"](#) on page 379).

Remote command:

[CALCulate<n>:SPECTrogram:FRAMe:COUNt](#) on page 706

#### **Clear Spectrogram ← Spectrogram Frames**

Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:

[CALCulate<n>:SPECTrogram:CLEar\[:IMMediate\]](#) on page 705

## 4.7 Trigger and gate configuration

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your signals.

Gating allows you to restrict measurement analysis to the important part or parts of the signal, for example bursts.

- [Triggering](#)..... 312
- [Gating](#)..... 322

### 4.7.1 Triggering

#### 4.7.1.1 Trigger basics

In a basic measurement with default settings, the sweep is started immediately. However, sometimes you want the measurement to start only when a specific condition is fulfilled, for example a signal level is exceeded, or in certain time intervals. For these cases, you can define a trigger for the measurement. In FFT sweep mode, the trigger defines when the data acquisition starts for the FFT conversion.

An "Offset" can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset).

For complex tasks, advanced trigger settings are available:

- Hysteresis to avoid unwanted trigger events caused by noise
- Holdoff to define exactly which trigger event causes the trigger in a jittering signal
- [Trigger source](#)..... 312
- [Trigger offset](#)..... 313
- [Trigger hysteresis](#)..... 313
- [Trigger drop-out time](#)..... 313
- [Trigger holdoff](#)..... 314

#### Trigger source

The trigger source defines which source must fulfill the condition that triggers the measurement. Basically, the source can be:

- Time: the measurement is repeated in a regular interval
- Power: an input signal is checked for a defined power level  
The trigger signal can be any of the following:
  - The input signal at one of various stages in the signal analysis process - before or after the input mixer, after the video filter etc.
  - A signal from an external device via one of the trigger connectors on the instrument

For details on the available trigger sources, see ["Trigger Source"](#) on page 317.

### Trigger offset

An offset can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset). Pre-trigger offsets are possible because the R&S ESW captures data continuously in the time domain, even before the trigger occurs.

See ["Trigger Offset"](#) on page 319.

### Trigger hysteresis

Setting a hysteresis for the trigger helps avoid unwanted trigger events caused by noise, for example. The hysteresis is a threshold to the trigger level that the signal must fall below on a rising slope or rise above on a falling slope before another trigger event occurs.

#### Example:

In the following example, the signal does not drop below the hysteresis (threshold) before it reaches the trigger level again. Thus, the second possible trigger event on the rising edge is ignored. On the falling edge, however, two trigger events occur. The signal exceeds the hysteresis before it falls to the trigger level the second time.

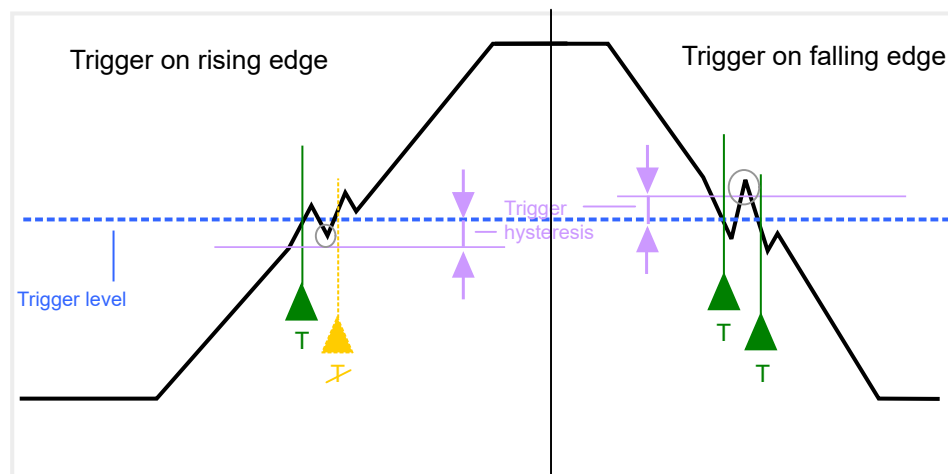


Figure 4-24: Effects of the trigger hysteresis

See ["Hysteresis"](#) on page 320

### Trigger drop-out time

If a modulated signal is instable and produces occasional "drop-outs" during a burst, you can define a minimum duration that the input signal must stay below the trigger level before triggering again. This is called the "drop-out" time. Defining a dropout time helps you stabilize triggering when the analyzer is triggering on undesired events.

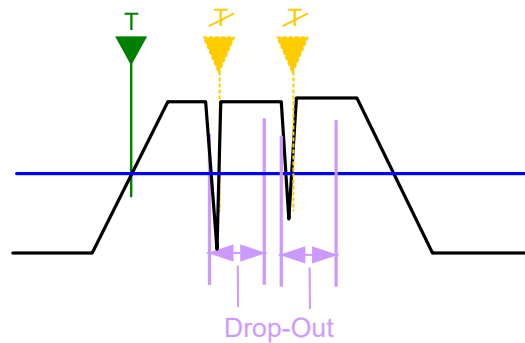


Figure 4-25: Effect of the trigger drop-out time

See ["Drop-Out Time"](#) on page 319.



### Drop-out times for falling edge triggers

If a trigger is set to a falling edge ("Slope" = "Falling", see ["Slope"](#) on page 320) the measurement is to start when the power level falls below a certain level. This is useful, for example, to trigger at the end of a burst, similar to triggering on the rising edge for the beginning of a burst.

If a drop-out time is defined, the power level must remain below the trigger level at least for the duration of the drop-out time (as defined above). However, if a drop-out time is defined that is longer than the pulse width, this condition cannot be met before the final pulse. Thus, a trigger event does not occur until the pulsed signal is over.

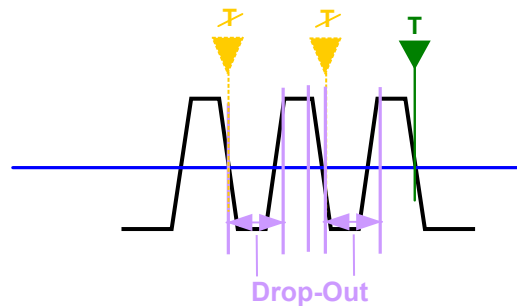


Figure 4-26: Trigger drop-out time for falling edge trigger

For gated measurements, a combination of a falling edge trigger and a drop-out time is generally not allowed.

### Trigger holdoff

The trigger holdoff defines a waiting period before the next trigger after the current one will be recognized.

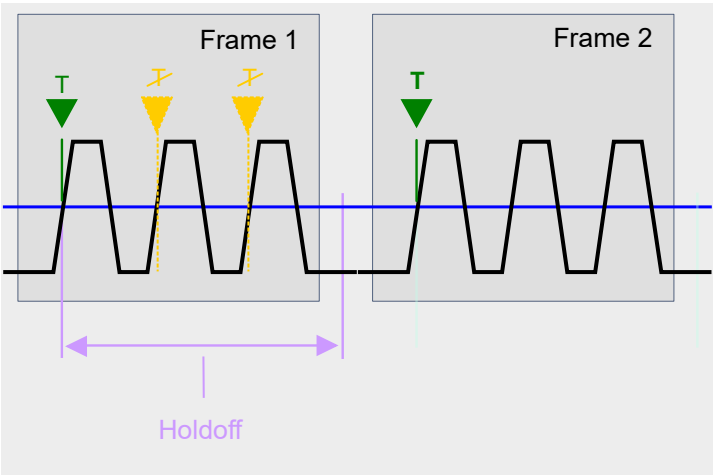
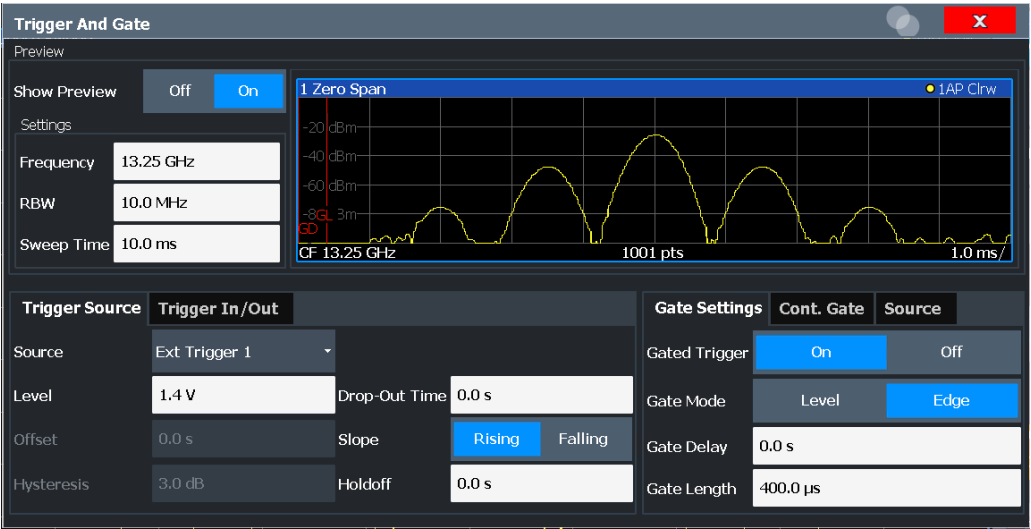


Figure 4-27: Effect of the trigger holdoff

See ["Trigger Holdoff"](#) on page 320.

4.7.1.2 Trigger settings

Access: "Overview" > "Trigger/Gate"



External triggers from one of the trigger connectors on the R&S ESW are configured in a separate tab of the dialog box.

See [Chapter 4.3.6.3, "Configuring additional outputs"](#), on page 279.

For step-by-step instructions on configuring triggered measurements, see [Chapter 4.7.1.4, "How to configure a triggered measurement"](#), on page 321.

|                   |     |
|-------------------|-----|
| Preview.....      | 316 |
| L Frequency.....  | 316 |
| L RBW.....        | 316 |
| L Sweep Time..... | 317 |

|                          |     |
|--------------------------|-----|
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| L Ext. Trigger 1/2.....  | 317 |
| L Video.....             | 317 |
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| Trigger Offset.....      | 319 |
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### Preview

The preview mode allows you to try out trigger and gate settings before actually applying them to the current measurement.

The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time. This is useful when analyzing bursts, for example, to determine the required gate settings.

The trigger and gate settings are applied to the measurement when the dialog box is closed.

**Note:** The zero span settings refer only to the preview diagram. The main diagram remains unchanged.

If preview mode is switched off, any changes to the settings in this dialog box are applied to the measurement diagram directly. In this case, the zero span settings for the preview diagram are not displayed.

For information on the zero span settings, see:

- "Center Frequency" on page 285
- "RBW" on page 211
- "Sweep Time" on page 306

### Frequency ← Preview

Defines the center frequency for the preview diagram.

Remote command:

[SENSe:] FREQuency:CENTer on page 652

### RBW ← Preview

Defines the resolution bandwidth for the preview diagram. The available resolution bandwidths are specified in the specifications document. Numeric input is always rounded to the nearest possible bandwidth.

Remote command:

[SENSe:] BANDwidth[:RESolution] on page 665



**Sweep Time ← Preview**

Defines the sweep time for the preview diagram. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the specifications document. Numeric input is always rounded to the nearest possible sweep time.

**Trigger Source**

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

For gated measurements, this setting also selects the gating source.

For more information, see ["Trigger source"](#) on page 312.

Remote command:

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 677

[\[SENSe:\]SWEep:EGATe:SOURce](#) on page 680

**Free Run ← Trigger Source**

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

Remote command:

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 677

**Ext. Trigger 1/2 ← Trigger Source**

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

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

For details, see the "Instrument Tour" chapter in the R&S ESW 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 "Output" configuration

"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 "Output" configuration.

Remote command:

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 677

**Video ← Trigger Source**

Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

A fixed hysteresis of  $\pm 5\%$  of the specified trigger value (in V) is applied to the video trigger level automatically and cannot be changed.

Video mode is only available in the time domain, and not for I/Q-based data.

Remote command:

`TRIGger<tp>[:SEquence]:SOURce` on page 677

### IF Power ← Trigger Source

The R&S ESW starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument specifications document.

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

This trigger source is only available for RF input.

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

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

**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:

`TRIGger<tp>[:SEquence]:SOURce` on page 677

### RF Power ← 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 specifications document.

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

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

Remote command:

`TRIGger<tp>[:SEquence]:SOURce` on page 677

`SWE:EGAT:SOUR RFP` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 680

**Time ← Trigger Source**

Triggers in a specified repetition interval.

See ["Repetition Interval"](#) on page 319.

Remote command:

[TRIGger<tp>\[:SEquence\]:SOURce](#) on page 677

**Trigger Level**

Defines the trigger level for the specified trigger source.

For gated measurements, this setting also defines the gate level.

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

For time triggers, the repetition interval is defined. See ["Repetition Interval"](#) on page 319.

Remote command:

[TRIGger\[:SEquence\]:LEVel:IFPower](#) on page 675

[TRIGger\[:SEquence\]:LEVel:IQPower](#) on page 676

[TRIGger<tp>\[:SEquence\]:LEVel\[:EXternal\]](#) on page 675

[TRIGger\[:SEquence\]:LEVel:RFPower](#) on page 676

**Repetition Interval**

Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If the required interval cannot be set with the available granularity, configure a multiple of the interval that can be set. Thus, the trigger remains synchronized to the signal.

Remote command:

[TRIGger\[:SEquence\]:TIME:RINTerval](#) on page 678

**Drop-Out Time**

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

For more information on the drop-out time, see ["Trigger drop-out time"](#) on page 313.

Remote command:

[TRIGger\[:SEquence\]:DTIME](#) on page 674

**Trigger Offset**

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

For more information, see ["Trigger offset"](#) on page 313.

|             |  |
|-------------|--|
| Offset > 0: | Start of the sweep is delayed  |
| Offset < 0: | <p>Sweep starts earlier (pretrigger)</p> <p>Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off</p> <p>Maximum allowed range limited by the sweep time:</p> <p><math>\text{Pretrigger}_{\text{max}} = \text{sweep time}_{\text{max}}</math></p> |

For the "Time" trigger source in swept measurements, this function is not available.

Remote command:

`TRIGger<tp>[:SEquence]:HOLDoff[:TIME]` on page 674

### Hysteresis

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

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

For more information, see ["Trigger hysteresis"](#) on page 313.

Remote command:

`TRIGger[:SEquence]:IFPower:HYSTeresis` on page 675

### Trigger Holdoff

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

For more information, see ["Trigger holdoff"](#) on page 314.

Remote command:

`TRIGger[:SEquence]:IFPower:HOLDoff` on page 674

### Slope

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

For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

Remote command:

`TRIGger<tp>[:SEquence]:SLOPe` on page 677

`[SENSe:]SWEep:EGATe:POLarity` on page 680

#### 4.7.1.3 How to determine the required trigger/gate parameters

1. In the "Trigger And Gate" dialog box, switch on "Show Preview".  
A zero span measurement for the currently defined center frequency is displayed.
2. Set the "Frequency", "RBW" and Sweep Time such that the relevant part of the signal is displayed, for example a complete burst.
3. Determine the parameters you want to use to define the trigger and gate conditions from the preview diagram, for example:
  - the length of a burst or slot
  - the upper or lower power level of a pulse
  - the maximum noise level
  - the power level or time at which a certain incident occurs

4. Try out different trigger and gate settings as described in [How to configure a triggered measurement](#) and [How to configure a gated measurement](#), then select "Update Main Diagram" to see the effect of the current settings on the main measurement in the background.
5. If the results are as expected, close the dialog box to keep the changes permanently. Otherwise, correct the settings as necessary.

#### 4.7.1.4 How to configure a triggered measurement

##### To define a time trigger:

1. In the "Trigger And Gate" dialog box, define the "Trigger Source" = "Time".
2. Define the "Repetition Interval": the time after which a new measurement is started.

##### To define an external trigger:

1. Connect an external device that will provide the trigger signal to one of the trigger connectors on the R&S ESW.  
For details see the R&S ESW "Getting Started" manual.
2. In the "Trigger And Gate" dialog box, define the "Trigger Source" = "External".
3. Configure the external trigger as described for the other power triggers.

##### To define a power trigger:

1. In the "Trigger And Gate" dialog box, define the "Trigger Source" = "IF Power". Alternatively, define "Trigger Source" = "Video". The video signal corresponds to the envelope of the IF signal: it has been processed by the resolution and video filters and the selected detector.
2. Define the "Trigger Level": the power level at which the measurement will start. For a "Video" trigger source you can move the level line graphically to define the level. If you define the value numerically, you must enter a percentage of the full diagram height as the level.
3. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
4. To start the measurement with a time delay, define a "Trigger Offset".
5. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. The holdoff time should be slightly larger than the burst.

## 4.7.2 Gating

|  |     |
|--|-----|
| • <a href="#">Gated measurements</a> .....                   | 322 |
| • <a href="#">Gate settings</a> .....                        | 324 |
| • <a href="#">Continuous gate settings</a> .....             | 326 |
| • <a href="#">How to configure a gated measurement</a> ..... | 327 |

### 4.7.2.1 Gated measurements

Like a gate provides an opening in a fence, a gated measurement lets data from the input signal pass in defined areas only. The *gate* controls exactly when data is included in the measurement results and when not. The gate is opened by the trigger source, which is also the gate source.

Gates can be used in two different modes:

- **Level:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the "Gate Level".  
Using a pulsed gate signal in level mode, the following behavior can be achieved: When the gate source signal is active, the input signal data is collected; when the gate signal is inactive, the input signal is ignored.
- **Edge:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined "Gate Length" is reached.

Additionally, a delay time can be defined so that the first few measurement points after the gate opening are ignored.

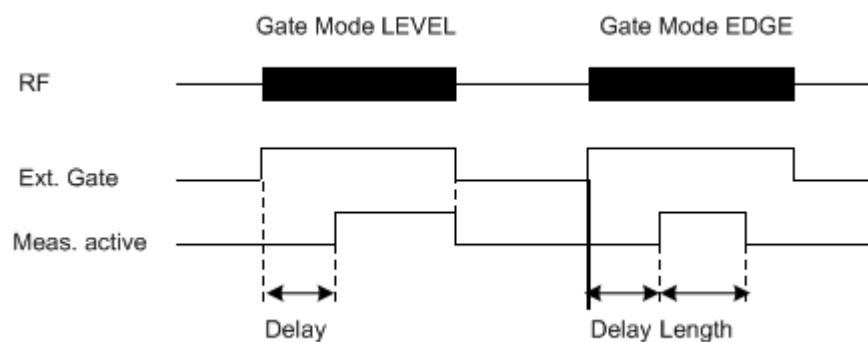


Figure 4-28: Effects of Gate mode, Gate delay and Gate length

**Example:**

By using a gate in sweep mode and stopping the measurement while the gate signal is inactive, the spectrum for pulsed RF carriers can be displayed without the superposition of frequency components generated during switching. Similarly, the spectrum can also be analyzed for an inactive carrier. The sweep can be controlled by an external gate or by the internal power trigger.

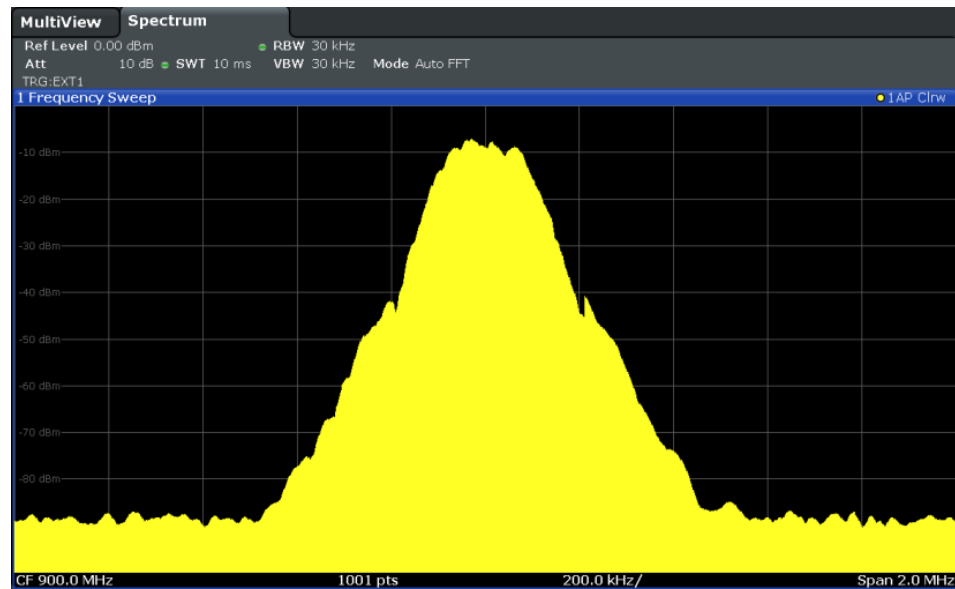


Figure 4-29: GSM signal with GATE OFF

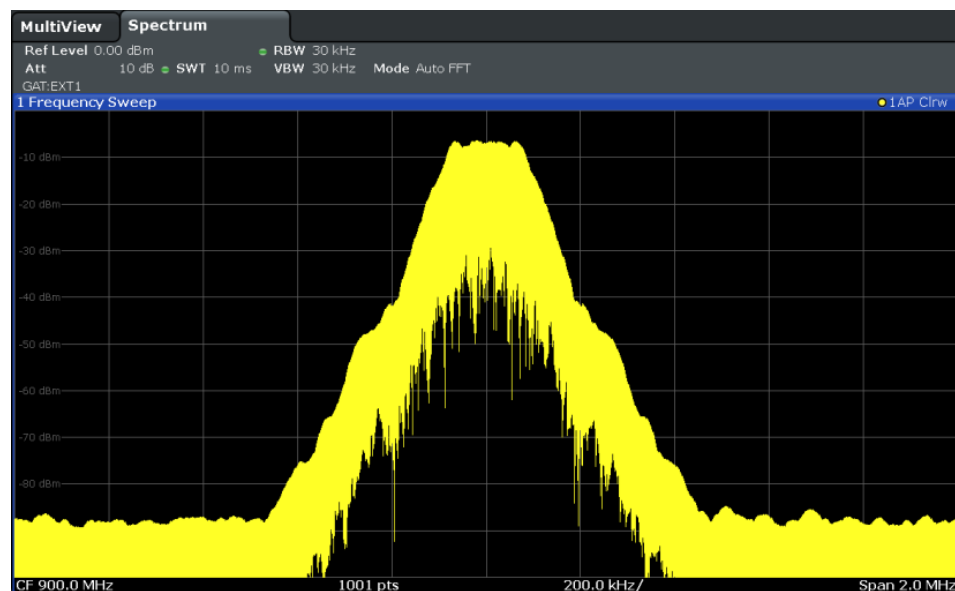


Figure 4-30: GSM signal with GATE ON

Gated sweep operation is also possible for zero span measurements. This allows you to display level variations of individual slots, for instance in burst signals, versus time.

To indicate that a gate is used for the sweep, "GAT" and the gate source is displayed in the channel bar.

### Continuous gating

With common gating, a measurement is performed each time the trigger event occurs. However, when using an external trigger, the measurement time for a single gate is restricted by the repetition rate of the external trigger.

Now, a new function in the R&S ESW allows you to perform a number of measurements periodically after each external trigger event. This function can speed up the measurement significantly. After the first external trigger event, a specified number of gate periods are generated internally, in a specified interval, without requiring additional trigger events. Only after the specified number of measurements have been performed, the R&S ESW waits for the next external trigger event.

#### Example:

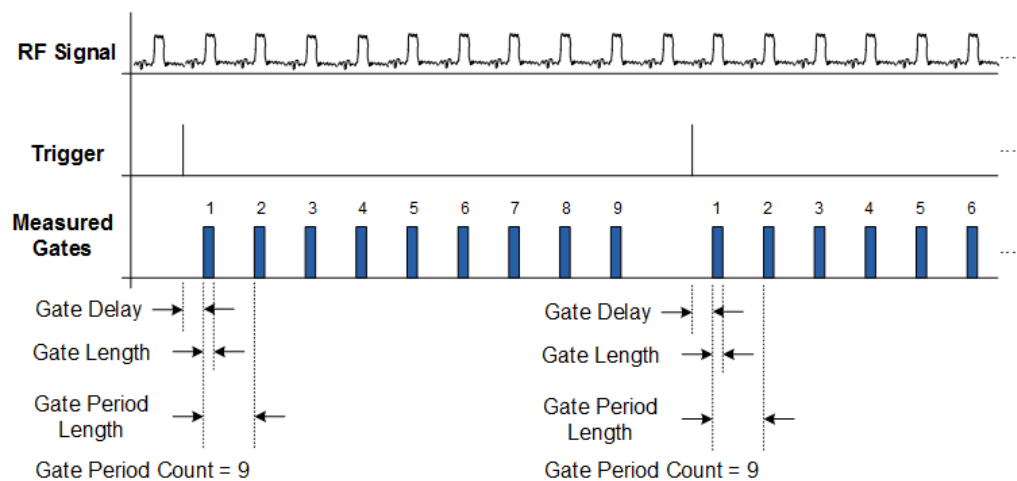


Figure 4-31: Continuous gating for a gate period count of 9

Continuous gating is useful, for example, if you want to measure a periodic signal which occurs after a specific trigger event. Using gate periods, you can average the individual periods of the signal for several trigger events.

Continuous gating can also improve the measurement speed, as you no longer have to wait for the next external trigger events, but can measure several periodic bursts after a single trigger event.

Settings for continuous gate periods are defined in a separate tab of the "Trigger / Gate Config" dialog box (see [Chapter 4.7.2.3, "Continuous gate settings"](#), on page 326).

#### 4.7.2.2 Gate settings

**Access:** "Overview" > "Trigger" > "Trigger / Gate Config." > "Gate Settings"

Gate settings define one or more extracts of the signal to be measured.



Gate Settings

Cont. Gate

Gated Trigger

On

Off

Gate Mode

Level


Edge

Gate Delay

0.0 s

Gate Length

400.0 µs


Gating is not available for measurements on I/Q-based data.

|                    |     |
|--------------------|-----|
| Gated Trigger..... | 325 |
| Gate Mode.....     | 325 |
| Gate Delay.....    | 326 |
| Gate Length.....   | 326 |

**Gated Trigger**  
Switches gated triggering on or off.

**Note:** Gating is not available for time domain scans and measurements on I/Q based data.

Remote command:  
[SENSe:] SWEEp:EGATe on page 678

**Gate Mode**  
Sets the gate mode.

For more information, see [Chapter 4.7.2.1, "Gated measurements"](#), on page 322

"Edge"           The trigger event for the gate to open is the detection of the signal edge.  
After the gate signal has been detected, the gate remains open until the gate length is over.

"Level"           The trigger event for the gate to open is a particular power level.  
After the gate signal has been detected, the gate remains open until the signal disappears.

**Note:** If you perform gated measurements in combination with the IF Power trigger, the R&S ESW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

Remote command:  
[SENSe:] SWEEp:EGATe:TYPE on page 681

**Gate Delay**

Defines the delay time between the gate signal and the continuation of the measurement.

In the Spectrum application, the delay position on the time axis in relation to the sweep is indicated by a line labeled "GD".

For more information, see [Chapter 4.7.2.1, "Gated measurements"](#), on page 322

Remote command:  
[\[SENSe:\]SWEep:EGATe:HOLDoff](#) on page 679

**Gate Length**

Defines how long the gate is open when it is triggered.

The gate length can only be set in the edge-triggered gate mode. In the level-triggered mode the gate length depends on the level of the gate signal.

The gate length in relation to the sweep is indicated by a line labeled "GL".

In the Spectrum application, the gate length in relation to the sweep is indicated by a line labeled "GL".

For more information, see [Chapter 4.7.2.1, "Gated measurements"](#), on page 322

Remote command:  
[\[SENSe:\]SWEep:EGATe:LENGth](#) on page 679

**4.7.2.3 Continuous gate settings**

**Access:** "Overview" > "Trigger" > "Trigger / Gate Config." > "Cont. Gate" tab

Continuous gating allows you to perform a continuous gated sweep after a single external trigger is received.

| Gate Settings      | Cont. Gate        |
|--------------------|-------------------|
| Continuous Gate    | <div>OnOff</div>  |
| Gate Period Length | <div>5.0 ms</div> |
| Gate Period Count  | <div>100</div>    |

For details see ["Continuous gating"](#) on page 324.

|                                    |     |
|------------------------------------|-----|
| <a href="#">Continuous Gate</a>    | 326 |
| <a href="#">Gate Period Length</a> | 327 |
| <a href="#">Gate Period Count</a>  | 327 |

**Continuous Gate**

Activates or deactivates continuous gating.

This setting is only available if [Gated Trigger](#) is "On".

Remote command:

[SENSe:]SWEep:EGATe:CONTInuous[:STATe] on page 681

### Gate Period Length

Defines the length in seconds of a single gate period in continuous gating. The length is determined from the beginning of one gate measurement to the beginning of the next one.

Remote command:

[SENSe:]SWEep:EGATe:CONTInuous:PLENgtH on page 682

### Gate Period Count

Defines the number of gate periods to be measured after a single trigger event in continuous gating.

Remote command:

[SENSe:]SWEep:EGATe:CONTInuous:PCOunt on page 681

## 4.7.2.4 How to configure a gated measurement

A gated measurement records data only while the gate conditions are fulfilled. These step-by-step instructions demonstrate how to configure a gated measurement manually.

### To configure a common gated measurement

1. Determine the required parameters as described in [Chapter 4.7.1.3, "How to determine the required trigger/gate parameters"](#), on page 320.
2. The gate is opened by a trigger event, which must be based on a power source. Define the trigger as described in [Chapter 4.7.1.3, "How to determine the required trigger/gate parameters"](#), on page 320.  
As the "Trigger Source", use "IF Power", "Video" or "External".
3. Define how long the gate is to remain open:  
To measure the signal as long as the trigger level is exceeded, for example for one or more pulses, define "Gate Mode" = "Level".  
To measure the signal for a certain time after a level is exceeded, for example during a burst:
  - a) Define "Gate Mode" = "Edge".
  - b) Define the time to measure for each gate: "Gate Length".
4. To open the gate with a time delay, for example to ignore an overshoot, define a "Gate Delay".
5. Select "Gated Trigger" = "On".

### To configure a continuous gated measurement

A continuous gated measurement is based on a common gated measurement. However, after a single external trigger event, multiple further gate measurements are performed.

1. The gate is opened by a trigger event, which must be provided by an external trigger source. Define the trigger as described in [Chapter 4.7.1.4, "How to configure a triggered measurement"](#), on page 321. As the "Trigger Source", use "External".
2. In the "Gate Settings" of the "Trigger and Gate" dialog box, select "Gated Trigger": "On".
3. Define the gate settings as described in ["To configure a common gated measurement"](#) on page 327.
4. Select the "Cont. Gate" tab next to the "Gate Settings".
5. Set "Continuous Gate" to "On".
6. Define the length in seconds from the beginning of one gate measurement to the beginning of the next one ("Gate Period Length").
7. Define how many gate measurements are to be performed after a single trigger event ("Gate Period Count").
8. Run a measurement and wait for the external trigger event to occur.

## 4.8 Adjusting settings automatically

**Access:** [AUTO SET]

Some settings can be adjusted by the R&S ESW automatically according to the current measurement settings. To do so, a measurement is performed. You can configure this measurement.



### Adjusting settings automatically during triggered measurements

When you select an auto adjust function, a measurement is performed to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how the R&S ESW should behave:

- (Default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger. The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows for "IF Power" and "RF Power" triggers:  
Trigger level = Reference level - 15 dB

**Remote command:**

`[SENSe:]ADJust:CONFigure:TRIGger` on page 684

|  |     |
|--|-----|
| Adjusting all Determinable Settings Automatically (Auto All).....  | 329 |
| Adjusting the Center Frequency Automatically (Auto Frequency)..... | 329 |
| Setting the Reference Level Automatically (Auto Level).....        | 329 |
| Resetting the Automatic Measurement Time (Meas Time Auto).....     | 329 |
| Changing the Automatic Measurement Time (Meas Time Manual).....    | 330 |
| Upper Level Hysteresis.....  | 330 |
| Lower Level Hysteresis.....  | 330 |

### Adjusting all Determinable Settings Automatically (Auto All)

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

- [Auto Frequency](#)
- [Auto Level](#)

Remote command:

[\[SENSe:\]ADJust:ALL](#) on page 682

### Adjusting the Center Frequency Automatically (Auto Frequency)

The R&S ESW adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest S/N ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

This function is not available during signal tracking (see [Chapter 4.4.3, "Keeping the center frequency stable - signal tracking"](#), on page 287).

Remote command:

[\[SENSe:\]ADJust:FREQuency](#) on page 685

### Setting the Reference Level Automatically (Auto Level)

Automatically determines a reference level which ensures that no overload occurs at the R&S ESW for the current input data. At the same time, the internal attenuators are adjusted. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S ESW.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

You can change the measurement time for the level measurement if necessary (see ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 330).

Remote command:

[\[SENSe:\]ADJust:LEVel](#) on page 685

### Resetting the Automatic Measurement Time (Meas Time Auto)

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) on page 683

**Changing the Automatic Measurement Time (Meas Time Manual)**

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

**Note:** The maximum measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration actually used to determine the automatic settings can be shorter than the value you define here.

Remote command:

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) on page 683

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation](#) on page 683

**Upper Level Hysteresis**

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:HYSTeresis:UPPer](#) on page 684

**Lower Level Hysteresis**

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:HYSTeresis:LOWer](#) on page 684

## 5 Common analysis and display functions

**Access:** "Overview" > "Analysis"

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings and functions that may deviate from these common settings.

|  |     |
|--|-----|
| • <a href="#">Result display configuration</a> ..... | 331 |
| • <a href="#">Zoomed displays</a> .....              | 338 |
| • <a href="#">Configuring traces</a> .....           | 345 |
| • <a href="#">Marker usage</a> .....                 | 391 |
| • <a href="#">Display and limit lines</a> .....      | 432 |

### 5.1 Result display configuration

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Thus, the result display is highly configurable to suit your specific requirements and optimize analysis. Here you can find out how to optimize the display for your measurement results.

Basic operations concerning the R&S ESW display, for example how to use the Smart-Grid, are described in the R&S ESW Getting Started manual.

General display settings that are usually configured during initial instrument setup, independently of the current measurement, e.g. which items or colors are displayed on the screen, are described in the R&S ESW User Manual.

|  |     |
|--|-----|
| • <a href="#">Basic evaluation methods</a> .....                         | 331 |
| • <a href="#">Laying out the result display with the smartgrid</a> ..... | 334 |

#### 5.1.1 Basic evaluation methods

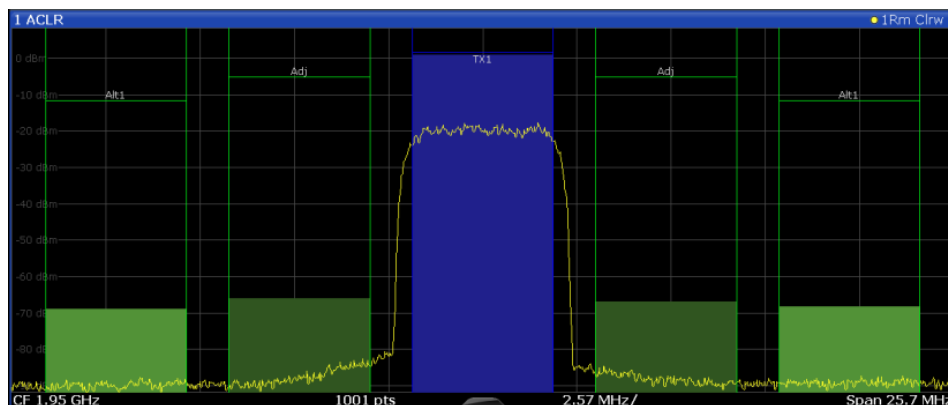
Measurement results can be displayed and evaluated using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

The evaluation methods described here are available for most measurements in the Spectrum application.

|  |     |
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| <a href="#">Diagram</a> .....          | 332 |
| <a href="#">Marker Table</a> .....     | 332 |
| <a href="#">Marker Peak List</a> ..... | 332 |
| <a href="#">Result Summary</a> .....   | 333 |
| <a href="#">Spectrogram</a> .....      | 333 |

### Diagram

Displays a basic level vs. frequency or level vs. time diagram of the measured data to evaluate the results graphically. This is the default evaluation method. Which data is displayed in the diagram depends on the "Trace" settings. Scaling for the y-axis can be configured.



Remote command:

LAY:ADD? '1', RIGH, DIAG, see [LAYout:ADD\[:WINDow\]?](#) on page 462

Results:

[TRACe<n>\[:DATA\]](#) on page 690

### Marker Table

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

This table is displayed automatically if configured accordingly.

| 2 Marker |     |     |            |            |          |                 |  |
|----------|-----|-----|------------|------------|----------|-----------------|--|
| Type     | Ref | Trc | Stimulus   | Response   | Function | Function Result |  |
| N1       |     | 1   | 13.197 GHz | -25.87 dBm | Count    | 13.197057       |  |
| D1       | N1  | 1   | -7.942 GHz | -49.41 dB  |          |                 |  |
| D2       | N1  | 2   | -3.918 GHz | -21.90 dB  |          |                 |  |
| D3       | N1  | 3   | 4.024 GHz  | -21.99 dB  |          |                 |  |

**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 462

Results:

[CALCulate<n>:MARKer<m>:X](#) on page 720

[CALCulate<n>:MARKer<m>:Y?](#) on page 735

### Marker Peak List

The marker peak list determines the frequencies and levels of peaks in the spectrum or time domain. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

You can define search and sort criteria to influence the results of the analysis.

[More information](#)



| 3 Marker Peak List |    |              |             |
|--------------------|----|--------------|-------------|
| Wnd                | No | X-Value      | Y-Value     |
| 2                  | 1  | 1.086245 ms  | -75.810 dBm |
| 2                  | 2  | 2.172490 ms  | -6.797 dBm  |
| 2                  | 3  | 3.258736 ms  | -76.448 dBm |
| 2                  | 4  | 4.831918 ms  | -76.676 dBm |
| 2                  | 5  | 6.255274 ms  | -76.482 dBm |
| 2                  | 6  | 6.798397 ms  | -6.800 dBm  |
| 2                  | 7  | 9.233084 ms  | -76.519 dBm |
| 2                  | 8  | 10.075861 ms | -76.172 dBm |
| 2                  | 9  | 11.405574 ms | -6.801 dBm  |

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

Remote command:

LAY:ADD? '1',RIGH, PEAK, see LAYout:ADD[:WINDow]? on page 462

Results:

CALCulate<n>:MARKer<m>:X on page 720

CALCulate<n>:MARKer<m>:Y? on page 735

### Result Summary

Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.

| 2 Result Summary |            |             |           |           |
|------------------|------------|-------------|-----------|-----------|
| Channel          | Bandwidth  | Offset      | Power     |           |
| Tx1 (Ref)        | 1.229 MHz  |             | -0.86 dBm |           |
| Tx Total         |            |             | -0.86 dBm |           |
| Channel          | Bandwidth  | Offset      | Lower     | Upper     |
| Adj              | 30.000 kHz | 750.000 kHz | -79.59 dB | -80.34 dB |
| Alt1             | 30.000 kHz | 1.980 MHz   | -85.04 dB | -83.85 dB |

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

Remote command:

LAY:ADD? '1',RIGH, RSUM, see LAYout:ADD[:WINDow]? on page 462

### Spectrogram

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency or sweep time, the y-axis shows the measurement time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

The spectrogram display consists of two diagrams: the standard spectrum result display (upper diagram) and the spectrogram result display (lower diagram).

For details see [Chapter 5.3.1.7, "Working with spectrograms"](#), on page 357.

Remote command:

LAY:ADD? '1',RIGH, SGR, see LAYout:ADD[:WINDow]? on page 462

### 5.1.2 Laying out the result display with the smartgrid

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Each type of evaluation is displayed in a separate window in the channel tab. Up to 16 individual windows can be displayed per channel (i.e. per tab). To arrange the diagrams and tables on the screen, the Rohde & Schwarz SmartGrid function helps you find the target position simply and quickly.

(For details on evaluation methods see the User Manual.)

Principally, the layout of the windows on the screen is based on an underlying grid, the SmartGrid. However, the SmartGrid is dynamic and flexible, allowing for many different layout possibilities. The SmartGrid functionality provides the following basic features:

- Windows can be arranged in columns or in rows, or in a combination of both.
  - Windows can be arranged in up to four rows and four columns.
  - Windows are moved simply by dragging them to a new position on the screen, possibly changing the layout of the other windows, as well.
  - All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar. If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. The same evaluation method can be displayed in multiple windows simultaneously.
  - New windows are added by dragging an evaluation icon from the evaluation bar to the screen. The position of each new window depends on where you drop the evaluation icon in relation to the existing windows.
  - All display configuration actions are only possible in SmartGrid mode. When SmartGrid mode is activated, the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.
- |   |     |
|---|-----|
| • <a href="#">Background information: the smartgrid principle</a> ..... | 334 |
| • <a href="#">How to activate smartgrid mode</a> .....                  | 336 |
| • <a href="#">How to add a new result window</a> .....                  | 336 |
| • <a href="#">How to close a result window</a> .....                    | 337 |
| • <a href="#">How to arrange the result windows</a> .....               | 337 |

#### 5.1.2.1 Background information: the smartgrid principle

##### SmartGrid display

During any positioning action, the underlying SmartGrid is displayed. Different colors and frames indicate the possible new positions. The position in the SmartGrid where you drop the window determines its position on the screen.

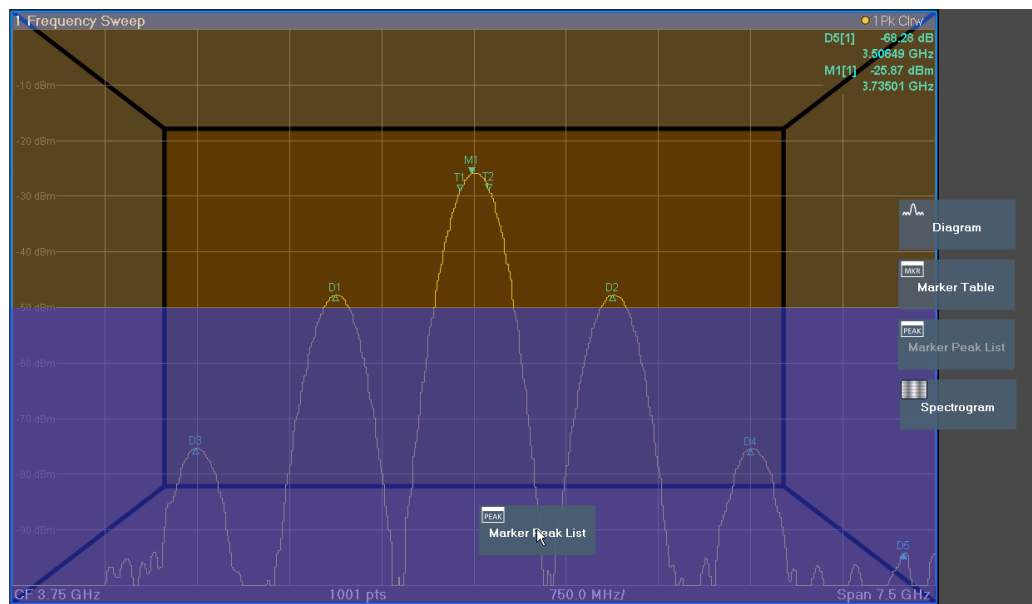


Figure 5-1: Moving a window in SmartGrid mode

The brown area indicates the possible "drop area" for the window, i.e. the area in which the window can be placed. A blue area indicates the (approximate) layout of the window as it would be if the icon were dropped at the current position. The frames indicate the possible destinations of the new window with respect to the existing windows: above/below, right/left or replacement (as illustrated in Figure 5-2). If an existing window would be replaced, the drop area is highlighted in a darker color shade.

### Positioning the window

The screen can be divided into up to four rows. Each row can be split into up to four columns, where each row can have a different number of columns. However, rows always span the entire width of the screen and may not be interrupted by a column. A single row is available as the drop area for the window in the SmartGrid. The row can be split into columns, or a new row can be inserted above or below the existing row (if the maximum of 4 has not yet been reached).

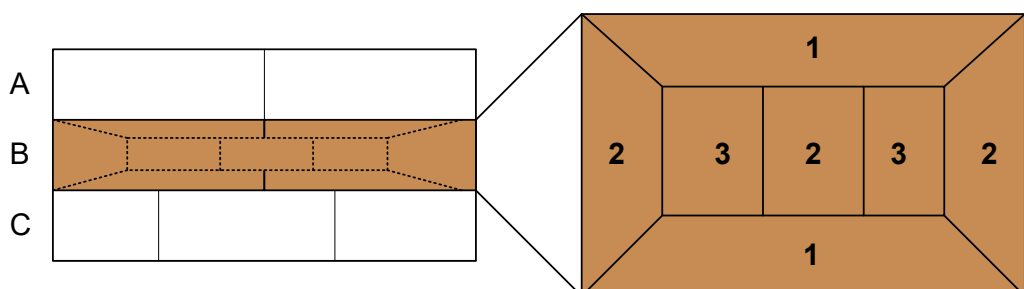


Figure 5-2: SmartGrid window positions

- 1 = Insert row above or below the existing row
- 2 = Create a new column in the existing row
- 3 = Replace a window in the existing row

### SmartGrid functions

Once the evaluation icon has been dropped, icons in each window provide delete and move functions.



The "Move" icon allows you to move the position of the window, possibly changing the size and position of the other displayed windows.



The "Delete" icon allows you to close the window, enlarging the display of the remaining windows.

#### 5.1.2.2 How to activate smartgrid mode

All display configuration actions are only possible in SmartGrid mode. In SmartGrid mode the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.

► To activate SmartGrid mode, do one of the following:



Select the "SmartGrid" icon from the toolbar.

- Select "Display Config" in the configuration "Overview".
- Select "Display Config" from the [Meas Config] menu.

The SmartGrid functions and the evaluation bar are displayed.



To close the SmartGrid mode and restore the previous softkey menu, select the "Close" icon, or press any key.

#### 5.1.2.3 How to add a new result window

Each type of evaluation is displayed in a separate window. Up to 16 individual windows can be displayed per channel (i.e. per tab).

1. Activate SmartGrid mode.

All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar.

2. Select the icon for the required evaluation method from the evaluation bar.

If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. Touch the evaluation bar between the icons and move it up or down until the required icon appears.

3. Drag the required icon from the evaluation bar to the SmartGrid, which is displayed in the diagram area, and drop it at the required position. (See [Chapter 5.1.2.5](#),

"How to arrange the result windows", on page 337 for more information on positioning the window).

**Remote command:**

`LAYout:ADD[:WINDow]?` on page 462 / `LAYout:WINDow<n>:ADD?` on page 467

#### 5.1.2.4 How to close a result window

- To close a window, activate SmartGrid mode and select the "Delete" icon for the window.



**Remote command:**

`LAYout:REMove[:WINDow]` on page 465 / `LAYout:WINDow<n>:REMove` on page 468

#### 5.1.2.5 How to arrange the result windows

1. Select an icon from the evaluation bar or the "Move" icon for an existing evaluation window.



2. Drag the evaluation over the SmartGrid.  
A blue area shows where the window will be placed.
3. Move the window until a suitable area is indicated in blue.
4. Drop the window in the target area.  
The windows are rearranged to the selected layout, and "Delete" and "Move" icons are displayed in each window.
5. To close a window, select the corresponding "Delete" icon.



**Remote command:**

`LAYout:REPLace[:WINDow]` on page 465 / `LAYout:WINDow<n>:REPLace` on page 468

LAYout:MOVE[:WINDow] on page 464

5.2 Zoomed displays

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touchscreen or a mouse pointer you can easily define the area to be enlarged.

Graphical Zoom Versus Measurement Zoom

Graphical zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points, the frequency range, or the reference level. Graphical zooming only changes the resolution of the displayed trace points temporarily. You must explicitly activate the graphical zoom function (see Chapter 5.2.2, "Zoom functions", on page 340).

When you change the display using touch gestures, however, the corresponding measurement settings are adapted. For example, dragging horizontally in a spectrum display changes the center frequency. Dragging vertically in a spectrum display changes the reference level (for absolute scaling). These changes are permanent for the measurement. This behavior is also referred to as *measurement zoom*, and is active by default in the new R&S ESW. However, you can also activate it manually for a display that has already been zoomed graphically. In this case, the temporary changes to the display are replaced by permanent changes to the measurement settings with the same effect.

Example:

Assume you have a spectrum display from a spurious emission measurement. You graphically zoom into the area around a detected spur. If you now activate a measurement zoom, the reference level, the center frequency, the frequency span, and the scaling settings are adapted so that the results of the measurement now indicate only the formerly zoomed area around the detected spur.



Zoom and the number of sweep points

Note that zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points!

You should increase the number of sweep points before zooming, as otherwise the function has no real effect (see Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count", on page 303).

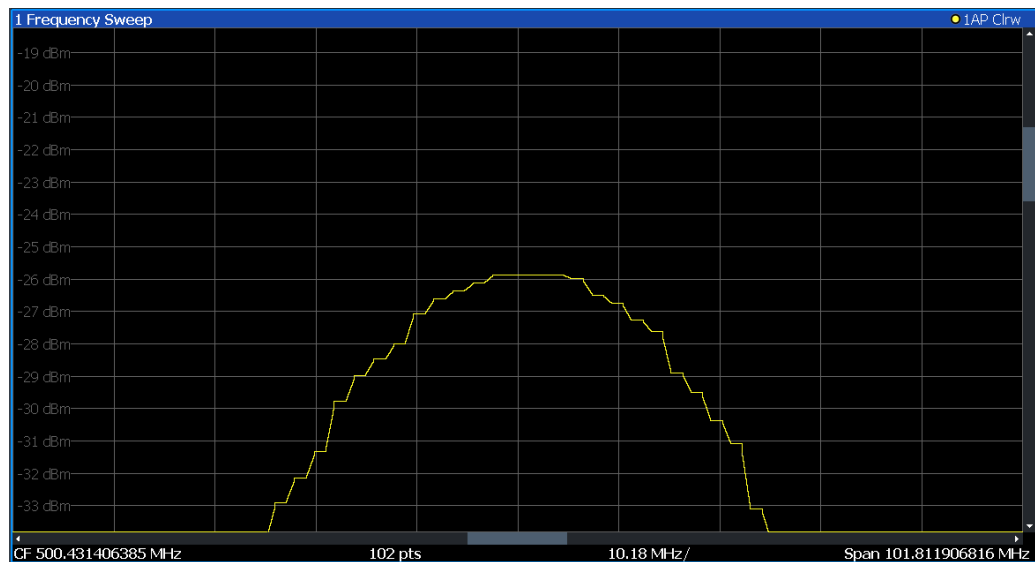
|  |     |
|--|-----|
| • <a href="#">Single zoom versus multiple zoom</a> | 339 |
| • <a href="#">Zoom functions</a>                   | 340 |
| • <a href="#">How to zoom into a diagram</a>       | 342 |

### 5.2.1 Single zoom versus multiple zoom

Two different (graphical) zoom modes are available: single zoom and multiple zoom. A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible. In multiple zoom mode, you can enlarge up to four different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom areas can be moved and resized any time. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.



**In the receiver application, multiple zoom is not available.**



**Figure 5-3: Single zoom**

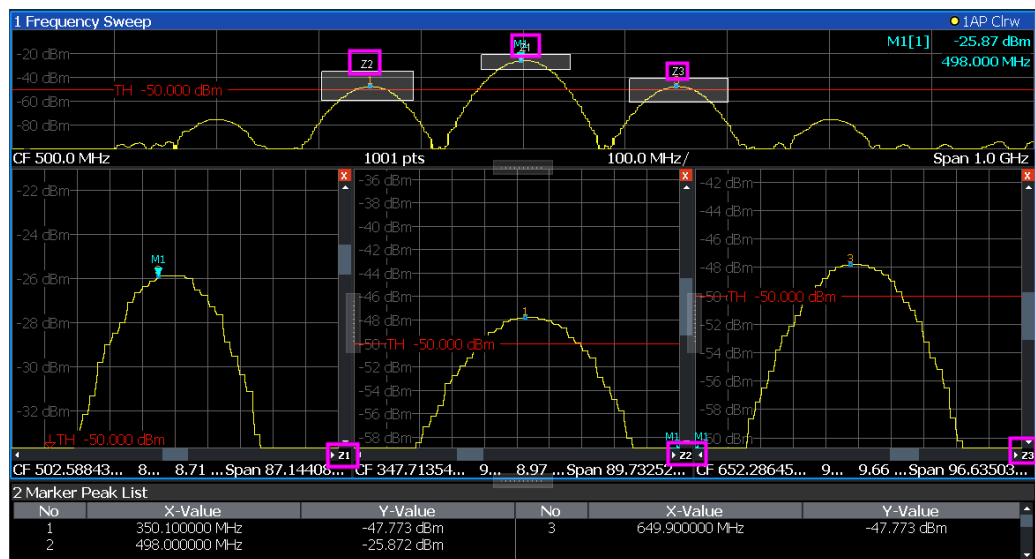


Figure 5-4: Multiple zoom



### Using the zoom area to restrict a peak search

In the Spectrum application, the selected zoom area can be used to restrict the search range for a peak search, but only in single zoom mode (see "Use Zoom Limits" on page 403).

## 5.2.2 Zoom functions

**Access:** "Zoom" icons in toolbar

|  |     |
|--|-----|
| Single Zoom                                    | 340 |
| Multi-Zoom                                     | 341 |
| Measurement Zoom                               | 341 |
| L Level Lock                                   | 341 |
| L X-Lock                                       | 342 |
| L Y-Lock                                       | 342 |
| L Adapt Measurement to Zoom (selected diagram) | 342 |
| Restore Original Display                       | 342 |

### Single Zoom



A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 688

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA` on page 686



## Multi-Zoom



In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`

on page 688

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA`

on page 687

## Measurement Zoom

As opposed to the graphical zoom, which is merely a visual tool, the measurement zoom adapts the measurement settings such that the data you are interested in is displayed in the required detail. In measurement zoom mode, you can change the display using touch gestures. This is the default operating mode of the R&S ESW.

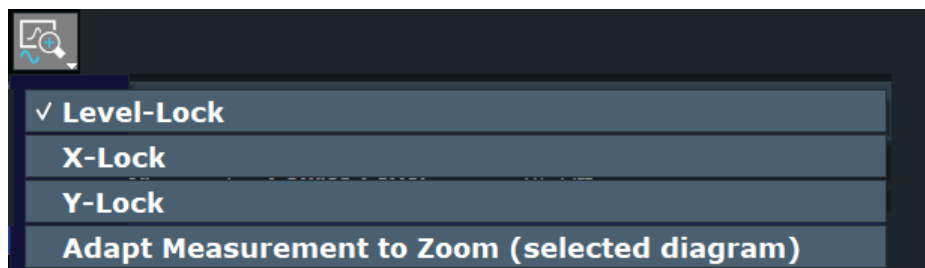
For details on touch gestures see "Operating Basics" in the R&S ESW Getting Started manual.

**Note:** The measurement settings are adapted to practical values based on a suitable grid for the current settings, rather than to unwieldy values that reflect precisely the pixel you happen to tap.

If the measurement zoom leads to undesirable results, you can easily return to the original measurement settings using the "UNDO" function.

When you select the "Measurement Zoom" icon, then tap in a diagram, a dotted rectangle is displayed which you can drag to define the zoom area. This allows you to define the zoom area more precisely than by spreading two fingers in the display.

The measurement zoom function provides further options in a context-sensitive menu, which is displayed when you tap the icon for about a second (or right-click it). These options concern the behavior of the firmware for subsequent touch gestures on the screen. Note that these settings remain unchanged after a channel preset.



### Level Lock ← Measurement Zoom

If activated (default), the reference level (and thus the attenuation) is locked, that is: remains unchanged during touch gestures on the screen.

**X-Lock ← Measurement Zoom**

If activated, the x-axis of the diagram is not changed during subsequent touch gestures.

**Y-Lock ← Measurement Zoom**

If activated, the y-axis of the diagram is not changed during subsequent touch gestures.

**Adapt Measurement to Zoom (selected diagram) ← Measurement Zoom**

If you already performed a graphical zoom using the ["Single Zoom"](#) on page 340 or ["Multi-Zoom"](#) on page 341 functions, this function automatically adapts the measurement settings to maintain the currently zoomed display.

**Restore Original Display**

Restores the original display, that is, the originally calculated displays for the entire capture buffer, and closes all zoom windows.

**Note:** This function only restores graphically zoomed displays. Measurement zooms, for which measurement settings were adapted, are recalculated based on the adapted measurement settings. In this case, the zoomed display is maintained.

Remote command:

Single zoom:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 688

Multiple zoom:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`  
on page 688 (for each multiple zoom window)

### 5.2.3 How to zoom into a diagram

The following tasks are described here:

- ["To zoom into the diagram at one position"](#) on page 342
- ["To return to original display"](#) on page 343
- ["To zoom into multiple positions in the diagram"](#) on page 343
- ["To maintain a zoomed display permanently"](#) on page 344

#### To zoom into the diagram at one position

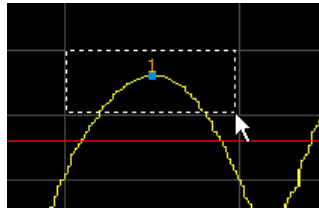
1.



Click on the "Single Zoom" icon in the toolbar.

Zoom mode is activated.

2. Tap and drag your finger in the diagram to select the area to be enlarged. The selected area is indicated by a dotted rectangle.



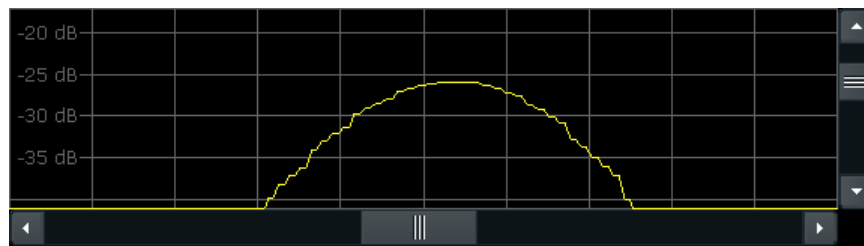
When you leave the touchscreen, the diagram is replaced by the zoomed trace area.

3. Repeat these steps, if necessary, to enlarge the diagram further.



### Scrolling in the zoomed display

You can scroll the diagram area to display the entire diagram using the scrollbars at the right and at the bottom of the diagram.



### To return to original display



Click on the "Zoom Off" icon in the toolbar.

The original trace display is restored. Zoom mode remains active, however.

### To zoom into multiple positions in the diagram



Click on the "Multi-Zoom" icon in the toolbar.

Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged as described in ["To zoom into the diagram at one position"](#) on page 342. The selected area is indicated by a dotted rectangle.

When you have completed your selection, the original trace is shown in an overview diagram with the selected area indicated by a dotted rectangle. The zoomed trace area is displayed in a separate window (see [Figure 5-4](#)).



Click on the "Multi-Zoom" icon in the toolbar again.

4. In the overview diagram, select the next area to be enlarged.

The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.

5. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

### To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

- To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.  
To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.

The contents of the zoom windows are adapted accordingly.

### To maintain a zoomed display permanently

Graphical zooming only changes the resolution of the displayed trace points temporarily. In order to change the display permanently, you must change the corresponding measurement settings.

(Note: Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display, see ["To perform a measurement zoom"](#) on page 344).

1. Perform a graphical zoom as described in the previous procedures.



2. Select the "Measurement Zoom" icon from the toolbar.

3. Select "Adapt Measurement to Zoom (selected diagram)".

The measurement settings are adapted as required to obtain the zoomed result display.

### To perform a measurement zoom

Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display.



1. Select the "Measurement Zoom" icon from the toolbar.
2. Do one of the following to define the zoom area:
  - Stretch two fingers in the diagram to enlarge the area between them.

- Tap and drag one finger in the diagram to select the area to be enlarged. The selected area is indicated by a dotted rectangle.

The measurement settings are adapted as required to obtain the zoomed result display.

## 5.3 Configuring traces

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

|  |     |
|--|-----|
| • <a href="#">Basic information about traces</a> ..... | 345 |
| • <a href="#">Trace configuration</a> .....            | 366 |
| • <a href="#">How to configure traces</a> .....        | 382 |
| • <a href="#">References</a> .....                     | 388 |

### 5.3.1 Basic information about traces

Some background knowledge on traces is provided here for a better understanding of the required configuration settings.

|   |     |
|---|-----|
| • <a href="#">Mapping samples to sweep points with the trace detector</a> ..... | 345 |
| • <a href="#">Analyzing several traces - trace mode</a> .....                   | 352 |
| • <a href="#">How many traces are averaged - sweep count + Sweep mode</a> ..... | 353 |
| • <a href="#">How trace data is averaged - the averaging mode</a> .....         | 354 |
| • <a href="#">Trace smoothing</a> .....   | 355 |
| • <a href="#">Displaying a reference trace - importing trace data</a> .....     | 356 |
| • <a href="#">Working with spectrograms</a> .....                               | 357 |

#### 5.3.1.1 Mapping samples to sweep points with the trace detector

A trace displays the values measured at the measurement points (also known as sweep points in some applications). However, the number of samples taken during a measurement can be much larger than the number of measurement points that are displayed in the measurement trace.

**Example:**

Assume the following measurement parameters:

- Sample rate: 32 MSamples / s
- Measurement points: 1000
- Measurement time: 100 ms
- Span: 5 GHz

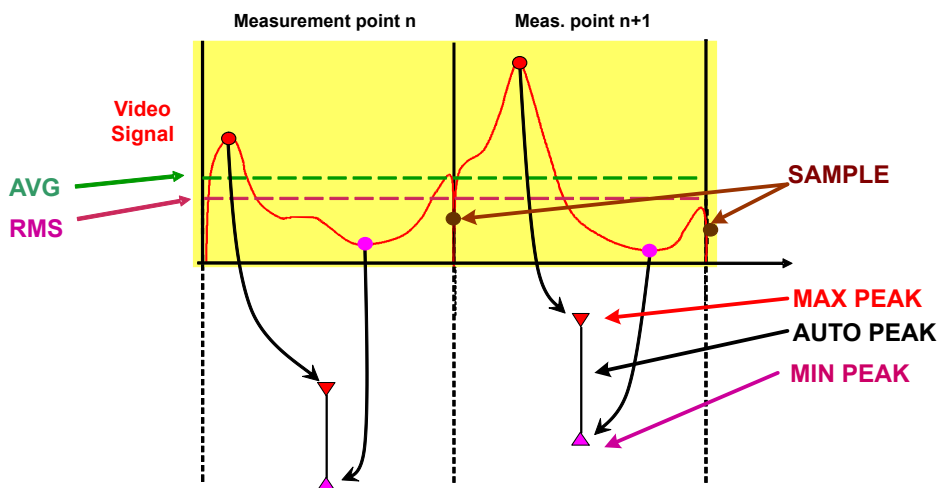
During a single measurement,  $3.2 \cdot 10^6$  samples are collected and distributed to 1000 measurement points, i.e. 3200 samples are collected per measurement point. For each measurement point, the measured data for a frequency span of 5 MHz ( $\text{span} / \text{measurement points}$ ) is analyzed.

Note that if you increase the number of measurement points, the frequency span analyzed for each point in the trace decreases, making the trace more reliable. The analyzed results become more accurate. On the other hand, for detectors that average the samples within the span, the trace becomes less stable because fewer samples are averaged.

See also [Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count"](#), on page 303.

Obviously, the data must be reduced to determine which of the samples are displayed for each measurement point. This is the trace detector's task. The trace detector can analyze the measured data using various methods.

The result obtained from the selected detector for a measurement point is displayed as the value at this frequency point in the trace.



You can define the trace detector to be used for the individual traces manually, or the R&S ESW can select the appropriate detector automatically.

The detectors of the R&S ESW are implemented as pure digital devices. All detectors work in parallel in the background, which means that the measurement speed is independent of the detector combination used for different traces.

However, you should select a measurement time that is sufficient for the detector that requires the longest measurement time.

### Auto detector

If the R&S ESW is set to define the appropriate detector automatically, the detector is set depending on the selected trace mode and average mode:

| Trace mode    | Detector                                       |
|---------------|--|
| "Clear Write" | Auto peak                                      |
| "Max Hold"    | Positive peak                                  |
| "Min Hold"    | Negative peak                                  |
| "Average"     | Sample peak<br>(for average mode "Power": RMS) |
| "View"        | –  |
| "Blank"       | –  |



The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation. Not all detector types are supported by all applications available for the R&S ESW.

**Table 5-1: Detector types**

| Detector      | Abbrev. |
|---------------|---------|
| Positive peak | "Pk"    |
| Negative peak | "Mi"    |
| Auto peak     | "Ap"    |
| RMS           | "Rm"    |
| Average       | "Av"    |

### Measurement time

The measurement time defines how long the R&S ESW measures the signal at the individual frequencies. Each detector needs a different period of time to fully charge and discharge; the individual requirements on the measurement time are described for each detector.

- [Positive peak \(max peak\) and negative peak \(min peak\) detector](#)..... 348
- [Auto peak detector](#)..... 348
- [RMS detector](#)..... 348
- [Average detector](#)..... 349
- [Sample detector](#)..... 350
- [Quasipeak detector](#)..... 350
- [CISPR average detector](#)..... 351
- [RMS average detector](#)..... 351

### Positive peak (max peak) and negative peak (min peak) detector

The positive (maximum) detector determines the largest of all positive peak values measured at the individual measurement points which are combined in one sample point.

The negative (minimum) peak detector determines the smallest of all negative peak values measured at the individual measurement points which are combined in one sample point.

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For pulsed signals, measurement time must be longer than the expected pulse length, that is: it must cover at least one pulse.

### Auto peak detector

The auto peak detector combines the "Positive peak (max peak) and negative peak (min peak) detector" on page 348. The maximum and the minimum values determined for each sample point are displayed.

Available in the spectrum application, but not for the Spectrum Emission Mask measurement.

### RMS detector

The RMS detector calculates the root mean square of all samples combined in a sweep point. The whole IF envelope is used to calculate the power for each measurement point. The IF envelope is digitized using a sample rate which is at least five times the selected resolution bandwidth. Based on the sample values, the power is calculated for each measurement point using the following formula:

$$P_{RMS} = \frac{U_{RMS}^2}{R} = \frac{\left( \sqrt{\frac{1}{N} * \sum_{i=1}^N s_i} \right)^2}{R} = \frac{1}{N * R} * \sum_{i=1}^N s_i^2$$

Where:

- $P_{RMS}$  = power represented by a measurement point
- $N$  = number of A/D converter values (samples) per measurement point
- $R$  = electrical impedance
- $s_i$  = linear digitized video voltage at the output of the A/D converter

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

$$P(dBm) = 30dBm + 10 \cdot \log_{10} \cdot P_{RMS} = 30dBm + 10 \cdot \log_{10} \left( \frac{1}{N * R} * \sum_{i=1}^N s_i^2 \right)$$

Where:

- $P$  (dB) = logarithmic power represented by a measurement point



Each sweep point thus corresponds to the root mean square of the measured values combined in the sweep point.

The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors to measure the power of the different signal classes are not required.

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For modulated signals, the measurement time must be long enough to make sure the averaging considers all variations due to the modulation characteristics of the signal.
- For pulsed signals, the measurement time must be long enough to capture a sufficient number of pulses. For averaging, a sufficient number of pulses is greater than 10.



#### The RMS detector and the video bandwidth

When using the RMS detector in the Spectrum application, the video bandwidth (VBW) in the hardware is bypassed. However, if the measurement time is determined automatically, the VBW is still considered. The measurement time is then set to the minimum time required by the current VBW setting. Thus, a similar averaging effect is achieved, while providing a correct RMS power result.

Video filtering together with the RMS detector would result in logarithmic averaging.

#### Average detector

The average detector calculates the linear average of all samples combined in a sweep point.

For average detection, the video voltage (envelope of IF signal) is averaged over the measurement time. Averaging is digital, i.e. the digitized values of the video voltage are summed up and divided by the number of samples at the end of the measurement time. This corresponds to a filtering with a rectangular window in the time domain and a filtering with  $\sin x/x$  characteristic in the frequency domain.

To this effect, R&S ESW uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). For linear display, the average value is displayed.

$$P_{Avg} = \frac{U_{Avg}^2}{R} = \frac{1}{R} * \left( \frac{1}{N} * \sum_{i=1}^N s_i \right)^2$$

Where:

- $P_{AVG}$  = power represented by a measurement point
- $N$  = number of A/D converter values per measurement point
- $R$  = electrical impedance
- $s_i$  = linear digitized video voltage at the output of the A/D converter

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

$$P(\text{dBm}) = 30\text{dBm} + 10 \cdot \log_{10} \cdot P_{\text{Avg}} = 30\text{dBm} + 10 \cdot \log_{10} \left( \frac{1}{R} * \left( \frac{1}{N} * \sum_{i=1}^N s_i \right)^2 \right)$$

Where:

- P (dBm) = logarithmic power represented by a measurement point

Each measurement point thus corresponds to the average of the measured values combined in the measurement point.

The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For modulated signals, the measurement time must be long enough to make sure the averaging considers all variations due to the modulation characteristics of the signal.
- For pulsed signals, the measurement time must be long enough to capture a sufficient number of pulses. For averaging, a sufficient number of pulses is greater than 10.

### Sample detector

The sample detector selects and displays a single sample (always the first or always the last) from all samples that are combined in the sweep point. All other measured values for the sample point are ignored.

### Quasipeak detector

The quasipeak detector resembles the behavior of an analog voltmeter by analyzing the measured values for a sample point. The quasipeak detector is especially designed for the requirements of EMI measurements and is used to analyze pulse-shaped spurs.

This detector is only available for the CISPR filter.

The quasipeak detector is not available for an RBW of 1 MHz.

The quasipeak detector displays the weighted maximum signal level according to CISPR 16-1-1 that was detected during the specified measurement time.

The filter bandwidth and time parameters of the detector depend on the measured frequency. The time lag of the simulated pointer instrument reflects the weighting factor of the signal depending on its form, modulation, etc.

Depending on the selected frequency, the R&S ESW automatically selects the detectors and IF bandwidths defined for bands A, B and C/D listed in the following table:

Tips regarding measurement time:

- The relatively long time constants of the quasipeak detector result in long measurement times to yield valid results.

- For unknown signals, use a measurement time of at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.
- For known signals, you can use a much shorter measurement time.

### CISPR average detector

The CISPR Average detector displays a weighted average signal level according to CISPR 16-1-1.

The average value according to CISPR 16-1-1 is the maximum value detected while calculating the linear average value during the specified measurement time.

This detector is only available for the CISPR filter.

The CISPR Average detector is applied to measure pulsed sinusoidal signals with a low pulse frequency, for example. It is calibrated with the RMS value of an unmodulated sinusoidal signal. The average value is determined by lowpass filters of the 2nd order (simulating a mechanical pointer instrument).

The lowpass time constants and the IF bandwidths depend on the measured frequency. The main parameters are listed in the following table:

Tips regarding measurement time:

- The relatively long time constants of the CISPR average detector result in long measurement times to yield valid results.
- For unknown signals, use a measurement time of at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.
- For unmodulated sinusoidal signals and signals with a high modulation frequency, you can use a much shorter measurement time.
- For slowly fluctuating signals or pulsed signals, use longer measurement times.

### RMS average detector

The RMS Average detector is a combination of the RMS detector (for pulse repetition frequencies above a corner frequency) and the Average detector (for pulse repetition frequencies below the corner frequency). It thus achieves a pulse response curve with the following characteristics:

- 10 dB/decade above the corner frequency
- 20 dB/decade below the corner frequency

The average value is determined by lowpass filters of the 2nd order (simulation of a mechanical pointer instrument).

The RMS Average detector is only available for the CISPR filter.

The detector is used to measure broadband emissions, for example, and can possibly replace the quasipeak detector in the future.

The detector parameters depend on the measured frequency.

Tips regarding measurement time:

- The relatively long time constants of the CISPR average detector result in long measurement times to yield valid results.

- For unknown signals, use a measurement time of at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.
- For unmodulated sinusoidal signals and signals with a high modulation frequency, you can use a much shorter measurement time.
- For slowly fluctuating signals or pulsed signals, use longer measurement times.



#### Measurement times shorter than 20 ms

With measurement times shorter than 20 ms, the detector weighting changes to plain RMS weighting.

#### 5.3.1.2 Analyzing several traces - trace mode

If several sweeps are performed one after the other, or continuous sweeps are performed, the trace mode determines how the data for subsequent traces is processed. After each sweep, the trace mode determines whether:

- The data is frozen ("View")
- The data is hidden ("Blank")
- The data is replaced by new values ("Clear Write")
- The data is replaced selectively ("Max Hold", "Min Hold", "Average")



Each time you change the trace mode, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 345.


The R&S ESW supports the following trace modes:

**Table 5-2: Overview of available trace modes**

| Trace Mode  | Description  |
|-------------|--|
| Blank       | Hides the selected trace.  |
| Clear Write | Overwrite mode: the trace is overwritten by each sweep. This is the default setting. All available detectors can be selected.  |
| Max Hold    | <p>The maximum value is determined over several measurements and displayed. The R&amp;S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.</p> <p>This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope.</p> <p>This mode is not available for statistics measurements.</p> |

| Trace Mode | Description   |
|------------|---|
| Min Hold   | <p>The minimum value is determined from several measurements and displayed. The R&amp;S ESW saves the sweep result in the trace memory only if the new value is lower than the previous one.</p> <p>This mode is useful for example for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level.</p> <p>This mode is not available for statistics measurements.</p> |
| Average    | <p>The average is formed over several measurements and displayed.</p> <p>The <a href="#">Sweep/Average Count</a> determines the number of averaging procedures.</p> <p>This mode is not available for statistics measurements.</p>  |
| View       | The current contents of the trace memory are frozen and displayed.  |



If a trace is frozen ("View" mode), you can change the measurement settings, apart from scaling settings, without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk  on the tab label.

If you change any parameters that affect the scaling of the diagram axes, the R&S ESW automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.

### 5.3.1.3 How many traces are averaged - sweep count + Sweep mode

In "Average" trace mode, the sweep count and sweep mode determine how many traces are averaged. The more traces are averaged, the smoother the trace is likely to become.

The algorithm for averaging traces depends on the sweep mode and sweep count.

- **sweep count = 0** (default)
  - In **"Continuous"** sweep mode, a continuous average is calculated for 10 sweeps, according to the following formula:

$$Trace = \frac{9 * Trace_{old} + MeasValue}{10}$$

Figure 5-5: Equation 1

Due to the weighting between the current trace and the average trace, past values have practically no influence on the displayed trace after about ten sweeps. With this setting, signal noise is effectively reduced without need for restarting the averaging process after a change of the signal.

- In **"Single"** sweep mode, the current trace is averaged with the previously stored averaged trace. No averaging is carried out for the first sweep but the measured value is stored in the trace memory. The next time a sweep is performed, the trace average is calculated according to the following formula:

$$Trace = \frac{Trace_{old} + MeasValue}{2}$$

The averaged trace is then stored in the trace memory.

- **sweep count = 1**

The currently measured trace is displayed and stored in the trace memory. No averaging is performed.

- **sweep count > 1**

For both **"Single"** sweep mode and **"Continuous"** sweep mode, averaging takes place over the selected number of sweeps. In this case the displayed trace is determined during averaging according to the following formula:

$$Trace_n = \frac{1}{n} \cdot \left[ \sum_{i=1}^{n-1} (T_i) + MeasValue_n \right]$$

**Figure 5-6: Equation 2**

Where n is the number of the current sweep (n = 2 ... sweep count).

No averaging is carried out for the first sweep but the measured value is stored in the trace memory. With increasing n, the displayed trace is increasingly smoothed since there are more individual sweeps for averaging.

After the selected number of sweeps, the average trace is saved in the trace memory. Until this number of sweeps is reached, a preliminary average is displayed.

When the averaging length defined by the "Sweep Count" is attained, averaging is continued in continuous sweep mode or for "Continue Single Sweep" according to the following formula:

$$Trace = \frac{(N-1) * Trace_{old} + MeasValue}{N}$$

Where N is the sweep count

#### 5.3.1.4 How trace data is averaged - the averaging mode

When the trace is averaged over several sweeps (Trace mode: "Average"), different methods are available to determine the trace average.

With logarithmic averaging, the dB values of the display voltage are averaged or subtracted from each other with trace mathematical functions.

With linear averaging, the level values in dB are converted into linear voltages or powers before averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals, the two methods yield the same result.

Logarithmic averaging is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals, the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved. The negative peak values are

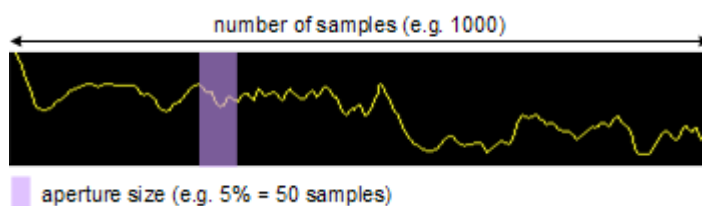
increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the R&S ESW offers the selection of linear averaging. The trace data is linearized before averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

### 5.3.1.5 Trace smoothing

A video bandwidth filter (VBW) is a hardware-based method of smoothing the trace (see also [Chapter 4.6.1.2, "Smoothing the trace using the video bandwidth"](#), on page 299). However, other sweep and bandwidth settings can be coupled to the VBW. For some signals, a VBW may not be freely selectable to obtain the required smoothing effect. Therefore, a software-based trace smoothing function is also available.

(Software-based) **smoothing** is a way to remove anomalies visually in the trace that can 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 5-7: Sample size included in trace smoothing**

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

x = sample offset from s

n = aperture size

### 5.3.1.6 Displaying a reference trace - importing trace data

Trace data that was stored during a previous measurement can be imported to the Spectrum application, for example as a reference trace.

The data in the import file must have a specified format (see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 388), and can be stored in .CSV or .DAT format.

#### Trace Mode

The trace mode for the imported traces is set to "View" so that the data is not overwritten immediately during the next sweep. Other trace settings remain unchanged. Thus, **the displayed trace may not comply with the displayed trace settings in the channel bar.**

#### Detector type and number of sweep points

In particular, the detector type and the number of sweep points remain unchanged.

If the detector type of the active trace requires two points per x-value ("Auto Peak"), but the file contains only one, each point is duplicated. If the detector type requires only one point per x-value, but the file contains two, each second point is ignored.

If the file contains more sweep points than the active trace requires, the superfluous points are ignored. If the file does not contain enough sweep points, the missing points are inserted as -200 dBm.

#### Units

If the unit of the y-axis values in the file does not correspond to the active result display, the imported values are converted. If no unit is defined in the file, it is assumed to be dBm.

#### Importing multiple traces in one file

If the import file contains more than one trace, you can import several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

Alternatively, you can import a single trace only, which is displayed for the trace number specified in "Import to Trace". This list contains all currently active traces in the result display. If a trace with the specified number exists in the import file, that trace is imported. Otherwise, the first trace in the file is imported (indicated by a message in the status bar).

#### Example:

The import file contains trace 1, trace 2, and trace 4. The current result display has 4 active traces.

"Import to Trace" = 2: trace 2 of the import file is displayed as trace 2 in the result display.



"Import to Trace" = 3: trace 3 is not available in the import file, thus trace 1 is imported and displayed as trace 3 in the result display

"Import all Traces" is enabled: Trace 1 is imported from the file and replaces trace 1 in the result display.

Trace 2 is imported from the file and replaces trace 2 in the result display.

Trace 4 is imported from the file and replaces trace 4 in the result display.

Trace 3 in the result display remains unchanged.

### Importing spectrogram traces

Trace data can also be imported to an active Spectrogram result display.

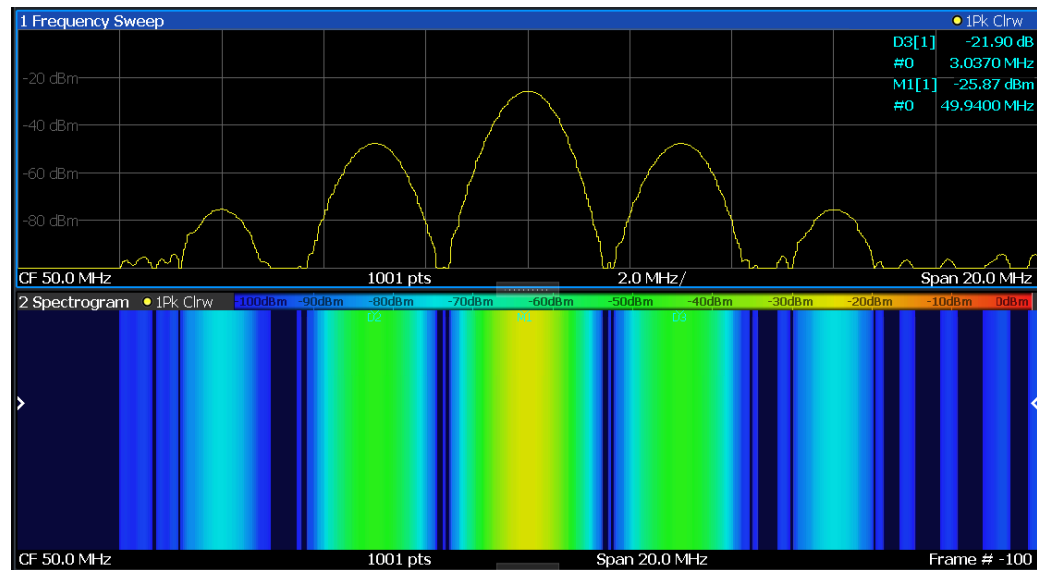
Note the following differences that apply in this case:

- The measurement must be stopped before import.
- Only trace 1 is imported to the spectrogram. Any other traces may be imported to a Spectrum display, if available. However, they do not change the spectrogram display, which always refers to trace 1.
- A single spectrum is inserted as a new frame number 0.
- The trace mode is *not* changed to "View" as for Spectrum trace imports.

#### 5.3.1.7 Working with spectrograms

In addition to the standard "level versus frequency" or "level versus time" traces, the R&S ESW also provides a spectrogram display of the measured data.

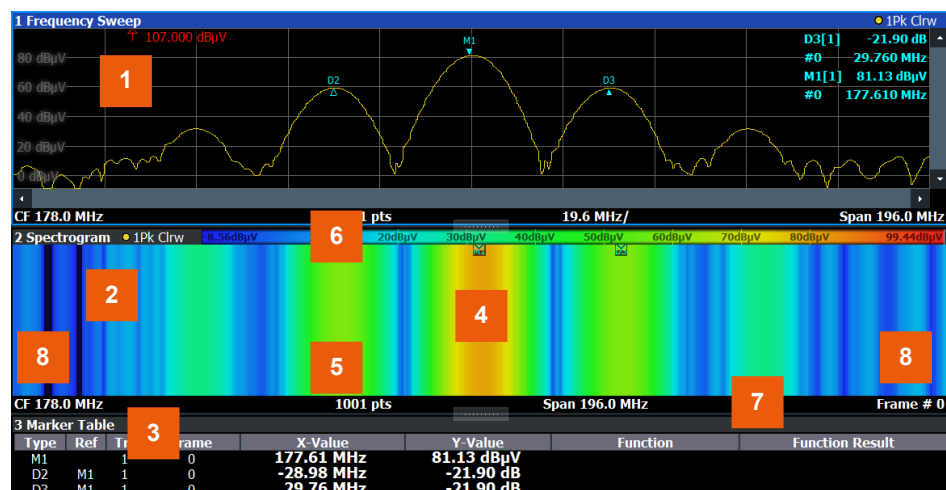
A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

**Example:**

In this example, you see the spectrogram for the calibration signal of the R&S ESW, compared to the standard spectrum display. Since the signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend above the spectrogram display describes the power levels the colors represent.

**Result display**

The spectrogram result can consist of the following elements:



**Figure 5-8: Screen layout of the spectrogram result display**

- 1 = Spectrum result display
- 2 = Spectrogram result display
- 3 = Marker list
- 4 = Marker

5 = Delta marker  
 6 = Color map  
 7 = Timestamp / frame number  
 8 = Current frame indicator

For more information about spectrogram configuration, see [Chapter 5.3.2.5, "Spectrogram settings"](#), on page 378.

#### Remote commands:

Activating and configuring spectrograms:

[Chapter 6.9.2.6, "Spectrogram configuration"](#), on page 705

Storing results:

`MMEMory:STORe<n>:SPEctrogram` on page 710

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#### Time frames

The time information in the spectrogram is displayed vertically, along the y-axis. Each line (or trace) of the y-axis represents one or more captured sweep and is called a **time frame** or simply "frame". As with standard spectrum traces, several measured values are combined in one sweep point using the selected detector.

Frames are sorted in chronological order, beginning with the most recently recorded frame at the top of the diagram (frame number 0). With the next sweep, the previous frame is moved further down in the diagram, until the maximum number of captured frames is reached. The display is updated continuously during the measurement, and the measured trace data is stored. Spectrogram displays are continued even after single measurements unless they are cleared manually.

The maximum number of frames that you can capture depends on the number of sweep points that are analyzed during the measurement.



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



#### Frame analysis in the Spectrum application - Frame count vs. sweep count

As described for standard spectrum sweeps, the sweep count defines how many sweeps are analyzed to create a single trace. Thus, for a trace in "Average" mode, for example, a sweep count of 10 means that 10 sweeps are averaged to create a single trace, or frame.

The frame count, on the other hand, determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). For a frame count of

2, for example, 2 frames will be plotted during each single sweep. For continuous sweep mode, the frame count is irrelevant; one frame is plotted per sweep until the measurement is stopped.

If you combine the two settings, 20 sweeps will be performed for each single sweep measurement. The first 10 will be averaged to create the first frame, the next 10 will be averaged to create the second frame.

As you can see, increasing the sweep count increases the accuracy of the individual traces, while increasing the frame count increases the number of traces in the diagram.

Especially for "Average" or "Min Hold" and "Max Hold" trace modes, the number of sweeps that are analyzed to create a single trace has an effect on the accuracy of the results. Thus, you can also define whether the results from frames in previous traces are considered in the analysis for each new trace ("Continue Frame").

### Tracking absolute time - timestamps

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

When active, the timestamp replaces the display of the frame number in the diagram footer (see [Figure 5-8](#)).

### Displaying individual frames

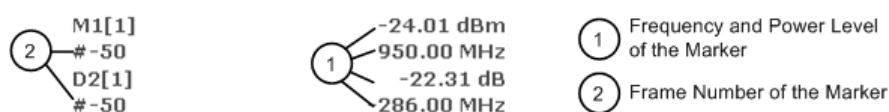
The spectrogram diagram contains all stored frames since it was last cleared. Arrows on the left and right border of the spectrogram indicate the currently selected frame. The scan or spectrum diagrams always display the spectrum for the currently selected frame.

The current frame number is indicated in the diagram footer, or alternatively a timestamp, if activated. The current frame, displayed at the top of the diagram, is frame number 0. Older frames further down in the diagram are indicated by a negative index, e.g. "-10". You can display the spectrum diagram of a previous frame by changing the current frame number.

### Markers in the spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They are only displayed in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

In the spectrum result display, the markers and their frequency and level values (1) are displayed as usual. Additionally, the frame number is displayed to indicate the position of the marker in time (2).



In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers.

In the spectrum result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode, this means that only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the spectrum result display, you must stop the measurement and select the corresponding frame.

### Three-dimensional spectrograms

A common spectrogram shows the frequency on the x-axis, while the y-axis shows the time (in frames). The power level is indicated by different colors of the 2-dimensional points.

In the 3-dimensional spectrogram, the power is indicated by a value in a third dimension, the z-axis. The color mapping is maintained for the point in the 3-dimensional result display.

This new display provides an even better overview of how the strength of the signal varies over time for different frequencies.

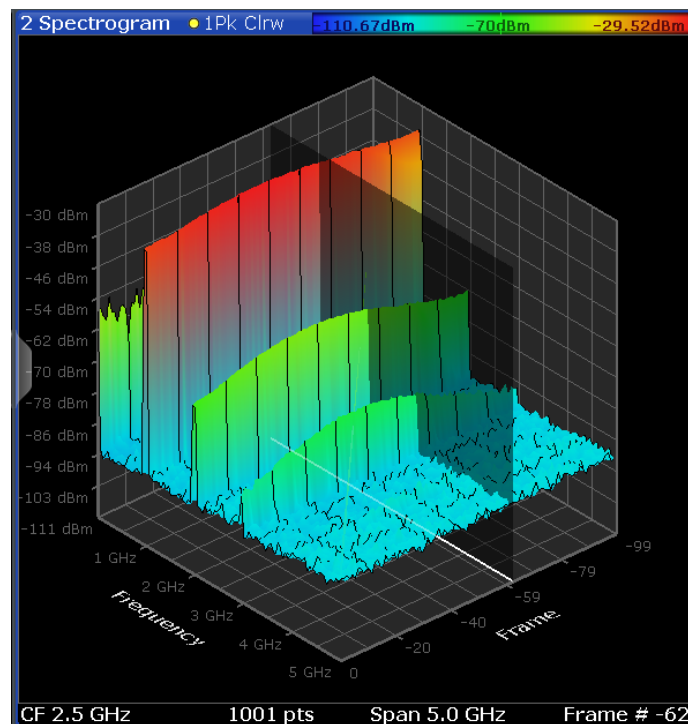


Figure 5-9: Three-dimensional spectrogram

The number of frames displayed on the time (y-)axis is user-definable, whereas for 2-dimensional spectrograms, the number of frames is determined automatically accord-

ing to the size of the window. All other spectrogram settings are identical for 3-dimensional and 2-dimensional spectrograms.

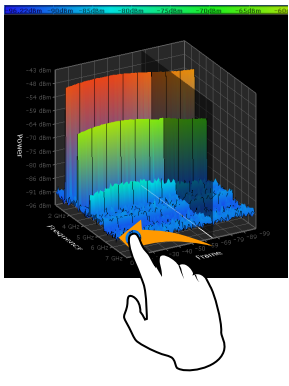
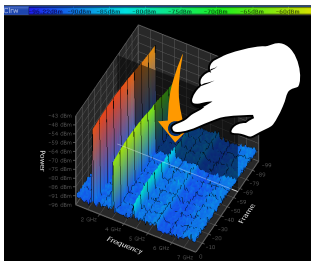
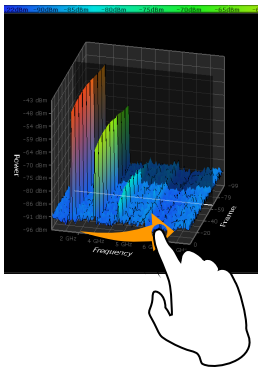
When the measurement is stopped or completed, the currently selected frame is indicated by a gray vertical plane. (As opposed to the small white arrows at the borders of the 2-dimensional display.) The spectrum diagram always displays the spectrum for the currently selected frame.

By default, the most recently recorded frame (frame 0) is selected, and added at the front of the diagram.

### Rotating the spectrogram in three dimensions

Depending on which aspect of the spectrogram is currently of interest, you can rotate the display to have a closer look at the frequency, the time, or the power dimension. Simply drag your finger or the mouse pointer over the spectrogram in the direction you want to rotate it. You can rotate the display left or right, up and down. Note, however, that the degree of rotation is restricted in the upward direction to avoid confusing views. If you rotate the spectrogram such that you see the frequency-frame-plane directly from above, the display is identical to the 2-dimensional spectrogram.

Table 5-3: Effect of rotating the spectrogram in three dimensions

|  |   |  |
|--|---|--|
|  |  |  |
| Rotation to the left > focus on frame  | Rotation down > focus on frequency and frame  | Rotation to the right > focus on frequency   |

### Markers in three-dimensional spectrograms

In three-dimensional spectrograms, the markers are indicated by the common arrows used in the spectrum display, for example. New markers are automatically placed on the current frame. You can move the markers to any position in all dimensions of the diagram. When you select a marker on the screen, three-dimensional cross-hairs indicate the position on all axes.

Sometimes, a marker can be hidden by other frames. If necessary, rotate the spectrogram or select a different frame as the current frame.

### Color maps

Spectrograms assign power levels to different colors to visualize them. The legend above the spectrogram display describes the power levels the colors represent.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use (Color scheme)
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e. where the focus of the visualization lies (shape of the color curve)

The individual colors are assigned to the power levels automatically by the R&S ESW.

### The Color Scheme

- **Hot**



Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

- **Cold**



Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

The "Cold" color scheme is the inverse "Hot" color scheme.

- **Radar**



Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high ones.

- **Grayscale**



Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high ones.

### The value range of the color map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range. Then it becomes easier to distinguish between values that are close together. Display only parts of interest.

### The shape and focus of the color curve

The color-mapping function assigns a specified color to a specified power level in the spectrogram display. By default, colors on the color map are distributed evenly. However, to visualize a certain area of the value range in greater detail than the rest, you can set the focus of the color mapping to that area. Changing the focus is performed by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of

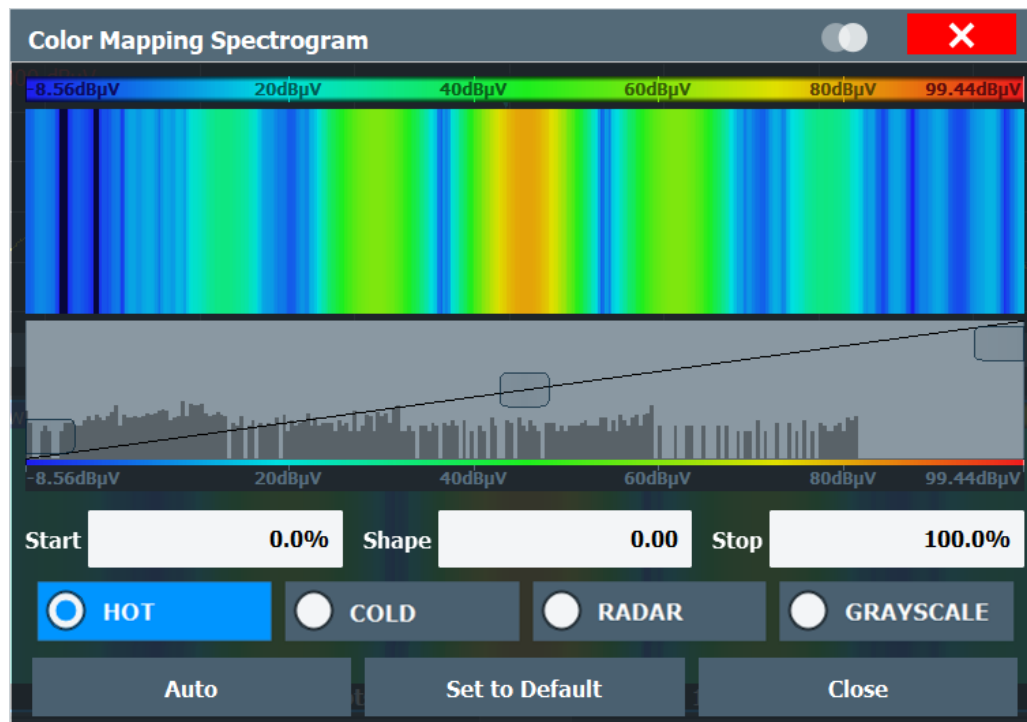
the color palette then covers a large range of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.



**Example:**

In the color map based on the linear color curve, the range from -100 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.



**Figure 5-10: Spectrogram with (default) linear color curve shape = 0**

The sample spectrogram is dominated by blue and green colors. After shifting the color curve to the left (negative value), more colors cover the range from -100 dBm to -60 dBm (blue, green and yellow). This range occurs more often in the example. The range from -60 dBm to -20 dBm, on the other hand, is dominated by various shades of red only.

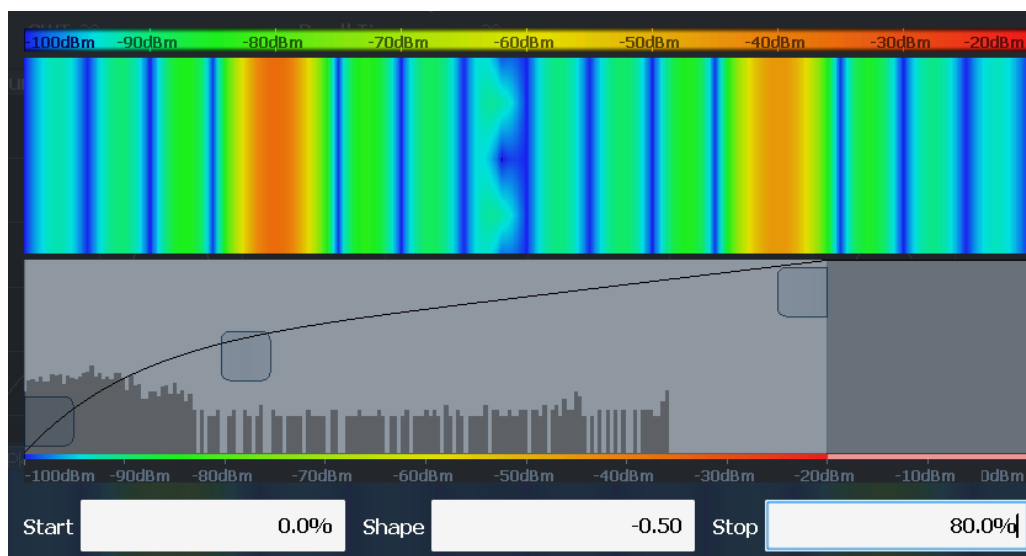


Figure 5-11: Spectrogram with non-linear color curve (shape = -0.5)

### 5.3.2 Trace configuration

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#### 5.3.2.1 Trace settings

**Access:** "Overview" > "Analysis" > "Traces" > "Traces"

The Spectrum application supports six traces that can have a different configuration.

| Traces  |             | Trace / Data Export                 | Copy Trace    | Trace Math               | Spectrogram              |         |
|---------|-------------|-------------------------------------|---------------|--------------------------|--------------------------|---------|
|         |             | Detector                            |               | Smoothing                |                          | Average |
|         | Mode        | Auto                                | Type          | Hold                     | State                    | Value   |
| Trace 1 | Clear Write | <input checked="" type="checkbox"/> | Positive Peak | <input type="checkbox"/> | <input type="checkbox"/> | 2 %     |
| Trace 2 | Blank       | <input checked="" type="checkbox"/> | Auto Peak     | <input type="checkbox"/> | <input type="checkbox"/> | 2 %     |
| Trace 3 | Blank       | <input checked="" type="checkbox"/> | Auto Peak     | <input type="checkbox"/> | <input type="checkbox"/> | 2 %     |
| Trace 4 | Blank       | <input checked="" type="checkbox"/> | Auto Peak     | <input type="checkbox"/> | <input type="checkbox"/> | 2 %     |
| Trace 5 | Blank       | <input checked="" type="checkbox"/> | Auto Peak     | <input type="checkbox"/> | <input type="checkbox"/> | 2 %     |
| Trace 6 | Blank       | <input checked="" type="checkbox"/> | Auto Peak     | <input type="checkbox"/> | <input type="checkbox"/> | 2 %     |

Quick Config

|                   |                                   |  |
|-------------------|-----------------------------------|--|
| Preset All Traces | Set Trace Mode<br>Max   Avg   Min | Set Trace Mode<br>Max   ClrWrite   Min |
|-------------------|-----------------------------------|--|

Average

Linear

Logarithmic

Power

Count: 0

The remote commands required to configure traces are described in [Chapter 6.9.2.2, "Trace settings"](#), on page 692.

|  |     |
|--|-----|
| Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6..... | 367 |
| Trace Mode.....                                      | 367 |
| Detector.....  | 368 |
| Hold.....  | 369 |
| Smoothing.....                                       | 369 |
| Average Mode.....                                    | 369 |
| Average Count.....                                   | 370 |
| Predefined Trace Settings - Quick Config.....        | 370 |
| Trace 1/ Trace 2/ Trace 3/ Trace 4 (Softkeys).....   | 370 |

### Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6

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

Remote command:

Selected via numeric suffix of: `TRACe<1 . . . 6>` commands


`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 696

### Trace Mode

Defines the update mode for subsequent traces.

For details, see [Chapter 5.3.1.2, "Analyzing several traces - trace mode"](#), on page 352.

"Clear/ Write" Overwrite mode (default): the trace is overwritten by each sweep.  
All available detectors can be selected.  
In Spectrum mode, the "Detector" is automatically set to "Auto Peak".

|            |   |
|------------|---|
| "Max Hold" | <p>The maximum value is determined over several measurements and displayed. The R&amp;S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.</p> <p>This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope.</p> <p>The "Detector" is automatically set to "PositivePeak".</p> <p>This mode is not available for statistics measurements.</p>  |
| "Min Hold" | <p>The minimum value is determined from several measurements and displayed. The R&amp;S ESW saves the sweep result in the trace memory only if the new value is lower than the previous one.</p> <p>This mode is useful for example for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level.</p> <p>The "Detector" is automatically set to "Negative Peak".</p> <p>This mode is not available for statistics measurements.</p>  |
| "Average"  | <p>The average is formed over several sweeps.</p> <p>The <a href="#">Sweep/Average Count</a> determines the number of averaging procedures.</p> <p>The "Detector" is automatically set to "Sample".</p> <p>This mode is not available for statistics measurements.</p>  |
| "View"     | <p>The current contents of the trace memory are frozen and displayed.</p> <p><b>Note:</b> If a trace is frozen, you can change the measurement settings, apart from scaling settings, without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk  on the tab label. If you change any parameters that affect the scaling of the diagram axes, the R&amp;S ESW automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.</p> |
| "Blank"    | Removes the selected trace from the display.  |

Remote command:

[DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:MODE](#) on page 694

### Detector

Defines the trace detector to be used for trace analysis.

For details see [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 345.

"Auto" (default:) Selects the optimum detector for the selected trace and filter mode

"Type" Defines the selected detector type.

Remote command:

[\[SENSe:\] \[WINDow<n>:\] DETector<t>\[:FUNCTION\]](#) on page 693

[\[SENSe:\] \[WINDow<n>:\] DETector<t>\[:FUNCTION\]:AUTO](#) on page 692

**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>][:SUBWindow<w>]:TRACe<t>:MODE:HCONTinuous`  
on page 695

**Smoothing**

If enabled, the 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.

**Note:** Effects of smoothing on post-processing functions. Note that in Spectrum mode, all functions performed after the sweep, such as limit checks, markers, or channel power measurements, are based on the smoothed trace data. Thus, the results differ from results based on the original trace.

For more information, see [Chapter 5.3.1.5, "Trace smoothing"](#), on page 355.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]`  
on page 695

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture`  
on page 694

**Average Mode**

Defines the mode with which the trace is averaged over several sweeps.

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

(See also ["Video bandwidth \(VBW\)"](#) on page 49).

How many sweeps are averaged is defined by the ["Sweep/Average Count"](#) on page 307.

For details see [Chapter 5.3.1.4, "How trace data is averaged - the averaging mode"](#), on page 354.

|               |  |
|---------------|--|
| "Linear"      | The power level values are converted into linear units before 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.<br>The power level values are converted into unit Watt before averaging. After the averaging, the data is converted back into its original unit. |

Remote command:

[SENSe:] AVERage<n>:TYPE on page 669

### Average Count

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

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

This value is identical to the [Sweep/Average Count](#) setting in the "Sweep" settings.

Remote command:

[SENSe:] AVERage<n>:COUNT on page 668

### 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<br>Auto Detector (Auto Peak)  |
|  | Traces 2-6:    | Blank<br>Auto Detector                    |
| Set Trace Mode<br>Max   Avg   Min      | Trace 1:       | Max Hold<br>Auto Detector (Positive Peak) |
|  | Trace 2:       | Average<br>Auto Detector (Sample)         |
|  | Trace 3:       | Min Hold<br>Auto Detector (Negative Peak) |
|  | Traces 4-6:    | Blank<br>Auto Detector                    |
| Set Trace Mode<br>Max   ClrWrite   Min | Trace 1:       | Max Hold<br>Auto Detector (Positive Peak) |
|  | Trace 2:       | Clear Write<br>Auto Detector (Auto Peak)  |
|  | Trace 3:       | Min Hold<br>Auto Detector (Negative Peak) |
|  | Traces 4-6:    | Blank<br>Auto Detector                    |

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

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


For details see [Chapter 5.3.3.1, "How to configure a standard trace"](#), on page 382.

Remote command:  
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 696

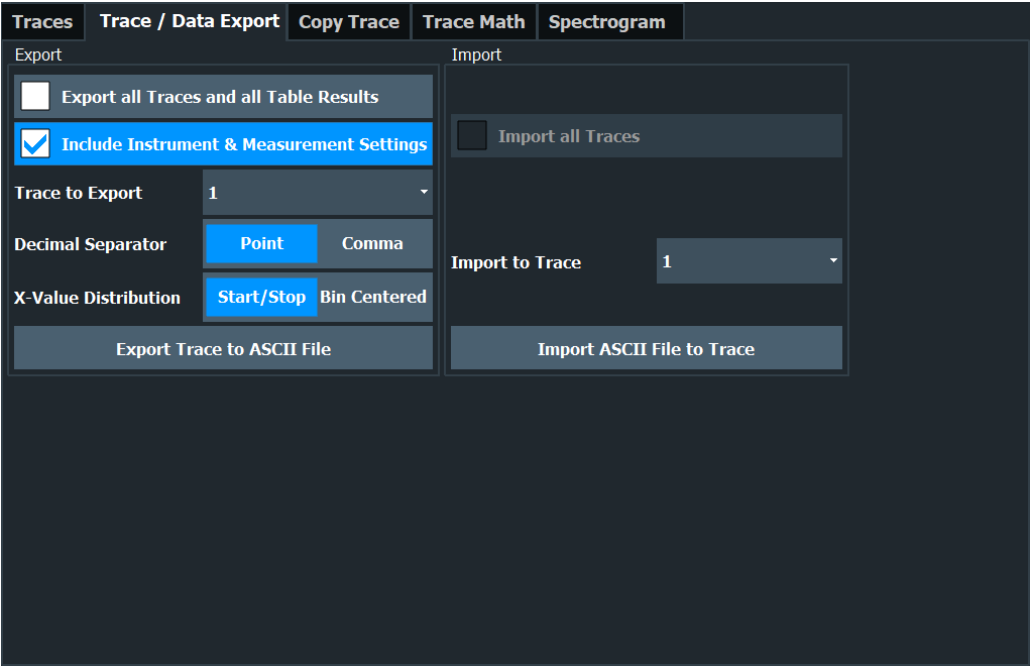
### 5.3.2.2 Exporting and importing traces

**Access:** "Overview" > "Analysis" > "Traces" > "Trace / Data Ex/Import"

The R&S ESW provides various evaluation methods for the results of the performed measurements. If you want to evaluate the data with other, external applications, you can export the measurement data to a standard ASCII format file (DAT or CSV).  
  
 You can also import existing trace data from a file, for example as a reference trace. The trace import is available in the spectrum application.



The standard data management functions (for example saving or loading instrument settings) that are available for all R&S ESW applications are not described here. Refer to the R&S ESW user manual for a description of the standard functions.



The remote commands required to export and import traces are described in [Chapter 6.9.2.3, "Trace import and export"](#), on page 697.

|   |     |
|---|-----|
| <a href="#">Export all Traces and all Table Results</a> .....       | 372 |
| <a href="#">Include Instrument &amp; Measurement Settings</a> ..... | 372 |
| <a href="#">Trace to Export</a> .....                               | 372 |
| <a href="#">Decimal Separator</a> .....                             | 372 |
| <a href="#">X-Value Distribution</a> .....                          | 372 |
| <a href="#">Export Trace to ASCII File</a> .....                    | 373 |
| L <a href="#">File Type</a> .....                                   | 373 |
| L <a href="#">Decimal Separator</a> .....                           | 374 |

|  |     |
|--|-----|
| L Column Separator.....                  | 374 |
| L File Explorer.....                     | 374 |
| Importing Traces.....                    | 374 |
| L Import All Traces/Import to Trace..... | 374 |
| L Import ASCII File to Trace.....        | 375 |
| L File Explorer.....                     | 375 |

### 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 699

### Include Instrument & Measurement Settings

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

See [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 388 for details.

Remote command:

`FORMat:DEXPort:HEADer` on page 699

### Trace to Export

Defines an individual trace to 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/import files. Evaluation programs require different separators in different languages.

Remote command:

`FORMat:DEXPort:DSEParator` on page 698

### X-Value Distribution

Defines how the x-values of the trace are determined in the frequency domain.

"Bin-Centered" The full measurement span is divided by the number of sweep points to obtain *bins*. The x-value of the sweep point is defined as the x-value at the center of the bin (bin/2).

"Start/Stop" (Default): The x-value of the first sweep point corresponds to the starting point of the full measurement span. The x-value of the last sweep point corresponds to the end point of the full measurement span. All other sweep points are divided evenly between the first and last points.

Remote command:

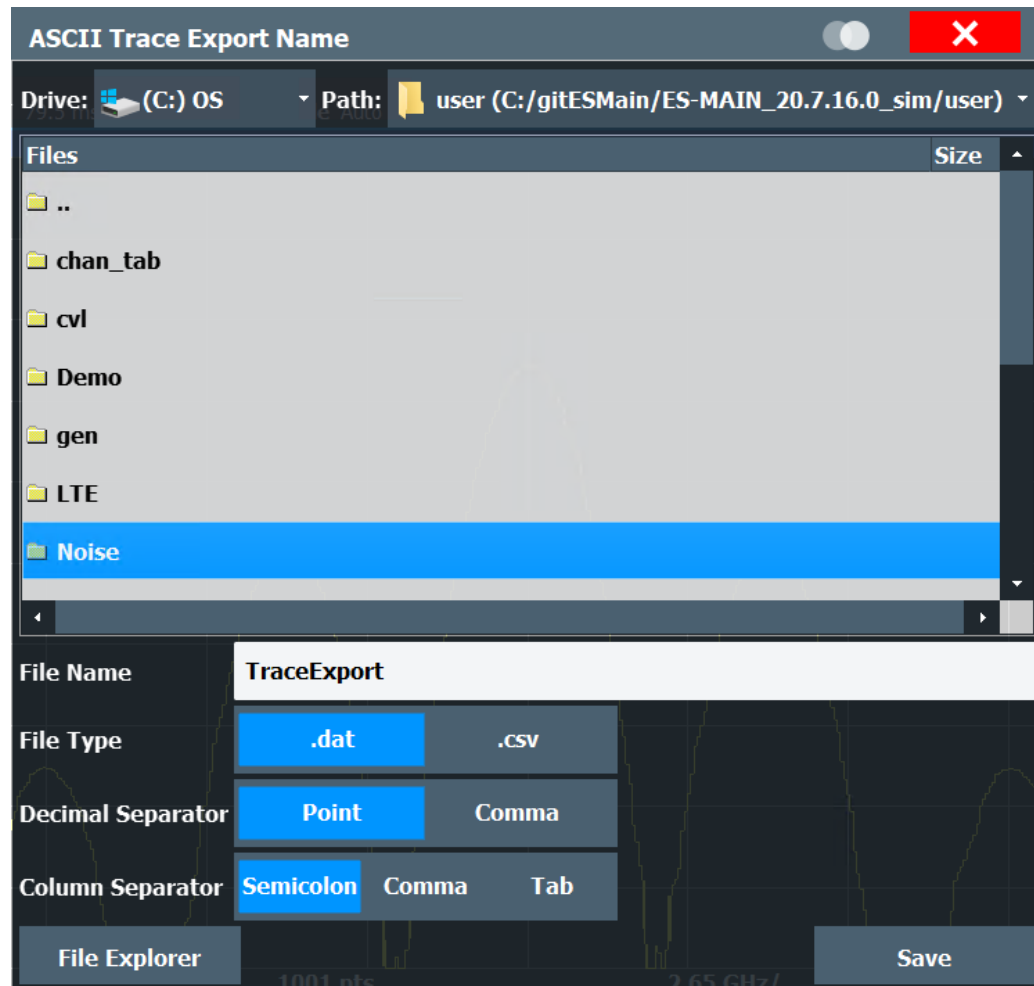
`FORMat:DEXPort:XDIStrib` on page 700



**Export Trace to ASCII File**

Saves the selected trace or all traces in the currently active result display to the specified file and directory in the selected ASCII format.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.



If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data for a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation can take some time.

For details on the file format in the Spectrum application, see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 388.

Remote command:

[MMEMory:STORe<n>:TRACe](#) on page 689

[MMEMory:STORe<n>:SPECTrogram](#) on page 710

**File Type ← Export Trace to ASCII File**

Determines the format of the ASCII file to be imported or exported.

Depending on the external program in which the data file was created or is evaluated, a comma-separated list (CSV) or a plain data format (DAT) file is required.

Remote command:

[FORMat:DEXPort:FORMat](#) on page 699

#### **Decimal Separator ← Export Trace to ASCII File**

Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:

[FORMat:DEXPort:DSEParator](#) on page 698

#### **Column Separator ← Export Trace to ASCII File**

Selects the character that separates columns in the exported ASCII file. The character can be either a semicolon, a comma or a tabulator (tab).

Example for semicolon:

```
Type;ESW26;Version;1.00;Date;01.Jan 3000;
```

Example for comma:

```
Type,ESW26,  
Version,1.00,  
Date,01.Jan 3000,
```

Example for tabulator (tab after the last column is not visible):

```
Type      ESW26  
Version    1.00  
Date       01.Jan 3000
```

The selected column separator setting remains the same, even after a preset.

Remote command:

[FORMat:DEXPort:CSEParator](#) on page 698

#### **File Explorer ← Export Trace to ASCII File**

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

#### **Importing Traces**

Trace data that was stored during a previous measurement can be imported to the Spectrum application, for example as a reference trace.

#### **Import All Traces/Import to Trace ← Importing Traces**

If the import file contains more than one trace, you can import several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

Alternatively, you can import a single trace only, which is displayed for the trace number specified in "Import to Trace". This list contains all currently active traces in the result display. If a trace with the specified number exists in the import file, that trace is imported. Otherwise, the first trace in the file is imported (indicated by a message in the status bar).

Remote command:  
[FORMat:DIMPort:TRACes](#) on page 700

**Import ASCII File to Trace ← Importing Traces**  
Loads one trace or all traces from the selected file in the selected ASCII format ( .DAT or .CSV) to the currently active result display.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

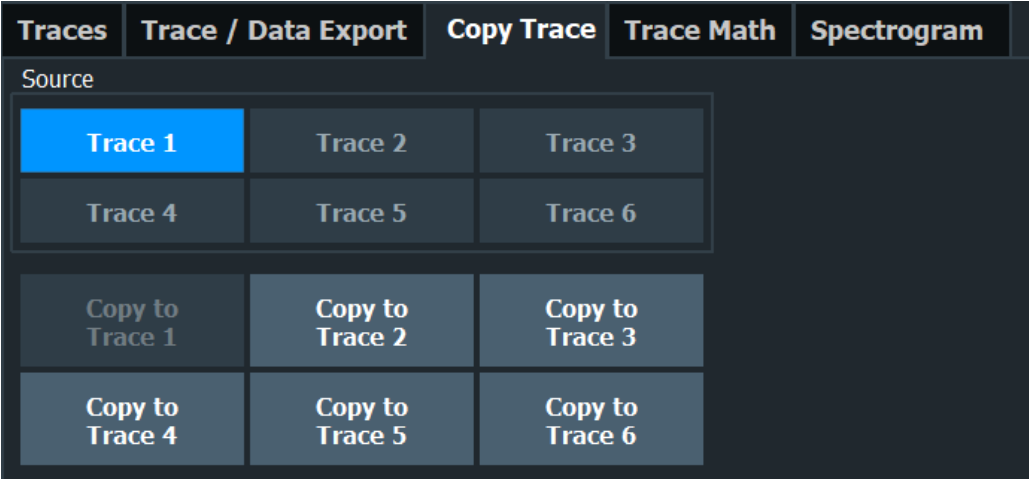
Remote command:  
[FORMat:DIMPort:TRACes](#) on page 700

**File Explorer ← Import ASCII File to Trace ← Importing Traces**  
Opens the Microsoft Windows File Explorer.

Remote command:  
not supported

5.3.2.3 Copying traces

**Access:** "Overview" > "Analysis" > "Traces" > "Copy Trace"



The remote commands required to copy traces are described in [Chapter 6.9.2.4, "Trace copy"](#), on page 702.

[Copy Trace](#).....375

**Copy Trace**  
**Access:** "Overview" > "Analysis" > "Traces" > "Copy Trace"  
Copies trace data to another trace.

The first group of buttons (labeled "Trace 1" to "Trace 6") selects the source trace. The second group of buttons (labeled "Copy to Trace 1" to "Copy to Trace 6") selects the destination.

Remote command:

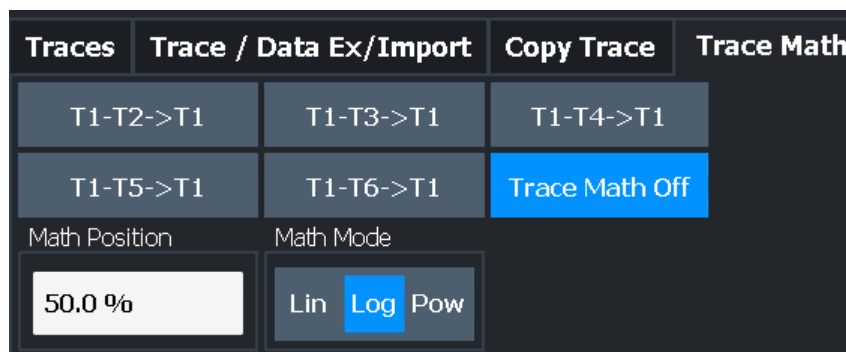
[TRACe<n>:COPY](#) on page 702

#### 5.3.2.4 Trace math

**Access:** [TRACE] > "Trace Math"

**Or:** "Overview" > "Analysis" > "Traces" > "Trace Math"

If you have several traces with different modes, for example an average trace and a maximum trace, it may be of interest to compare the results of both traces. In this example, you could analyze the maximum difference between the average and maximum values. To analyze the span of result values, you could subtract the minimum trace from the maximum trace. For such tasks, the results from several traces can be combined using mathematical functions.



|   |     |
|---|-----|
| <a href="#">Trace Math Function</a> ..... | 376 |
| <a href="#">Trace Math Off</a> .....      | 377 |
| <a href="#">Trace Math Position</a> ..... | 377 |
| <a href="#">Trace Math Mode</a> .....     | 377 |

#### Trace Math Function

You can select one of several different math operations.

Each operation subtracts one trace from another as indicated on the corresponding button and writes the result to one of the traces. "T1 - T3 > T1", for example, subtracts trace 3 from trace 1 and writes the result to trace 1. You can apply one operation at a time.

The result refers to the zero point defined with the [Trace Math Position](#) setting. The following subtractions can be performed:

|             |                                 |
|-------------|---------------------------------|
| "T1-T2->T1" | Subtracts trace 2 from trace 1. |
| "T1-T3->T1" | Subtracts trace 3 from trace 1  |
| "T1-T4->T1" | Subtracts trace 4 from trace 1  |

|             |                                |
|-------------|--------------------------------|
| "T1-T5->T1" | Subtracts trace 5 from trace 1 |
| "T1-T6->T1" | Subtracts trace 6 from trace 1 |

To switch off the trace math, use the [Trace Math Off](#) button.

Remote command:

[CALCulate<n>:MATH<t>\[:EXPRession\]\[:DEFine\]](#) on page 703

[CALCulate<n>:MATH<t>:STATe](#) on page 704

### Trace Math Off

Deactivates any previously selected trace math functions.

Remote command:

[CALC:MATH:STAT OFF](#), see [CALCulate<n>:MATH<t>:STATe](#) on page 704

### Trace Math Position

Defines the zero point on the y-axis of the resulting trace in % of the diagram height. The range of values extends from -100 % to +200 %.

Remote command:

[CALCulate<n>:MATH<t>:POSition](#) on page 704

### Trace Math Mode

Defines the mode for the trace math calculations.

- |         |   |
|---------|---|
| "Lin"   | <p>Activates linear subtraction, which means that the power level values are converted into linear units prior to subtraction. After the subtraction, the data is converted back into its original unit.</p> <p>This setting takes effect if the grid is set to a linear scale. In this case, subtraction is done in two ways (depending on the set unit):</p> <ul style="list-style-type: none"> <li>• The unit is set to either W or dBm: the data is converted into W prior to subtraction, i.e. averaging is done in W.</li> <li>• The unit is set to either V, A, dBmV, dBμV, dBμA or dBpW: the data is converted into V prior to subtraction, i.e. subtraction is done in V.</li> </ul> |
| "Log"   | <p>Activates logarithmic subtraction.</p> <p>This subtraction method only takes effect if the grid is set to a logarithmic scale, i.e. the unit of the data is dBm. In this case the values are subtracted in dBm. Otherwise (i.e. with linear scaling) the behavior is the same as with linear subtraction.</p>  |
| "Power" | <p>Activates linear power subtraction.</p> <p>The power level values are converted into unit Watt prior to subtraction. After the subtraction, the data is converted back into its original unit.</p> <p>Unlike the linear mode, the subtraction is always done in W.</p>   |

Remote command:

[CALCulate<n>:MATH<t>:MODE](#) on page 703

5.3.2.5 Spectrogram settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram"

Functions to configure spectrograms described elsewhere:

- Color mapping: "Color map settings" on page 380
  - Sweep configuration: "Spectrogram Frames" on page 310
  - Markers: Chapter 5.4.3, "Marker search settings and positioning functions", on page 400
- General spectrogram settings.....378
  - Color map settings.....380

General spectrogram settings

This section describes general settings for spectrogram display. They are available when you press the [Trace] key and then select the "Spectrogram Config" softkey.

|                   |                     |            |            |             |
|-------------------|---------------------|------------|------------|-------------|
| Traces            | Trace / Data Export | Copy Trace | Trace Math | Spectrogram |
| State             | On                  | Off        |            |             |
| 3D Spectrogram    | On                  | Off        |            |             |
| Settings          |                     |            |            |             |
| Select Frame      | 0                   |            |            |             |
| History Depth     | 3000                |            |            |             |
| 3D Display Depth  | 300                 |            |            |             |
| Time Stamp        | On                  | Off        |            |             |
| Color Mapping     |                     |            |            |             |
| Continuous Sweep  | Single Sweep        |            |            |             |
| Clear Spectrogram |                     |            |            |             |

|                                  |     |
|----------------------------------|-----|
| State.....                       | 379 |
| Select Frame.....                | 379 |
| History Depth.....               | 379 |
| Time Stamp.....                  | 379 |
| Color Mapping.....               | 379 |
| Continuous Sweep / Run Cont..... | 379 |
| Single Sweep / Run Single.....   | 380 |
| Clear Spectrogram.....           | 380 |

**State**

Activates and deactivates the spectrogram result display

Remote command:

`CALCulate<n>:SPECTrogram[:STATe]` on page 708

**Select Frame**

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details, see ["Time frames"](#) on page 359.

Remote command:

`CALCulate<n>:SPECTrogram:FRAMe:SElect` on page 706

**History Depth**

Sets the number of frames that the R&S ESW stores in its memory.

The maximum size of the spectrogram history depends on the available memory.

If the memory is full, the R&S ESW deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:

`CALCulate<n>:SPECTrogram:HDEPth` on page 707

**Time Stamp**

Activates and deactivates the timestamp. The timestamp shows the system time while the measurement is running. In single sweep mode or if the sweep is stopped, the timestamp shows the time and date of the end of the sweep.

When active, the timestamp replaces the display of the frame number.

Remote command:

`CALCulate<n>:SPECTrogram:TSTamp[:STATe]` on page 708

`CALCulate<n>:SPECTrogram:TSTamp:DATA?` on page 707

**Color Mapping**

Opens the "Color Mapping" dialog.

For details see ["Color maps"](#) on page 362.

**Continuous Sweep / Run Cont**

After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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

**Note:** Sequencer. If the Sequencer is active, "Continuous Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.

Furthermore, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

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

Remote command:

Measurement mode: `INITiate<n>:CONTInuous` on page 471

Run measurement: `INITiate<mt>[:IMMediate]` on page 470

### Single Sweep / Run Single

After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

**Note:** Sequencer. If the Sequencer is active, "Single Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.

Furthermore, [RUN SINGLE] controls the Sequencer, not individual sweeps. [RUN SINGLE] starts the Sequencer in single mode.

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

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

Remote command:

Measurement mode: `INITiate<n>:CONTInuous` on page 471

Run measurement: `INITiate<mt>[:IMMediate]` on page 470

`CALCulate<n>:SPECTrogram:CONTInuous` on page 705

### Clear Spectrogram

Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:

`CALCulate<n>:SPECTrogram:CLEar[:IMMediate]` on page 705

### Color map settings

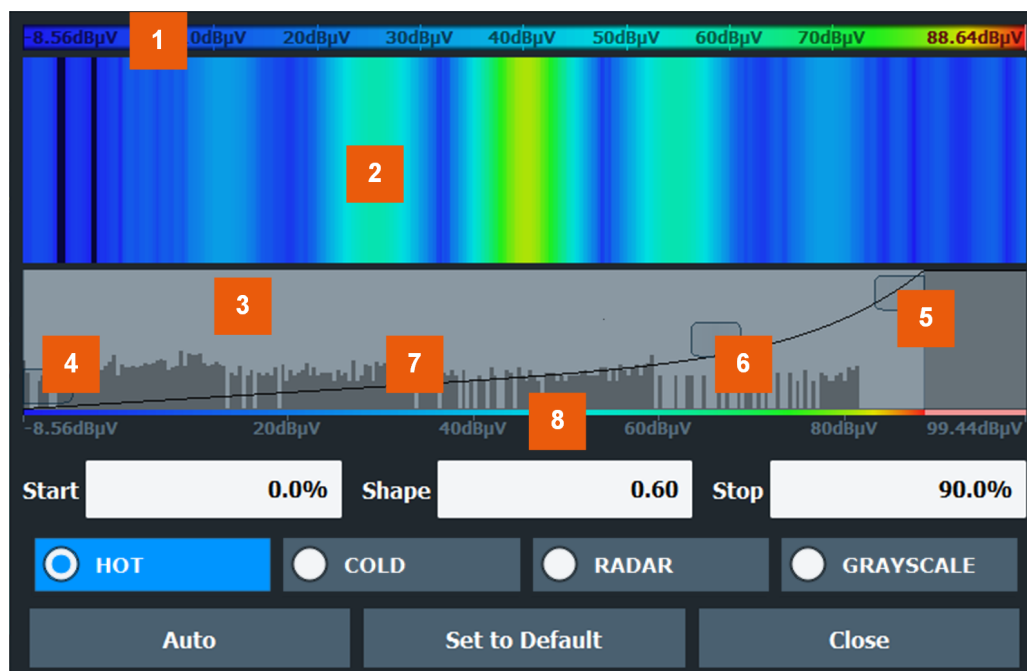
**Access:** "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

**or:** [TRACE] > "Spectrogram Config" > "Color Mapping"

For more information on color maps, see "Color maps" on page 362. For details on changing color-mapping settings, see "How to configure the color mapping" on page 386.



In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.



**Figure 5-12: Color Mapping dialog box**

- 1 = Color map: shows the current color distribution
- 2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
- 3 = Color curve pane: graphical representation of all settings available to customize the color scheme
- 4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
- 6 = Color curve slider: adjusts the focus of the color curve
- 7 = Histogram: shows the distribution of measured values
- 8 = Scale of the horizontal axis (value range)

The remote commands required to configure the color map are described in [Chapter 6.9.2.6, "Spectrogram configuration"](#), on page 705.

|  |     |
|--|-----|
| <a href="#">Start / Stop</a> .....             | 381 |
| <a href="#">Shape</a> .....                    | 381 |
| <a href="#">Hot/Cold/Radar/Grayscale</a> ..... | 382 |
| <a href="#">Auto</a> .....                     | 382 |
| <a href="#">Set to Default</a> .....           | 382 |
| <a href="#">Close</a> .....                    | 382 |

### Start / Stop

Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:

`DISPlay[:WINDow<n>]:SPECTrogram:COLor:LOWer` on page 709

`DISPlay[:WINDow<n>]:SPECTrogram:COLor:UPPer` on page 709

### Shape

Defines the shape and focus of the color curve for the spectrogram result display.

|            |   |
|------------|---|
| "-1 to <0" | More colors are distributed among the lower values  |
| "0"        | Colors are distributed linearly among the values    |
| ">0 to 1"  | More colors are distributed among the higher values |

Remote command:

[DISPlay\[:WINDow<n>\]:SPECTrogram:COLor:SHApe](#) on page 709

#### Hot/Cold/Radar/Grayscale

Sets the color scheme for the spectrogram.

Remote command:

[DISPlay\[:WINDow<n>\]:SPECTrogram:COLor\[:STYLE\]](#) on page 710

#### Auto

Defines the color range automatically according to the existing measured values for optimized display.

#### Set to Default

Sets the color mapping to the default settings.

Remote command:

[DISPlay\[:WINDow<n>\]:SPECTrogram:COLor:DEFAULT](#) on page 709

#### Close

Saves the changes and closes the dialog box.

### 5.3.3 How to configure traces

- [How to configure a standard trace](#)..... 382
- [How to export trace data and numerical results](#)..... 383
- [How to import traces](#)..... 384
- [How to display and configure a spectrogram](#)..... 384

#### 5.3.3.1 How to configure a standard trace

Step-by-step instructions on configuring the trace settings are provided here.

For details on individual functions and settings see [Chapter 5.3.2.1, "Trace settings"](#), on page 366.

The remote commands required to perform these tasks are described in [Chapter 6.9.2, "Trace configuration"](#), on page 689.

Trace settings are configured in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Press [TRACE] and then select "Trace Config".
  - Select "Analysis" from the "Overview", then select the "Traces" tab.
1. For each trace, select the "Trace Mode" and "Trace Detector". Traces with the trace mode "Blank" are not displayed.

2. To configure several traces to predefined display modes in one step, press the button for the required function:
  - "Preset All Traces"
  - "Set Trace Mode Max | Avg | Min"
  - "Set Trace Mode Max | ClrWrite | Min"

For details see [Chapter 5.3.2.1, "Trace settings"](#), on page 366.

3. For "Average" trace mode, define the number of sweeps to be averaged in the "Count:" field.
4. If linear scaling is used, select the "Average Mode": "Linear".
5. To improve the trace stability, increase the number of "Sweep Points" or the Sweep Time (in the "Sweep" settings).

All configured traces (not set to "Blank") are displayed after the next sweep.

### How to Copy Traces

1. A trace copy function is provided in a separate tab of the "Traces" dialog box. To display this tab do one of the following:
  - Select [TRACE] and then "Trace Copy".
  - Select "Analysis" from the "Overview", then select the "Trace Copy" tab.

2. Select the "Source" trace to be copied.

3. Select "Copy to Trace" for the trace to which the settings are to be applied.

The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next sweep.

### 5.3.3.2 How to export trace data and numerical results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each sweep point, the measured trace position and value are output.

The file is stored with a .DAT or .CSV extension. For details on the storage format, see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 388.



For the results of a Spectrum Emission Mask (SEM) or Spurious Emissions measurement, special file export functions are available, see [Chapter 3.5.6.2, "How to save SEM result files"](#), on page 136 (SEM) and ["Save Evaluation List"](#) on page 155 (Spurious).

### To export trace data and table results

1. Select [TRACE] > "Trace Config" > "Trace / Data Export" tab.
2. Select "Export all Traces and all Table Results" to export all available measurement result data for the current application, or select a specific "Trace to Export".

3. Optionally, select "Include Instrument & Measurement Settings" to insert additional information in the export file header.
4. If necessary, change the decimal separator for the ASCII export file.
5. Select "Export Trace to ASCII File".
6. In the file selection dialog box, select the storage location and file name for the export file.
7. Select "Save" to close the dialog box and export the data to the file.

#### 5.3.3.3 How to import traces

Trace data that was stored during a previous measurement can be imported to the Spectrum application, for example as a reference trace.

##### To import trace data

1. Press [Trace].
2. Select "Trace Config" > "Trace / Data Export"/"Import".
3. Select "Import All Traces" to import traces for all the currently active traces, or select a specific trace to be imported in "Import to Trace".
4. Select "Import ASCII File to Trace".
5. Select the file format in which the data is stored.
6. Select the file that contains the trace data.
7. Select "Select" to close the dialog box and start the import.

#### 5.3.3.4 How to display and configure a spectrogram

Step-by-step instructions on how to display and configure a spectrogram are provided here. For details on individual functions and settings see [Chapter 5.3.2.5, "Spectrogram settings"](#), on page 378.

The remote commands required to perform these tasks are described in [Chapter 6.9.2, "Trace configuration"](#), on page 689.

The following tasks are described here:

- ["To display a spectrogram"](#) on page 385
- ["To remove the spectrogram display"](#) on page 385
- ["To set a marker in the spectrogram"](#) on page 385
- ["To configure a spectrogram"](#) on page 385
- ["To select a color scheme"](#) on page 386
- ["To set the value range graphically using the color range sliders"](#) on page 387
- ["To set the value range of the color map numerically"](#) on page 387
- ["To set the color curve shape graphically using the slider"](#) on page 388

- ["To set the color curve shape numerically"](#) on page 388

### To display a spectrogram

1. In the "Overview", select "Display", then drag the evaluation type "Spectrogram" to the diagram area.  
Alternatively:
  - a) Select [TRACE] and then "Spectrogram Config".
  - b) Toggle "Spectrogram" to "On".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using [RUN SINGLE] or [RUN CONT].  
The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific time frame:
  - a) Stop the continuous measurement or wait until the single sweep is completed.
  - b) Select the frame number in the diagram footer.
  - c) Enter the required frame number in the edit dialog box.  
Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

### To remove the spectrogram display

1. Select [TRACE] and then "Spectrogram Config".
2. Toggle "Spectrogram" to "Off".  
The standard spectrum display is restored.

### To set a marker in the spectrogram

1. While a spectrogram is displayed, select [MARKER].
2. Select a "Marker" softkey.
3. Enter the frequency or time (x-value) of the marker or delta marker.
4. Enter the frame number for which the marker is to be set, for example 0 for the current frame, or -2 for the second to last frame. Note that the frame number is always 0 or a negative value!  
The marker is only visible in the spectrum diagram if it is defined for the currently selected frame. In the spectrogram result display all markers are visible that are positioned on a visible frame.

### To configure a spectrogram

1. Configure the spectrogram frames:
  - a) Select [SWEEP].
  - b) Select "Sweep Config".
  - c) In the "Sweep/Average Count" field, define how many sweeps are to be analyzed to create a single frame.

- d) In the "Frame Count" field, define how many frames are to be plotted during a single sweep measurement.
  - e) To include frames from previous sweeps in the analysis of the new frame (for "Max Hold", "Min Hold" and "Average" trace modes only), select "Continue Frame" = "On".
2. Define how many frames are to be stored in total:
  - a) Select [TRACE] and then "Spectrogram Config".
  - b) Select "History Depth".
  - c) Enter the maximum number of frames to store.
3. Optionally, replace the frame number by a time stamp by toggling "Time Stamp" to "On".
4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in ["How to configure the color mapping"](#) on page 386.

### How to configure the color mapping

The color display is highly configurable to adapt the spectrogram to your needs.

The settings for color mapping are defined in the "Color Mapping" dialog box. To display this dialog box, do one of the following:

- Select the color map in the window title bar of the "Spectrogram" result display.
- Select "Color Mapping" in the "Spectrogram" menu.

### To select a color scheme

You can select which colors are assigned to the measured values.

- In the "Color Mapping" dialog box, select the option for the color scheme to be used.

### Editing the value range of the color map

The distribution of the measured values is displayed as a histogram in the "Color Mapping" dialog box. To cover the entire measurement value range, make sure the first and last bar of the histogram are included.

To ignore noise in a spectrogram, for example, exclude the lower power levels from the histogram.

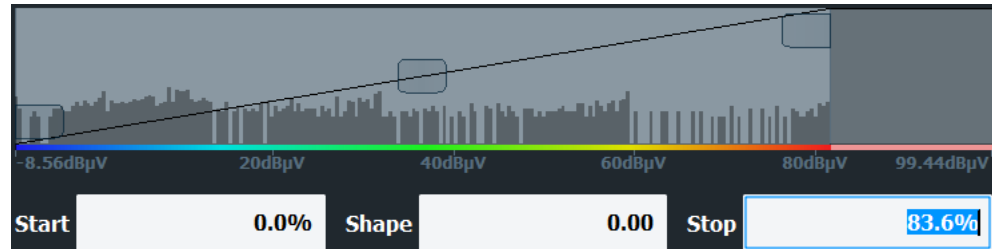


The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram, that means, the difference between the start and stop values must be at least 10%.

The value range of the color map can be set numerically or graphically.

### To set the value range graphically using the color range sliders

1. Select and drag the bottom color curve slider (indicated by a gray box at the left of the color curve pane) to the lowest value you want to include in the color mapping.
2. Select and drag the top color curve slider (indicated by a gray box at the right of the color curve pane) to the highest value you want to include in the color mapping.



### To set the value range of the color map numerically

1. In the "Start" field, enter the percentage from the left border of the histogram that marks the beginning of the value range.
2. In the "Stop" field, enter the percentage from the right border of the histogram that marks the end of the value range.

#### Example:

The color map starts at -110 dBm and ends at -10 dBm (that is: a range of 100 dB). In order to suppress the noise, you only want the color map to start at -90 dBm. Thus, you enter 10% in the "Start" field. The R&S ESW shifts the start point 10% to the right, to -90 dBm.



### Adjusting the reference level and level range

Since the color map is configured using percentages of the total value range, changing the reference level and level range of the measurement (and thus the power value range) also affects the color mapping in the spectrogram.

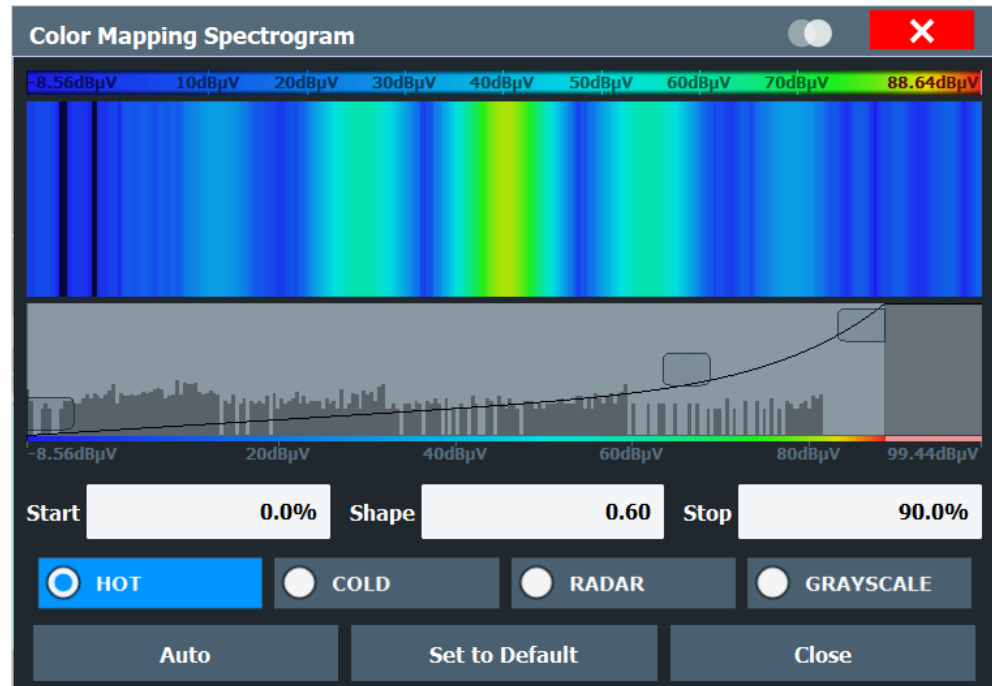
### Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large number of results, while the other end distributes several colors over a relatively small result range.

The color curve shape can be set numerically or graphically.

### To set the color curve shape graphically using the slider

- Select and drag the color curve shape slider (indicated by a gray box in the middle of the color curve) to the left or right. The area beneath the slider is focused, i.e. more colors are distributed there.



### To set the color curve shape numerically

- In the "Shape" field, enter a value to change the shape of the curve:
  - A negative value (-1 to <0) focuses the lower values
  - 0 defines a linear distribution
  - A positive value (>0 to 1) focuses the higher values

## 5.3.4 References

- [Reference: ASCII file export format](#)..... 388
- [Formats for returned values: ASCII format and binary format](#)..... 391

### 5.3.4.1 Reference: ASCII file export format

Trace data can be exported to a file in ASCII format for further evaluation in other applications. This reference describes in detail the format of the export files for result data.

(For details see [Chapter 5.3.3.2, "How to export trace data and numerical results"](#), on page 383).





For a description of the file formats for spectrum emission mask (SEM) measurement settings and results, see [Chapter 3.5.8, "Reference: SEM file descriptions"](#), on page 138.

The file format for Spurious Emissions measurement results is described in [Chapter 3.6.6, "Reference: ASCII export file format \(spurious\)"](#), on page 157.

The file consists of the header information (general configuration of the measurement) and the measurement results. Optionally, the header can be excluded from the file.

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section starts with the keyword "Trace <n>" (<n> = number of stored trace). The measured data follows in one or several columns (depending on the measurement), which are also separated by a semicolon.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS Excel. Different language versions of evaluation programs can require a different handling of the decimal point. Thus, you can define the decimal separator to use (decimal point or comma).

If the spectrogram display is selected when you select "ASCII Trace Export", the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

**Table 5-4: ASCII file format for trace export in the Spectrum application**

| File contents                    | Description   |
|----------------------------------|---|
| <b>Header data</b>               |   |
| Type;R&S ESW;                    | Instrument model  |
| Version;1.00;                    | Firmware version  |
| Date;01.Oct 2022;                | Date of data set storage  |
| Mode;ANALYZER;                   | Operating mode  |
| Preamplifier;OFF                 | Preamplifier status   |
| Transducer; OFF                  | Transducer status   |
| Center Freq;55000;Hz             | Center frequency  |
| Freq Offset;0;Hz                 | Frequency offset  |
| Start;10000;Hz<br>Stop;100000;Hz | Start/stop of the display range.<br>Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements |
| Span;90000;Hz                    | Frequency range (0 Hz in zero span and statistics measurements)   |
| Ref Level;-30;dBm                | Reference level   |
| Level Offset;0;dB                | Level offset  |

| File contents   | Description   |
|---|---|
| Rf Att;20;dB  | Input attenuation   |
| EI Att;2.0;dB   | Electrical attenuation  |
| RBW;100000;Hz   | Resolution bandwidth  |
| VBW;30000;Hz  | Video bandwidth   |
| SWT;0.005;s   | Sweep time  |
| Sweep Count;20;   | Number of sweeps set  |
| Ref Position;75;%   | Position of reference level referred to diagram limits (0 % = lower edge)   |
| Level Range;100;dB  | Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN   |
| x-Axis;LIN;   | Scaling of x-axis linear (LIN) or logarithmic (LOG)   |
| y-Axis;LOG;   | Scaling of y-axis linear (LIN) or logarithmic (LOG)   |
| x-Unit;Hz;  | Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements  |
| y-Unit;dBm;   | Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN   |
| <b>Data section for individual window</b>                               |   |
| Window;1;Frequency Sweep  | Window number and name  |
| Trace 1;;   | Selected trace  |
| Trace Mode;AVERAGE;   | Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD  |
| Detector;AUTOPEAK;  | Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASIPeak   |
| Values; 1001;   | Number of measurement points  |
| 10000;-10.3;-15.7<br>10130;-11.5;-16.9<br>10360;-12.0;-17.4<br>...;...; | Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point. |
| <b>Data section for individual trace</b>                                |   |
| Trace 2;;   | Next trace in same window   |
| ...   |   |
| <b>Data section for individual window</b>                               |   |
| Window;2 ..;  | Name of next window   |
| <b>Data section for individual trace</b>                                |   |
| Trace 1;;   | First trace   |
| ...   |   |

#### 5.3.4.2 Formats for returned values: ASCII format and binary format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMAt[:DATA]` on page 697. The possible formats are described here.

- **ASCII Format (FORMAt ASCII):**  
The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.
- **Binary Format (FORMAt REAL,16/32/64):**  
The data is stored as binary data (definite length block data according to IEEE 488.2), each measurement value being formatted in 16-bit/32-bit/64-bit IEEE 754 floating-point-format.  
The schema of the result string is as follows:  
#<Length of length><Length of data><value1><value2>...<value n>  
with:

|                    |  |
|--------------------|--|
| <Length of length> | Number of digits of the following number of data bytes |
| <Length of data>   | Number of following data bytes                         |
| <Value>            | 2-byte/4-byte/8-byte floating point value              |

**Example:** #41024<Data>... contains 1024 data bytes

#### Data blocks larger than 999,999,999 bytes

According to SCPI, the header of the block data format allows for a maximum of 9 characters to describe the data length. Thus, the maximum REAL 32 data that can be represented is 999,999,999 bytes. However, the R&S ESW is able to send larger data blocks. In this case, the length of the data block is placed in brackets, e.g.  
#(1234567890)<value1><value2>...



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

## 5.4 Marker usage

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display both in the time and frequency domain. In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.



### Markers in Spectrogram Displays

In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame.

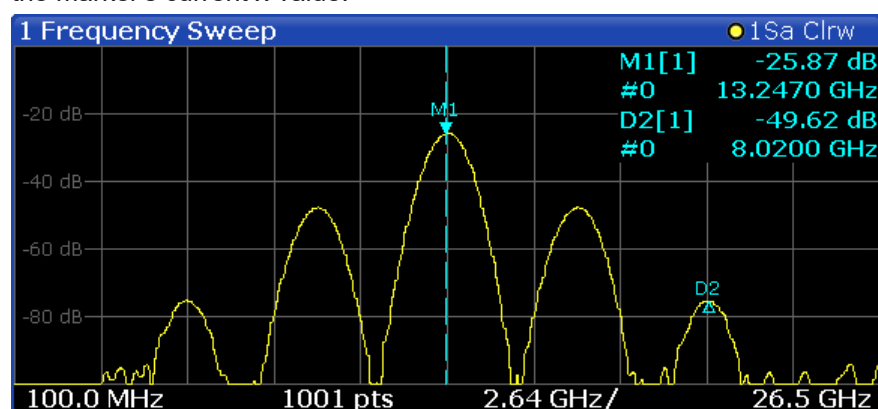
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- [Marker settings](#).....395
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#### 5.4.1 Basics on markers

Some background knowledge on marker settings and functions is provided here for a better understanding of the required configuration settings.

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. R&S ESW provides 17 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- To set individual markers very quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- The easiest way to work with markers is using a mouse. Simply drag the marker and drop it at the required position.
- When you select a marker in a diagram, a vertical line is displayed which indicates the marker's current x-value.



- Alternatively, change the position of the selected marker using the rotary knob. By default, the marker is moved from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (General Marker Setting).

- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touch screen and hold your finger for about 2 seconds until the context menu is opened, then select the required entry.
- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.
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#### 5.4.1.1 Marker types

All markers can be used either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta marker indicates the value of the marker relative to the specified reference marker (by default marker 1).

The Spectrum application also features special functions that you can assign to individual markers. The availability of special marker functions depends on whether the measurement runs in the frequency or time domain.

Temporary markers are used in addition to the markers and delta markers to analyze the measurement results for special marker functions. They disappear when the associated function is deactivated.

#### 5.4.1.2 Activating markers

Only active markers are displayed in the diagram and in the marker table.

Active markers are indicated by a highlighted softkey.

By default, marker 1 is active and positioned on the maximum value (peak) of trace 1 as a normal marker. If several traces are displayed, the marker is set to the maximum value of the trace which has the lowest number and is not frozen (View mode). The next marker to be activated is set to the frequency of the next lower level (next peak) as a delta marker; its value is indicated as an offset to marker 1.

A marker can only be activated when at least one trace in the corresponding window is visible. If a trace is switched off, the corresponding markers and marker functions are also deactivated. If the trace is switched on again, the markers along with coupled functions are restored to their original positions, provided the markers have not been used on another trace.

### 5.4.1.3 Marker results

Normal markers point to a trace point on the x-axis and display the associated numeric value for that trace point. Delta markers indicate an offset between the level at the delta marker position and the level at the position of the assigned reference marker, in dB.

Signal count markers determine the frequency of a signal at the marker position very accurately.

The results can be displayed directly within the diagram area or in a separate table. By default, the first two active markers are displayed in the diagram area. If more markers are activated, the results are displayed in a marker table.

#### Marker information in diagram area

By default, the results of the last two markers or delta markers that were activated are displayed in the diagram area.

|       |             |
|-------|-------------|
| D2[1] | -21.90 dB   |
|       | -3.9180 GHz |
| M1[1] | -25.87 dBm  |
|       | 13.1970 GHz |

The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number
- The assigned trace number in square brackets [ ]
- The marker value on the y-axis, or the result of the marker function
- The marker position on the x-axis

For n dB down markers, additional information is displayed, see [Table 5-6](#).

#### Marker information in marker table

In addition to the marker information displayed within the diagram area, a separate marker table may be displayed beneath the diagram. This table provides the following information for all active markers:

**Table 5-5: Contents of the marker table in the Spectrum application**

|         |  |
|---------|--|
| Type    | Marker type: N (normal), D (delta), T (temporary, internal) and number                           |
| Ref     | Reference marker for delta markers   |
| Trc     | Trace to which the marker is assigned  |
| Frame   | Spectrogram frame the marker is positioned in. Displayed only when the Spectrogram is displayed. |
| X-value | X-value of the marker  |
| Y-value | Y-value of the marker  |

|                 |   |
|-----------------|---|
| Function        | Activated marker or measurement function            |
| Function Result | Result of the active marker or measurement function |

## 5.4.2 Marker settings

**Access:** "Overview" > "Analysis" > "Marker"

Marker settings can be configured via the [Marker] menu or in the "Marker" dialog box.

The remote commands required to define these settings are described in [Chapter 6.9.3, "Marker configuration"](#), on page 713.

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### 5.4.2.1 Individual marker setup

**Access:** "Overview" > "Analysis" > "Marker" > "Markers"

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.

Markers

Marker Settings

Search

|                 | Selected | State  | X-Value      | Frame | Type       | Ref Marker     | Link to Marker   | Trace          |
|-----------------|----------|--------|--------------|-------|------------|----------------|------------------|----------------|
| 1-5             | Marker 1 | On Off | 13.24495 GHz | 0     | Norm Delta | <div>▼</div>   | Off <div>▼</div> | 1 <div>▼</div> |
| 6-11            | Delta 1  | On Off | 1.0 Hz       | 0     | Norm Delta | 1 <div>▼</div> | Off <div>▼</div> | 1 <div>▼</div> |
|                 | Delta 2  | On Off | 1.0 Hz       | 0     | Norm Delta | 1 <div>▼</div> | Off <div>▼</div> | 1 <div>▼</div> |
| 12-16           | Delta 3  | On Off | 1.0 Hz       | 0     | Norm Delta | 1 <div>▼</div> | Off <div>▼</div> | 1 <div>▼</div> |
|                 | Delta 4  | On Off | 1.0 Hz       | 0     | Norm Delta | 1 <div>▼</div> | Off <div>▼</div> | 1 <div>▼</div> |
|                 | Delta 5  | On Off | 1.0 Hz       | 0     | Norm Delta | 1 <div>▼</div> | Off <div>▼</div> | 1 <div>▼</div> |
| All Markers Off |          |        |              |       |            |                |                  |                |

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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|                                      |     |
|--------------------------------------|-----|
| Frame (Spectrogram only).....        | 396 |
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| Linking to Another Marker.....       | 397 |
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| Select Marker.....                   | 397 |
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### 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 719

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 717

### 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 720

`CALCulate<n>:DELTamarker<m>:X` on page 718

### Frame (Spectrogram only)

Spectrogram frame the marker is assigned to.

Remote command:

`CALCulate<n>:MARKer<m>:SPECTrogram:FRAME` on page 736

`CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAME` on page 739

### 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 719

`CALCulate<n>:DELTamarker<m>[:STATe]` on page 717



**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 a fixed reference point is configured (see ["Defining a Fixed Reference"](#) on page 400), the reference point ("FXD") can also be selected instead of another marker.

Remote command:

`CALCulate<n>:DELTaMarker<m>:MREference` on page 716

**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<ms>:LINK:TO:MARKer<md>` on page 718

`CALCulate<n>:DELTaMarker<ms>:LINK:TO:MARKer<md>` on page 715

`CALCulate<n>:DELTaMarker<m>:LINK` on page 714

**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 719

**Select Marker**

The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.

Select Marker

| Selected | State  | Selected | State  | Selected | State  |
|----------|--------|----------|--------|----------|--------|
| Marker 1 | On Off | Delta 6  | On Off | Delta 12 | On Off |
| Delta 1  | On Off | Delta 7  | On Off | Delta 13 | On Off |
| Delta 2  | On Off | Delta 8  | On Off | Delta 14 | On Off |
| Delta 3  | On Off | Delta 9  | On Off | Delta 15 | On Off |
| Delta 4  | On Off | Delta 10 | On Off | Delta 16 | On Off |
| Delta 5  | On Off | Delta 11 | On Off |          |        |

Remote command:

[CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 719

[CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 717

#### All Markers Off

Deactivates all markers in one step.

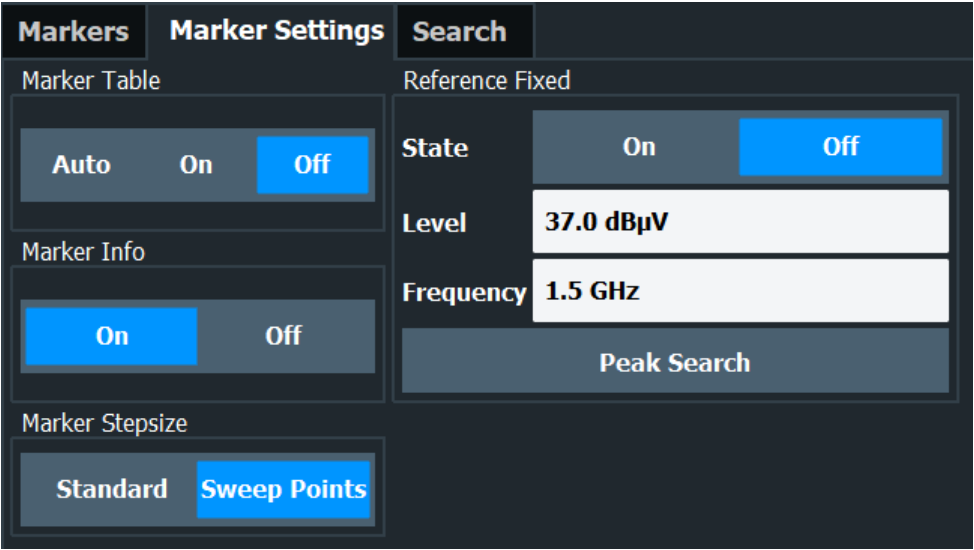
Remote command:

[CALCulate<n>:MARKer<m>:AOFF](#) on page 718

#### 5.4.2.2 General marker settings

**Access:** "Overview" > "Analysis" > "Marker" > "Marker Settings"

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



|                                 |     |
|---------------------------------|-----|
| Marker Table Display.....       | 399 |
| Marker Info.....                | 399 |
| Marker Stepsize.....            | 400 |
| Defining a Fixed Reference..... | 400 |

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" No separate marker table is displayed.  
If [Marker Info](#) is active, the marker information is displayed within the diagram area.
- "Auto" (Default) If more than two markers are active, the marker table is displayed automatically.  
If [Marker Info](#) is active, the marker information for up to two markers is displayed in the diagram area.

Remote command:  
[DISPlay\[:WINDow<n>\]:MTABle](#) on page 723

Marker Info

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

| 1AP Clrw |                           |
|----------|---------------------------|
| M1[1]    | 81.13 dBµV<br>177.610 MHz |
| D2[1]    | -22.18 dB<br>-28.980 MHz  |
|          |                           |

Remote command:

`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 723

### Marker Stepsize

Defines the size of the steps that the marker position is moved using the rotary knob.

|                |  |
|----------------|--|
| "Standard"     | The marker position is moved in steps of (Span/1000), which corresponds approximately to the number of pixels for the default display of 1001 sweep points. This setting is most suitable to move the marker over a larger distance.             |
| "Sweep Points" | The marker position is moved from one sweep point to the next. This setting is required for a very precise positioning if more sweep points are collected than the number of pixels that can be displayed on the screen. It is the default mode. |

Remote command:

`CALCulate<n>:MARKer<m>:X:SSIZE` on page 722

### Defining a Fixed Reference

Instead of using a reference marker whose position can vary depending on the measurement results, you can define a fixed reference marker for trace analysis.

Note that this function is not available in all result displays.

For "State" = "On", a vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value. The delta marker refers to the fixed reference marker.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference marker. To move the fixed reference, move the red display lines marked "FXD" in the diagram, or change the position settings in the "Marker Settings" tab of the "Marker" dialog box.

**Peak Search** sets the fixed reference marker to the current maximum value of the trace assigned to marker 1.

If activated, the fixed reference marker ("FXD") can also be selected as a [Reference Marker](#) instead of another marker.

Remote command:

`CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed[:STATe]` on page 722

`CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y` on page 721

`CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:X` on page 721

`CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:MAXimum[:PEAK]` on page 720

## 5.4.3 Marker search settings and positioning functions

**Access:** "Overview" > "Analysis" > "Marker" > "Search"

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.

The remote commands required to define these settings are described in [Chapter 6.9.3.3, "Marker search"](#), on page 724 and [Chapter 6.9.3.4, "Markers positioning"](#), on page 728.

- [Marker search settings](#).....401
- [Marker search settings for spectrograms](#).....403
- [Positioning functions](#).....405

5.4.3.1 Marker search settings

**Access:** "Overview" > "Analysis" > "Marker" > "Search"

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



For Spectrograms, special marker settings are available, see [Chapter 5.4.3.2, "Marker search settings for spectrograms"](#), on page 403.

Markers

Marker Settings

Search

Next X Search

Left

Absolute

Right

Next Y Search

Up

Absolute

Down

Search Type

X Search

Y Search

XY Search

Search Area

Visible

Memory

Exclude LO

On

Off

Peak Excursion

6.0 dB

Auto Max Peak

On

Off

Auto Min Peak

On

Off

Search Limits

Left Limit

☐

150.0 kHz

Right Limit

☐

26.5 GHz

Threshold

☐

-13.0 dBµV

Use Zoom Limits

On

Off

Search Limits Off

- [Search Mode for Next Peak](#).....402
- [Exclude LO](#).....402
- [Peak Excursion](#).....402
- [Auto Max Peak Search / Auto Min Peak Search](#).....402
- [Search Limits](#).....403
  - [Search Limits \(Left / Right\)](#).....403

|                          |     |
|--------------------------|-----|
| L Search Threshold.....  | 403 |
| L Use Zoom Limits.....   | 403 |
| L Search Limits Off..... | 403 |

### 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:

Find a list of remote commands in [Chapter 6.9.3.4, "Markers positioning"](#), on page 728.

### Exclude LO

If activated, restricts the frequency range for the marker search functions.

|       |  |
|-------|--|
| "On"  | The minimum frequency included in the peak search range is $\geq 5 \times$ resolution bandwidth (RBW).<br>Due to the interference by the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search. |
| "Off" | No restriction to the search range. The frequency 0 Hz is included in the marker search functions.   |

Remote command:

[CALCulate<n>:MARKer<m>:LOEXclude](#) on page 724

### 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.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see [Chapter 5.4.4.8, "Marker peak list"](#), on page 423.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 724

### Auto Max Peak Search / Auto Min Peak Search

If activated, a maximum or minimum peak search is performed automatically for marker 1 after each sweep.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:

[CALCulate<n>:MARKer<m>:MAXimum:AUTO](#) on page 730

[CALCulate<n>:MARKer<m>:MINimum:AUTO](#) on page 732

**Search Limits**

The search results can be restricted by limiting the search area or adding search conditions.

**Search Limits (Left / Right) ← Search Limits**

If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches, see ["Peak search limits"](#) on page 424.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 726

[CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 725

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 725

**Search Threshold ← Search Limits**

Defines an absolute threshold as an additional condition for the peak search. If enabled, only peaks that exceed the threshold are detected.

Remote command:

[CALCulate<n>:THReshold:STATe](#) on page 727

[CALCulate<n>:THReshold](#) on page 727

**Use Zoom Limits ← Search Limits**

If activated, the peak search is restricted to the active zoom area defined for a single zoom.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM\[:STATe\]](#) on page 726

**Search Limits Off ← Search Limits**

Deactivates the search range limits.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 726

[CALCulate<n>:THReshold:STATe](#) on page 727

**5.4.3.2 Marker search settings for spectrograms**

**Access:** "Overview" > "Analysis" > "Marker" > "Search"

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.

Functions for marker search in spectrograms described elsewhere:

- ["Exclude LO"](#) on page 402
- ["Peak Excursion"](#) on page 402
- ["Auto Max Peak Search / Auto Min Peak Search"](#) on page 402
- ["Search Limits \(Left / Right\)"](#) on page 403
- ["Search Threshold"](#) on page 403

- ["Use Zoom Limits"](#) on page 403
- ["Search Limits Off"](#) on page 403

|  |     |
|--|-----|
| <a href="#">Search Mode for Next Peak in X-Direction</a> ..... | 404 |
| <a href="#">Search Mode for Next Peak in Y-Direction</a> ..... | 404 |
| <a href="#">Marker Search Type</a> .....                       | 404 |
| <a href="#">Marker Search Area</a> .....                       | 404 |

### Search Mode for Next Peak in X-Direction

Selects the search mode for the next peak search within the currently selected frame.

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

Remote command:

Find a list of remote commands in [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 735.

### Search Mode for Next Peak in Y-Direction

Selects the search mode for the next peak search within all frames at the current marker position.

|            |  |
|------------|--|
| "Up"       | Determines the next maximum/minimum above the current peak (in more recent frames).  |
| "Absolute" | Determines the next maximum/minimum above or below the current peak (in all frames). |
| "Down"     | Determines the next maximum/minimum below the current peak (in older frames).        |

Remote command:

Find a list of remote commands in [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 735.

### Marker Search Type

Defines the type of search to be performed in the spectrogram.

|             |  |
|-------------|--|
| "X-Search"  | Searches only within the currently selected frame.                     |
| "Y-Search"  | Searches within all frames but only at the current frequency position. |
| "XY-Search" | Searches in all frames at all positions.                               |

Remote command:

Find a list of remote commands in [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 735.

### Marker Search Area

Defines which frames the search is performed in.

|           |   |
|-----------|---|
| "Visible" | Only the visible frames are searched.         |
| "Memory"  | All frames stored in the memory are searched. |



Remote command:

[CALCulate<n>:MARKer<m>:SPECTrogram:SARea](#) on page 736

[CALCulate<n>:DELTamarker<m>:SPECTrogram:SARea](#) on page 740

### 5.4.3.3 Positioning functions

**Access:** [MKR →]

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

|   |     |
|---|-----|
| <a href="#">Peak Search</a> .....                         | 405 |
| <a href="#">Search Next Peak</a> .....                    | 405 |
| <a href="#">Search Minimum</a> .....                      | 405 |
| <a href="#">Search Next Minimum</a> .....                 | 406 |
| <a href="#">Center Frequency = Marker Frequency</a> ..... | 406 |
| <a href="#">Reference Level = Marker Level</a> .....      | 406 |

#### Peak Search

Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:

[CALCulate<n>:MARKer<m>:MAXimum\[:PEAK\]](#) on page 732

[CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 729

#### Search Next Peak

Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next peak is to be searched in.

Remote command:

[CALCulate<n>:MARKer<m>:MAXimum:NEXT](#) on page 731

[CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 731

[CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 731

[CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 728

[CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 729

[CALCulate<n>:DELTamarker<m>:MAXimum:LEFT](#) on page 728

#### Search Minimum

Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the minimum is to be searched in.

Remote command:

[CALCulate<n>:MARKer<m>:MINimum\[:PEAK\]](#) on page 733

[CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 730

**Search Next Minimum**

Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

For spectrogram displays, define which frame the next minimum is to be searched in.

Remote command:

`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 733

`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 733

`CALCulate<n>:MARKer<m>:MINimum:RIGHT` on page 733

`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 730

`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 729

`CALCulate<n>:DELTamarker<m>:MINimum:RIGHT` on page 730

**Center Frequency = Marker Frequency**

Sets the center frequency to the selected marker or delta marker frequency. A peak can thus be set as center frequency, for example to analyze it in detail with a smaller span.

This function is not available for zero span measurements.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:CENTer` on page 655

**Reference Level = Marker Level**

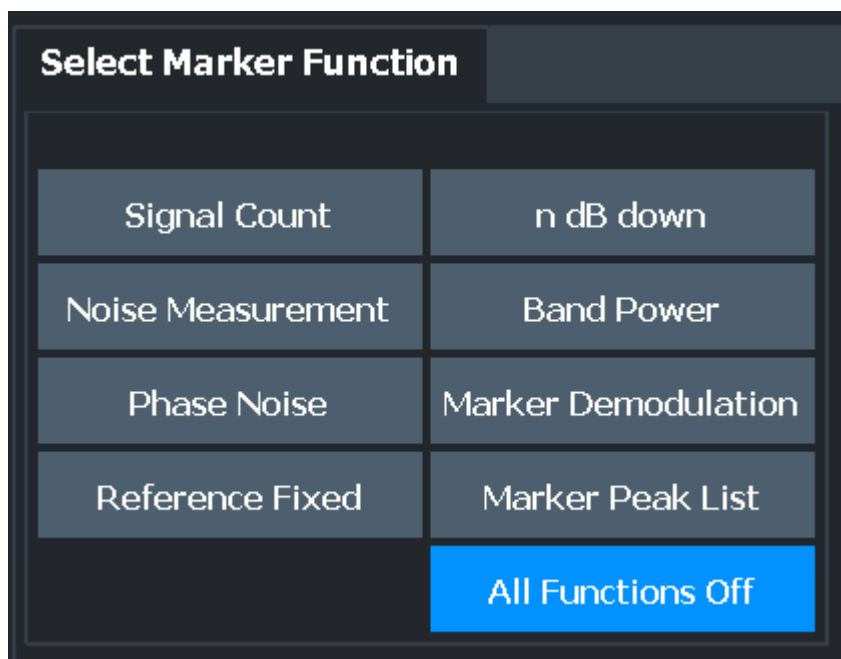
Sets the reference level to the selected marker level.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:REFerence` on page 658

#### 5.4.4 Marker (measurement) functions

**Access:** "Overview" > "Analysis" > "Marker Functions"



The remote commands required to define these settings are described in [Chapter 6.9.3.7, "Marker functions"](#), on page 742.

- [Precise frequency \(signal count\) marker](#).....407
- [Measuring noise density \(noise meas marker\)](#).....409
- [Phase noise measurement marker](#).....412
- [Measuring characteristic bandwidths \(n db down marker\)](#).....414
- [Fixed reference marker](#).....416
- [Measuring the power in a channel \(band power marker\)](#).....417
- [Demodulating marker values and providing audio output \(marker demodulation\)](#)421
- [Marker peak list](#).....423
- [Deactivating all marker functions](#).....427

#### 5.4.4.1 Precise frequency (signal count) marker

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Select Marker Function" > "Signal Count" > "Signal Count Config"

**Or:** [MKR FUNC] > "Select Marker Function" > "Signal Count" > "Signal Count Config"


A normal marker determines the position of the point on the trace and indicates the signal frequency at this position. The trace, however, contains only a limited number of points. Depending on the selected span, each trace point can contain many measurement values. Thus, the frequency resolution of each trace point is limited.

(See also [Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count"](#), on page 303).

Frequency resolution is further restricted by the RBW and sweep time settings.

To determine the frequency of a signal point accurately without changing the sweep settings, the R&S ESW is equipped with a signal counter. The signal counter sets the

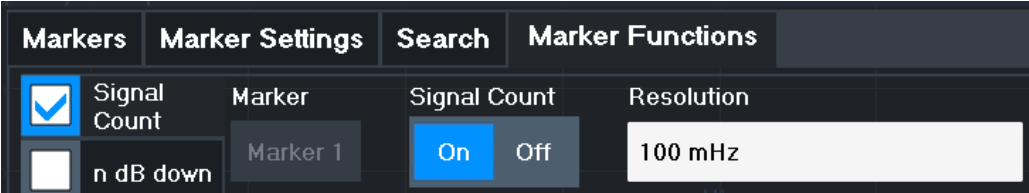
RF to the current marker position, then counts the zero crossings of the IF (thus the term signal *counter*) and derives the precise frequency value.




To determine the frequency accurately using the signal counter function, the marker must be sufficiently close to the actual signal (for a 3-dB Gauss filter, the delta must be less than 2\*RBW). Usually, the marker peak function detects a trace point that is close enough. However, for a large span or a small number of sweep points, the result can be inaccurate.

Signal counting can be performed explicitly at the current marker position ("Signal Count" marker function), or implicitly by the R&S ESW for certain functions.

Signal counting is only possible while the instrument is not sweeping. Thus, to perform a signal count for a marker, the sweep is stopped at the marker position. The frequency is determined with the desired resolution and then the sweep is allowed to continue.



A measurement example is described in [Chapter 3.1.3.2, "Measuring the signal frequency using the signal counter"](#), on page 24.



Signal counters are not available for measurements on I/Q-based data.

**Remote commands:**

"[Example: performing a highly accurate frequency measurement using the signal count marker](#)" on page 769

`CALCulate<n>:MARKer<m>:COUNT` on page 742

`CALCulate<n>:MARKer<m>:COUNT:RESolution` on page 744

|   |     |
|---|-----|
| <a href="#">Signal Count Marker State</a> ..... | 408 |
| <a href="#">Resolution</a> .....                | 409 |

**Signal Count Marker State**

Activates or deactivates the special signal count marker function.

When activated, the sweep stops at the reference marker until the signal counter has delivered a result.

Remote command:

`CALCulate<n>:MARKer<m>:COUNT` on page 742

`CALCulate<n>:MARKer<m>:COUNT:FREQuency?` on page 743

**Resolution**

Defines the resolution with which the signal is analyzed around the reference marker 1.

Remote command:

`CALCulate<n>:MARKer<m>:COUNT:RESolution` on page 744

**5.4.4.2 Measuring noise density (noise meas marker)**

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Select Marker Function" > "Noise Measurement" > "Noise Meas Config"

**Or:** [MKR FUNC] > "Select Marker Function" > "Noise Measurement" > "Noise Meas Config"

Using the noise measurement marker function, the noise power density is measured at the position of the marker. In the time domain mode, all points of the trace are used to determine the noise power density. When measurements are performed in the frequency domain, eight points to the right and left of the marker (if available) are used for the measurement to obtain a stable result.

**Result display**

Noise density is the noise referred to a bandwidth of 1 Hz. With logarithmic amplitude units (dBm, dBmV, dBm $\mu$ V, dB $\mu$ A), the noise power density is output in dBm/Hz, i.e. as the level in 1 Hz bandwidth with reference to 1 mW. With linear amplitude units (V, A, W), the noise voltage density is analyzed in  $\mu\text{V}/\sqrt{\text{Hz}}$ ; the noise current density in  $\mu\text{A}/\sqrt{\text{Hz}}$ ; the noise power density in  $\mu\text{W}/\sqrt{\text{Hz}}$ .

The result is indicated as the **function result in the Marker Table**.

**Prerequisite settings**

The following settings are required to obtain correct values:

- Detector: Sample or RMS
- Video bandwidth:
  - $\leq 0.1$  resolution bandwidth with sample detector
  - $\geq 3 \times$  resolution bandwidth with RMS detector
- Trace averaging:
 

In the default setting, the R&S ESW uses the sample detector for the noise function. With the sample detector, you can set the trace to "Average" mode to stabilize the measured values. When the RMS detector is used, trace averaging produces noise levels that are too low and cannot be corrected. Instead, increase the sweep time to obtain stable measurement results.

**Correction factors**

The R&S ESW uses the following correction factors to analyze the noise density from the marker level:

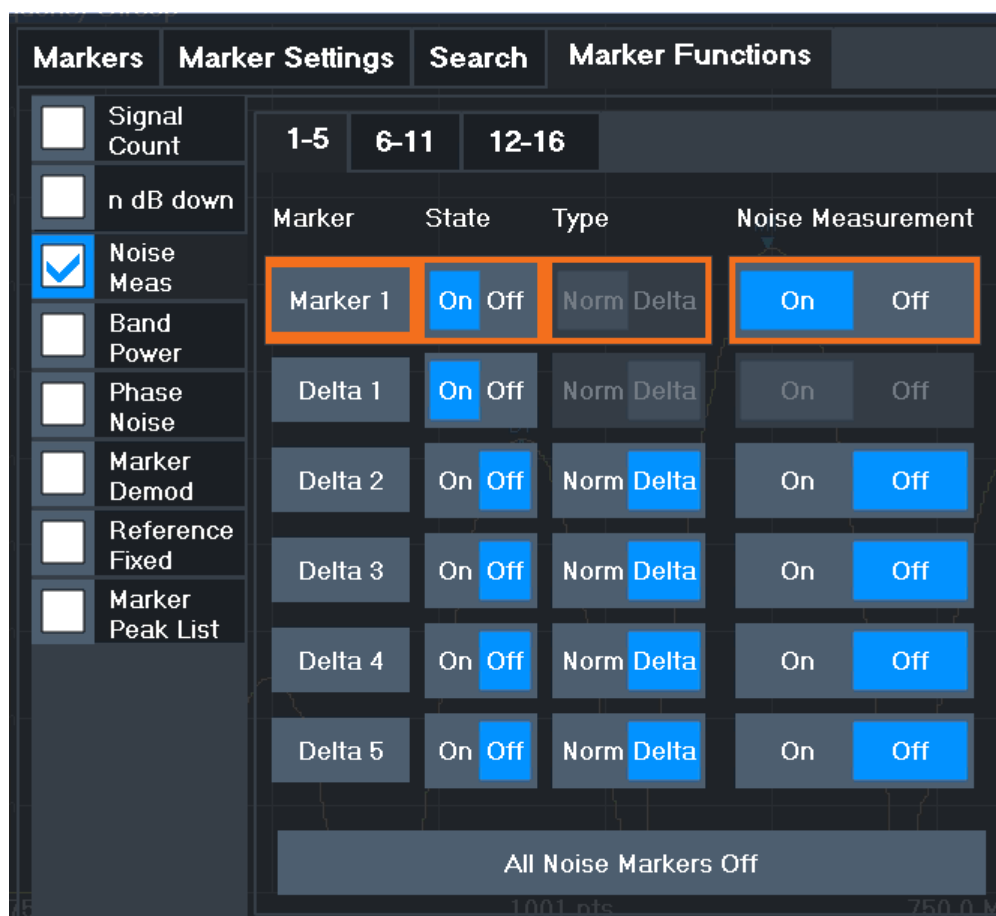
- Since the noise power is indicated with reference to 1 Hz bandwidth, the bandwidth correction value is deducted from the marker level. It is  $10 \times \lg(1 \text{ Hz}/\text{BWNoise})$ , where BWNoise is the noise or power bandwidth of the set resolution filter (RBW).

- RMS detector: With the exception of bandwidth correction, no further corrections are required since this detector already indicates the power for each point of the trace.
- Sample detector: As a result of video filter averaging and trace averaging, 1.05 dB is added to the marker level. This is the difference between the average value and the RMS value of white noise. With a logarithmic level axis, 1.45 dB is added additionally. Logarithmic averaging is thus fully taken into account, which yields a value that is 1.45 dB lower than that of linear averaging.
- To allow for a more stable noise display, eight trace points on each side of the measurement frequency are averaged.
- For span > 0, the measured values are averaged versus time (after a sweep).



The R&S ESW noise figure can be calculated from the measured power density level. It is calculated by deducting the set RF attenuation (RF Att) from the displayed noise level and adding 174 to the result.

The individual marker settings correspond to those defined in the "Marker" dialog box (see [Chapter 5.4.2.1, "Individual marker setup"](#), on page 395). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



**Remote commands:**

"Example: measuring noise density" on page 765

CALCulate<n>:MARKer<m>:FUNCTION:NOISE[:STATe] on page 745

CALCulate<n>:MARKer<m>:FUNCTION:NOISE:RESult? on page 744

|  |     |
|--|-----|
| Marker State.....                        | 411 |
| Marker Type.....                         | 411 |
| Noise Measurement State.....             | 411 |
| Switching All Noise Measurement Off..... | 411 |

**Marker State**

Activates or deactivates the marker in the diagram.

Remote command:

CALCulate<n>:MARKer<m>[:STATe] on page 719

CALCulate<n>:DELTamarker<m>[:STATe] on page 717

**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 719

CALCulate<n>:DELTamarker<m>[:STATe] on page 717

**Noise Measurement State**

Activates or deactivates noise measurement for the marker in the diagram.

This function is only available for normal markers.

If activated, the marker displays the noise power density measured at the position of the marker.

For details see [Chapter 5.4.4.2, "Measuring noise density \(noise meas marker\)"](#), on page 409.

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:NOISE[:STATe] on page 745

CALCulate<n>:MARKer<m>:FUNCTION:NOISE:RESult? on page 744

**Switching All Noise Measurement Off**

Deactivates noise measurement for all markers.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:NOISe[:STATe]` on page 745

#### 5.4.4.3 Phase noise measurement marker

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Phase Noise" > "Phase Noise Config"

**Or:** [MKR FUNC] > "Select Marker Function" > "Phase Noise" > "Phase Noise Config"

For each of the 16 markers, you can activate a phase noise measurement.

Phase noise is unintentional modulation of a carrier; it creates frequencies next to the carrier frequency. A phase noise measurement consists of noise density measurements at defined offsets from the carrier; the results are given in relation to the carrier level (dBc). The phase noise marker function measures the noise power at the delta markers referred to 1 Hz bandwidth. Marker 1 is used as the reference for the phase noise measurement. By default, the current frequency and level of marker 1 are used as the fixed reference marker. However, you can start a peak search to use the current signal peak as the reference point, or you can define a reference point manually.

The reference point for the phase noise measurement is fixed. After phase noise measurement is started, you can set the reference level or the center frequency so that the carrier is outside the displayed frequency range. You can also activate a notch filter to suppress the carrier.

Alternatively, the reference point can be determined automatically by a peak search after each sweep. Use this function to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Thus, the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

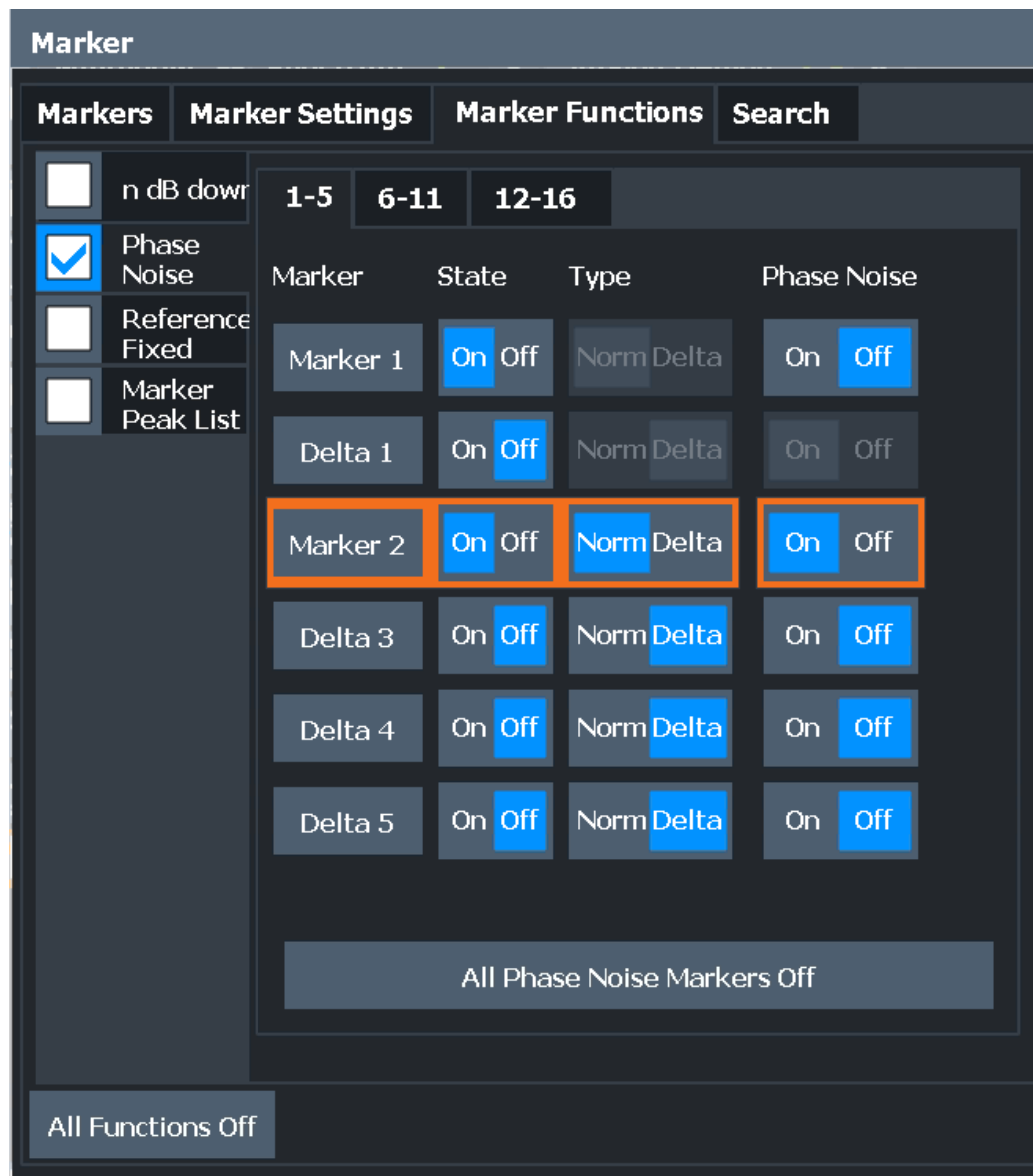
The result of the phase noise measurement is the difference in level between the reference point and the noise power density. It is indicated as the function result of the phase noise marker in the "marker table".

The sample detector is automatically used and the video bandwidth set to 0.1 times the resolution bandwidth (RBW). The two settings are considered in the correction values used for the noise power measurement. To obtain stable results, two pixels on the right and the left of the delta marker position are taken for the measurement.

The procedure to determine the noise power is identical to the method used for the noise power measurement (see [Chapter 5.4.4.2, "Measuring noise density \(noise meas marker\)"](#), on page 409).

The individual marker settings correspond to those defined in the "Marker" dialog box. Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



**Remote commands:**

[CALCulate<n>:MARKer<m>:FUNCTION:PNOise\[:STATe\]](#) on page 747

[CALCulate<n>:MARKer<m>:FUNCTION:PNOise:RESult?](#) on page 747

[Phase Noise Measurement State](#)..... 413

[Defining Reference Point](#)..... 414

[Switching All Phase Noise Measurements Off](#)..... 414

**Phase Noise Measurement State**

Activates or deactivates phase noise measurement for the reference point in the diagram.

This function is only available for delta markers.

If activated, the delta markers display the phase noise measured at defined offsets from the reference position.

Remote command:

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise[:STATe]` on page 746

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:RESult?` on page 746

### Defining Reference Point

Instead of using marker 1 as the reference marker, a fixed reference marker can be defined for phase noise measurement.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

Alternatively, a **Peak Search** can be performed to set the maximum value of the selected trace as the reference point.

If "Automatic Peak Search" is activated, a peak search is started automatically after each sweep and the result is used as the reference point.

Remote command:

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPoint:Y` on page 721

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPoint:X` on page 721

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPoint:MAXimum[:PEAK]` on page 720

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:AUTO` on page 745

### Switching All Phase Noise Measurements Off

Deactivates phase noise measurement for all markers.

Remote command:

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise[:STATe]` on page 746

#### 5.4.4.4 Measuring characteristic bandwidths (n dB down marker)

**Access:** "Overview" > "Analysis" > "Marker Functions" > "n dB down" > "n dB Down Config"

**Or:** [MKR FUNC] > "Select Marker Function" > "n dB down" > "n dB Down Config"

When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. To measure this bandwidth, you could use several markers and delta markers and determine the bandwidth manually. However, using the n dB down marker function makes the task very simple and quick.

The n dB down marker function uses the current value of marker 1 as the reference point. It activates two temporary markers T1 and T2 located on the signal, whose level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but it can be changed.

If a positive offset is entered, the markers T1 and T2 are placed below the active reference point. If a negative value is entered (for example for notch filter measurements), the markers T1 and T2 are placed above the active reference point.

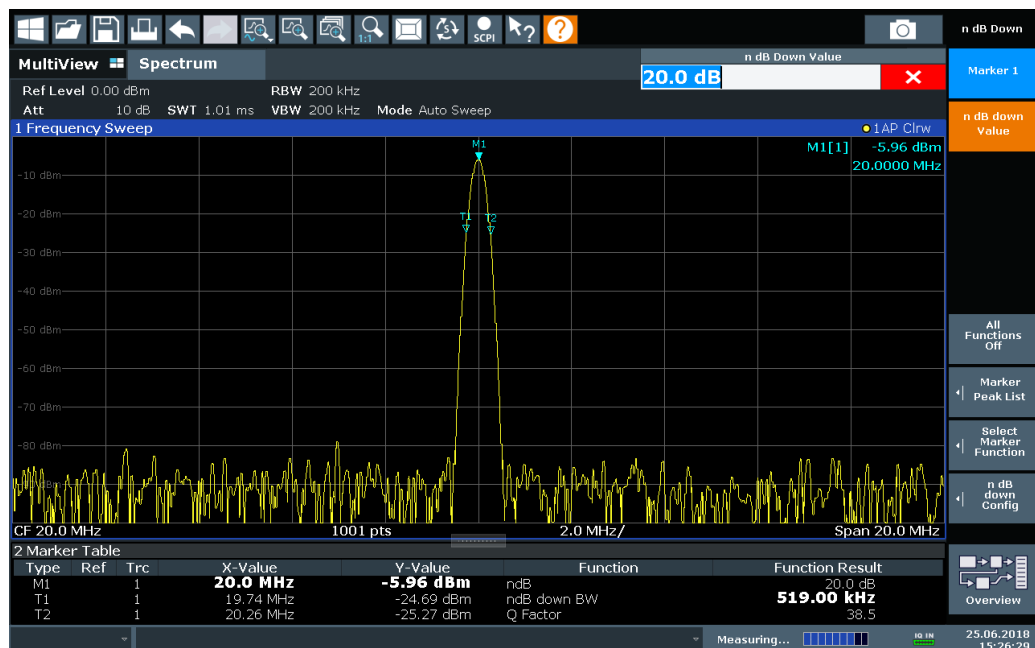


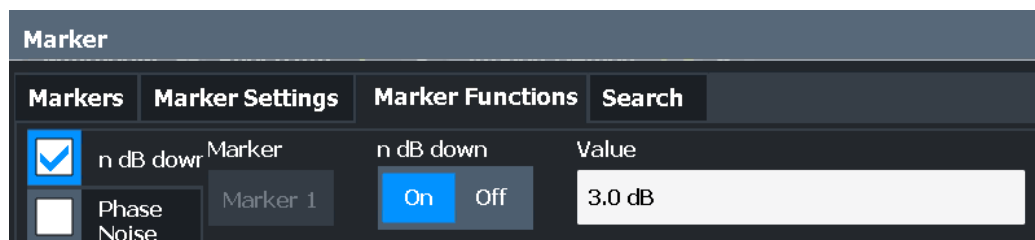
Figure 5-13: n dB down marker function

The following marker function results are displayed:

Table 5-6: n dB down marker function results

| Label              | Description   |
|--------------------|---|
| M1                 | Current position and level of marker 1  |
| ndB                | Offset value (n dB down)  |
| ndB down Bw / PWid | Determined bandwidth or pulse width (zero span) at the offset   |
| Q-factor           | Center frequency / n-dB-down-bandwidth<br>Quality factor of the determined bandwidth (characteristic of damping or resonance) |
| T1, T2             | Current position and level of the temporary markers   |

If the required position for the temporary markers cannot be determined uniquely, for example due to noise, dashes are displayed as a result.



#### Remote commands:

CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:STATe on page 750

[CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:RESult?](#) on page 749

|  |     |
|--|-----|
| <a href="#">n dB down Marker State</a> ..... | 416 |
| <a href="#">n dB down Value</a> .....        | 416 |

#### **n dB down Marker State**

Activates or deactivates the special n dB down marker function.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:STATe](#) on page 750

[CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:RESult?](#) on page 749

#### **n dB down Value**

Defines the delta level from the reference marker 1 used to determine the bandwidth or time span.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:FREQuency?](#) on page 748

[CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:TIME?](#) on page 750

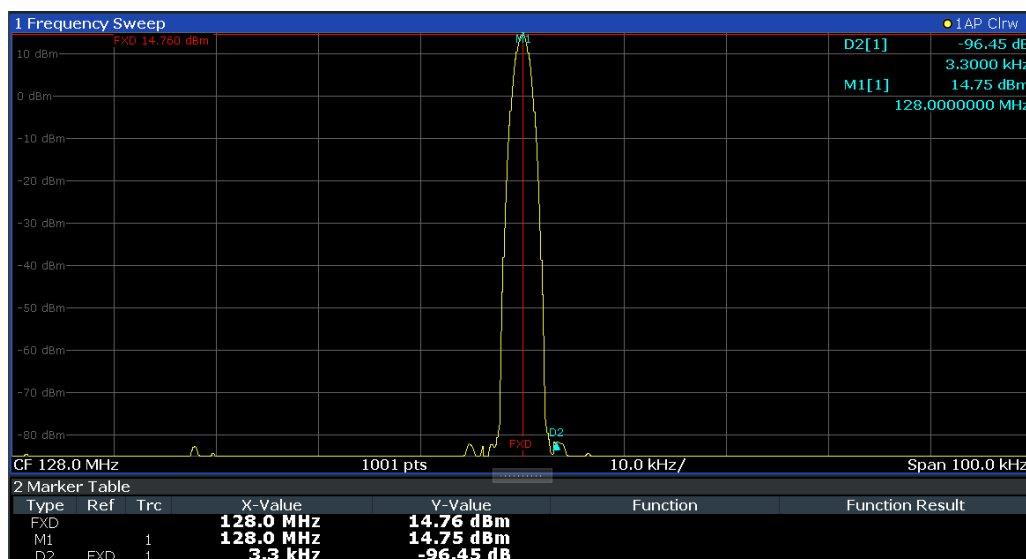
#### **5.4.4.5 Fixed reference marker**

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Reference Fixed"

**Or:** [MKR FUNC] > "Select Marker Function" > "Reference Fixed"

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitly move it manually.

When you select this marker function, a vertical and a horizontal red display line are displayed, marked as "FXD". A normal marker is activated and set to the peak value and a delta marker to the next peak. The fixed reference marker is set to the position of the normal marker at the peak value. The delta marker refers to the fixed reference marker.



You can move the position of the fixed reference marker graphically by dragging the display lines, or numerically by entering values for the marker position and level.

#### Remote commands:

"Example: using a fixed reference marker" on page 764

CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed[:STATe] on page 722

CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:X on page 721

CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y on page 721

#### 5.4.4.6 Measuring the power in a channel (band power marker)

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Band Power" > "Band Power Config"

**or:** [MKR FUNC] > "Select Marker Function" > "Band Power"

To determine the noise power in a transmission channel, you can use a noise marker and multiply the result with the channel bandwidth. However, the results are only accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the "marker table" for each band power marker.



### Relative band power markers

The results for band power markers which are defined as *delta* markers and thus have a reference value can also be calculated as reference power values (in dB).

For Analog Modulation Analysis, relative band power markers are not available.

In this case, the result of the band power deltamarker is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.

*[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]*

The measured power for the reference marker may be an absolute power at a single point (if the reference marker is not a band power marker), or the power in a band (if the reference marker is a band power marker itself).

If the reference marker for the band power marker is also a delta marker, the absolute power level for the reference marker is used for calculation.

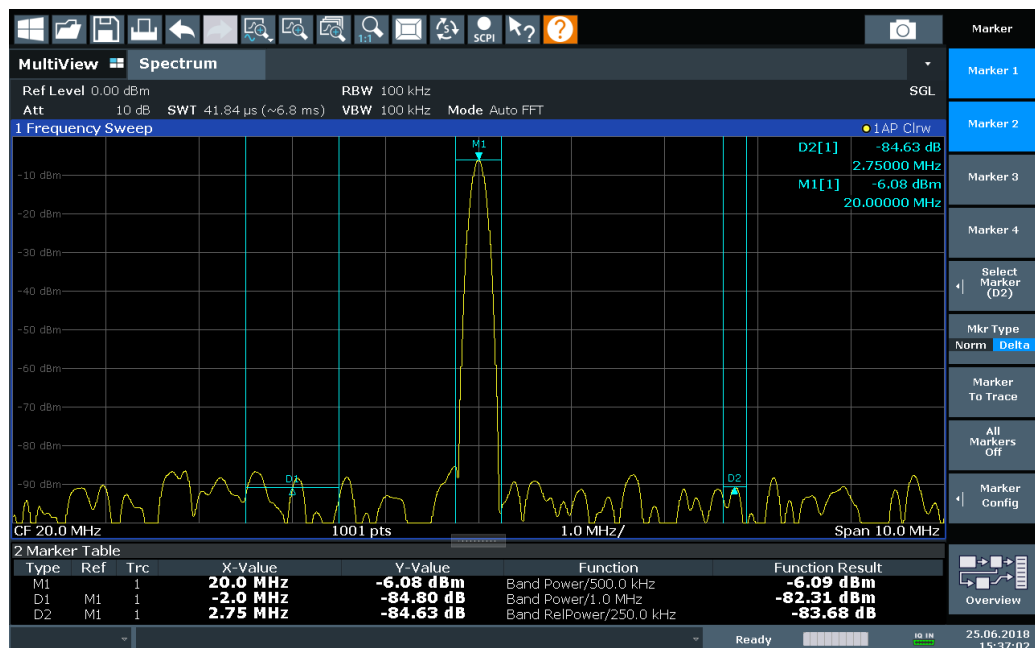


Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum and Spectrum application. In Analog Modulation Analysis with AM, FM, or PM spectrum results, this marker function does not determine a power value, but rather the deviation within the specified span.

For the I/Q Analyzer application, band power markers are only available for Spectrum displays.

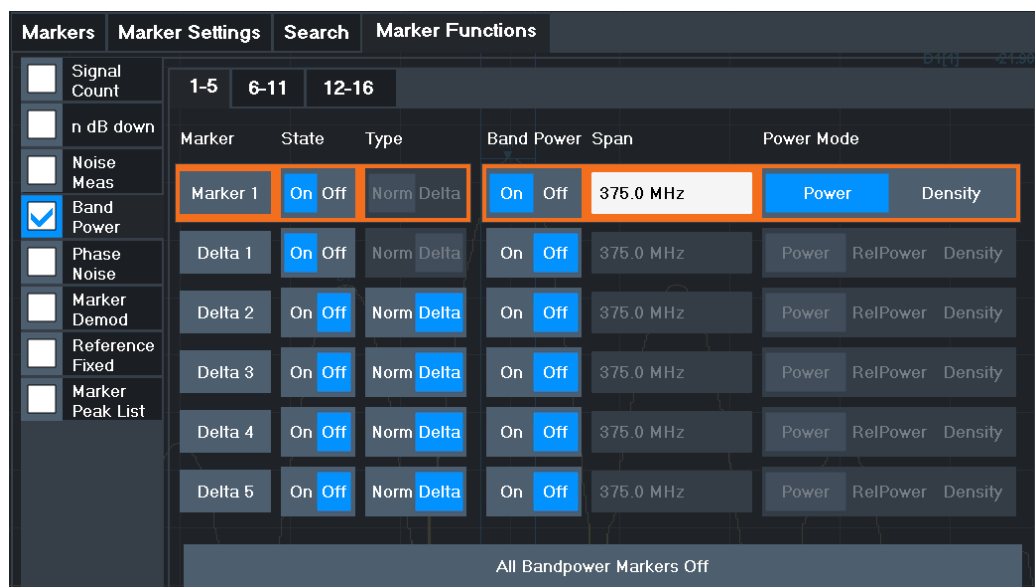
The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



All markers can be defined as band power markers, each with a different span. When a band power marker is activated, if no marker is active yet, marker 1 is activated. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are deactivated).

If the detector mode for the marker trace is set to "Auto", the RMS detector is used.

The individual marker settings correspond to those defined in the "Marker" dialog box (see [Chapter 5.4.2.1, "Individual marker setup"](#), on page 395). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



**Remote commands:**

"Example: measuring the power in a channel using band power markers" on page 767

CALCulate<n>:MARKer<m>:FUNction:BPOWer[:STATe] on page 754

CALCulate<n>:MARKer<m>:FUNction:BPOWer:RESult? on page 753

|  |     |
|--|-----|
| Band Power Measurement State.....              | 420 |
| Span.....                                      | 420 |
| Power Mode.....                                | 420 |
| Switching All Band Power Measurements Off..... | 421 |

**Band Power Measurement State**

Activates or deactivates band power measurement for the marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

If activated, the markers display the power or density measured in the band around the current marker position.

For details see [Chapter 5.4.4.6, "Measuring the power in a channel \(band power marker\)"](#), on page 417.

Remote command:

CALCulate<n>:MARKer<m>:FUNction:BPOWer[:STATe] on page 754

CALCulate<n>:DELTAmarker<m>:FUNction:BPOWer[:STATe] on page 752

**Span**

Defines the span (band) around the marker for which the power is measured.

The span is indicated by lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

Remote command:

CALCulate<n>:MARKer<m>:FUNction:BPOWer:SPAN on page 753

CALCulate<n>:DELTAmarker<m>:FUNction:BPOWer:SPAN on page 752

**Power Mode**

Defines the mode of the power measurement result.

For Analog Modulation Analysis, the power mode is not editable for AM, FM, or PM spectrum results. In this case, the marker function does not determine a power value, but rather the deviation within the specified span.

"Power"                      The result is an absolute power level.  
                                     The power unit depends on the [Unit](#) setting.



|                  |   |
|------------------|---|
| "Relative Power" | <p>This setting is only available for a delta band power marker.</p> <p>The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker (see "Reference Marker" on page 207). The powers are subtracted logarithmically, so the result is a dB value.</p> $[\text{Relative band power (Delta2) in dB}] = [\text{absolute band power (Delta2) in dBm}] - [\text{absolute (band) power of reference marker in dBm}]$ <p>For details see "Relative band power markers" on page 418</p> |
| "Density"        | <p>The result is a power level in relation to the bandwidth, displayed in dBm/Hz.</p>   |

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:BPOWER:MODE on page 753

CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER:MODE on page 751

### Switching All Band Power Measurements Off

Deactivates band power measurement for all markers.

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:BPOWER[:STATe] on page 754

CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER[:STATe] on page 752

#### 5.4.4.7 Demodulating marker values and providing audio output (marker demodulation)

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Select Marker Function" > "Marker Demodulation" > "Marker Demod Config"

**Or:** [MKR FUNC] > "Select Marker Function" > "Marker Demodulation" > "Marker Demod Config"

The R&S ESW provides demodulators for AM, FM and PM signals. The demodulation marker function sends the demodulated data at the current marker frequency to the audio output. Thus, a displayed signal can be identified acoustically with the help of the internal loudspeaker or with headphones.



Marker demodulation is unavailable

- when one of the outputs is active
- for Spectrum Emission Mask measurements
- for measurements on I/Q-based data

The sweep stops at the frequency determined by marker 1 for the selected time and the RF signal is demodulated in a bandwidth that corresponds to the RBW. Alternatively, demodulation can be activated continuously, i.e. audio output occurs regardless of the marker position and the marker stop time. For measurements in the time domain (zero span), demodulation is always continuous.

Optionally, a minimum level ("Squelch Level") can be defined so that the signal is only demodulated when it exceeds the set level. This is useful during continuous demodulation to avoid listening to noise.

The squelch function activates the video trigger function (see "Video" on page 317) and deactivates any other trigger or gating settings. The squelch level and trigger level are set to the same value. The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

Select Marker Function

Marker Demod Config

| Marker   | Marker Demodulation | Continuous Demodulation | Marker Stop Time |
|----------|---------------------|-------------------------|------------------|
| Marker 1 | On                  | On                      | 1.0 s            |

Modulation

Squelch

Squelch Level

|    |    |          |       |    |     |        |
|----|----|----------|-------|----|-----|--------|
| AM | FM | AC VIDEO | AUDIO | On | Off | 50.0 % |
|----|----|----------|-------|----|-----|--------|

Remote commands:

Chapter 6.9.3.8, "Programming examples for using markers and marker functions", on page 761

|                                |     |
|--------------------------------|-----|
| Marker Demodulation State..... | 422 |
| Continuous Demodulation.....   | 422 |
| Marker Stop Time.....          | 423 |
| Modulation.....                | 423 |
| Squelch.....                   | 423 |
| Squelch Level.....             | 423 |

Marker Demodulation State

Activates or deactivates the demodulation output. If activated, the signal is demodulated and sent to the audio output.

Remote command:  
CALCulate<n>:MARKer<m>:FUNction:DEModulation[:STATe] on page 756

Continuous Demodulation

If activated, the signal is demodulated continuously and sent to the audio output, instead of stopping the sweep at the marker frequency of marker 1 and demodulating there for the configured marker stop time. This allows you to monitor the frequency range acoustically (assuming the sweep time is long enough).

For zero span measurements, demodulation is always active continuously.

For EMI measurements, during the initial peak search, demodulation is not stopped at the determined markers, even if "Continuous Demodulation" is disabled.

During the final measurement, demodulation is always performed at the detected peak marker positions only (for the defined dwell time), regardless of the "Continuous Demodulation" setting.

Remote command:  
CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTinuous on page 754

**Marker Stop Time**

Defines how long the sweep is stopped at the marker position to output the demodulated signal.

For zero span measurements, demodulation is always active continuously, regardless of the marker stop time.

For EMI measurements, the duration of the demodulation at each marker position is limited by the dwell time of the EMI measurement marker (see ["Dwell Time"](#) on page 211).

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:DEModulation:HOLDoff](#) on page 755

**Modulation**

Defines the demodulation mode for output. The default setting is AM.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:DEModulation:SElect](#) on page 755

**Squelch**

Activates or deactivates the squelch function. If activated, the audible AF is cut off below a defined threshold level. Thus, you avoid hearing noise at the audio output when no signal is available.

The squelch function activates the video trigger function (see ["Video"](#) on page 317) and deactivates any other trigger or gating settings. The squelch level and trigger level are set to the same value. The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

Remote command:

[\[SENSe:\]DEMod:SQUelch\[:STATe\]](#) on page 757

**Squelch Level**

Defines the level threshold below which the audible AF is cut off if squelching is enabled. The video trigger level is set to the same value.

The squelch level is indicated by a red line in the diagram.

Remote command:

[\[SENSe:\]DEMod:SQUelch:LEVel](#) on page 756

**5.4.4.8 Marker peak list**

**Access:** "Overview" > "Analysis" > "Marker Functions" > "Marker Peak List"

A common measurement task is to determine peak values, i.e. maximum or minimum signal levels. The R&S ESW provides various peak search functions and applications:

- Setting a marker to a peak value once (Peak Search)
- Searching for a peak value within a restricted search area (Search Limits)
- Creating a "marker table" with all or a defined number of peak values for one sweep ("Marker Peak List")

- Updating the marker position to the current peak value automatically after each sweep (Auto Peak Search)
- Creating a fixed reference marker at the current peak value of a trace (Fixed Reference)

### Peak search limits

The peak search can be restricted to a search area. The search area is defined by limit lines which are also indicated in the diagram. In addition, a minimum value (threshold) can be defined as a further search condition.

### When is a peak a peak? - Peak excursion

During a peak search, noise values are detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak Excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

### Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

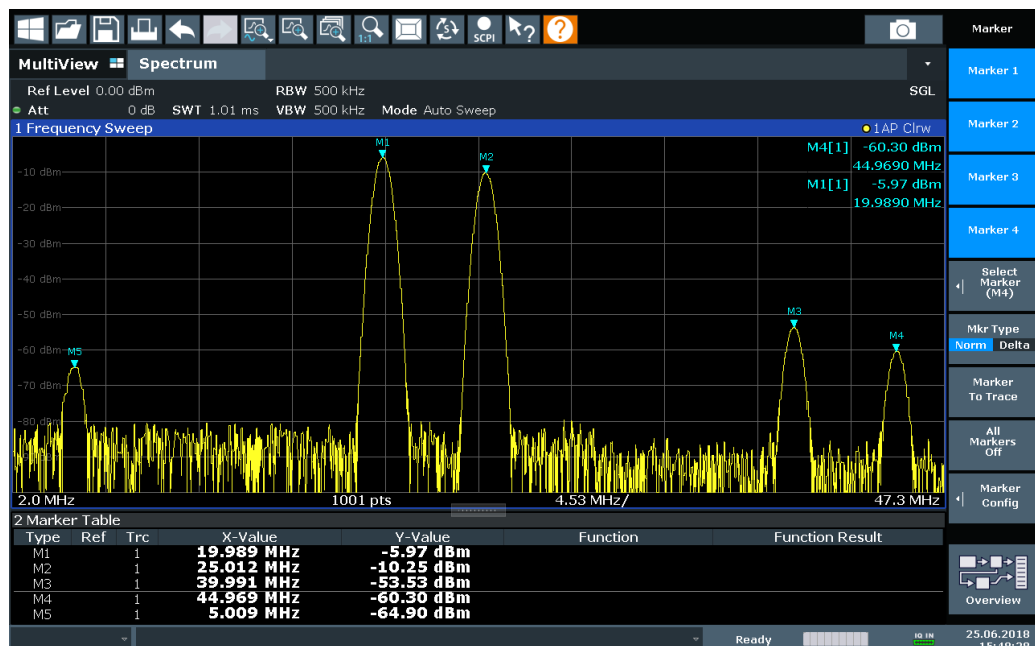


Figure 5-14: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

| Marker # | Min. amplitude decrease to either side of the signal |
|----------|--|
| 1        | 80 dB  |
| 2        | 80 dB  |
| 3        | 55 dB  |
| 4        | 39 dB  |
| 5        | 32 dB  |

To eliminate the smaller peaks M3, M4 and M5 in the example above, a peak excursion of at least 60 dB is required. In this case, the amplitude must rise at least 60 dB before falling again before a peak is detected.

### Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

### Automatic peak search

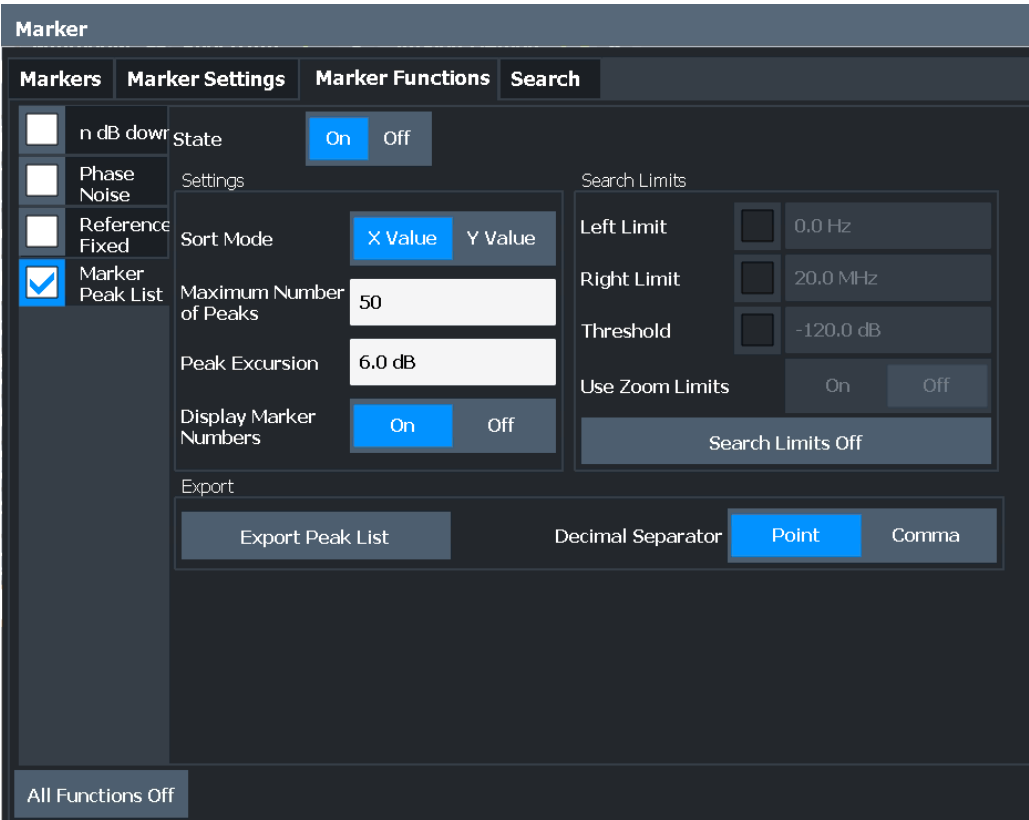
A peak search can be repeated automatically after each sweep to keep the maximum value as the reference point for a phase noise measurement. Automatic peak search is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore, the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

In the Spectrum application, a peak search can be repeated automatically after each sweep to keep the maximum value as the reference point for a phase noise measurement. Automatic peak search is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

### Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the maximum level can be determined by an initial peak search and then be used as a reference point for further measurement results.

The individual marker settings correspond to those defined in the "Marker" dialog box (see [Chapter 5.4.2, "Marker settings"](#), on page 395). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



Remote commands:

"Example: obtaining a marker peak list" on page 765

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:STATe on page 759

TRAC? LIST,

See TRACe<n>[:DATA] on page 690

|                              |     |
|------------------------------|-----|
| Peak List State.....         | 426 |
| Sort Mode.....               | 427 |
| Maximum Number of Peaks..... | 427 |
| Peak Excursion.....          | 427 |
| Display Marker Numbers.....  | 427 |
| Export Peak List.....        | 427 |

Peak List State

Activates/deactivates the marker peak list. If activated, the peak list is displayed and the peaks are indicated in the trace display.

For each listed peak, the frequency/time ("X-value") and level ("Y-Value") values are given.

Remote command:

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:STATe on page 759

**Sort Mode**

Defines whether the peak list is sorted according to the x-values or y-values. In either case, the values are sorted in ascending order.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:SORT](#) on page 759

**Maximum Number of Peaks**

Defines the maximum number of peaks to be determined and displayed.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:LIST:SIZE](#) on page 758

**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.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see [Chapter 5.4.4.8, "Marker peak list"](#), on page 423.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 724

**Display Marker Numbers**

By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks, the marker numbers can decrease readability; in this case, deactivate the marker number display.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:ANnotation:LABEL\[:STATE\]](#) on page 757

**Export Peak List**

The peak list can be exported to an ASCII file (.DAT) for analysis in an external application.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

Remote command:

[MMEMory:STORe<n>:PEAK](#) on page 761

[FORMat:DEXPort:DSEPARATOR](#) on page 698

**5.4.4.9 Deactivating all marker functions**

**Access:** "Overview" > "Analysis" > "Marker Functions" > "All Functions Off"

All special marker functions can be deactivated in one step.

Remote command:

### 5.4.5 How to work with markers

The following step-by-step instructions demonstrate in detail how to work with markers.

- [How to analyze a signal point in detail](#).....428
- [How to use a fixed reference marker](#).....428
- [How to export a peak list](#).....429
- [How to output the demodulated signal accoustically](#).....430

#### 5.4.5.1 How to analyze a signal point in detail



Step-by-step instructions on working with markers are provided here. For details on individual functions and settings see [Chapter 5.4, "Marker usage"](#), on page 391.

The remote commands required to perform these tasks are described in [Chapter 6.9.3, "Marker configuration"](#), on page 713.

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing [Peak Search].
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
  - a) Press [Mkr ->].
  - b) Select "Next Peak" or "Next Min".
  - c) If necessary, change the search settings by selecting "Search Config".
3. Center the display around the determined signal point by setting the marker value to the center frequency. Select "Center = Mkr Freq".
4. Determine the precise frequency of the signal point:
  - a) Select "Select Marker Function".
  - b) Select "Signal Count".
  - c) Select "Signal Count Resolution".
  - d) Select the resolution depending on how precise the result needs to be.

#### 5.4.5.2 How to use a fixed reference marker

By default, delta markers refer to marker 1. However, they can also refer to a fixed reference marker.

##### How to Define and Move a Fixed Reference Marker

1. To display a fixed reference marker, do one of the following:



- Press [MKR FUNC], then select the "Reference Fixed" marker function.
- In the "Marker" dialog box, in the "Reference Fixed" area of the "Marker Config" tab, set the "State" to "On".

A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.

2. To move the fixed reference marker, do one of the following:
  - Change the "Level" and "Frequency" of the reference point in the "Marker Config" tab of the "Marker" dialog box, . By default, the current peak value of trace 1 is set.
  - Set the fixed reference marker to the current peak value by selecting "Peak Search" in the "Marker Config" tab of the "Marker" dialog box.
  - Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

#### How to Assign a Fixed Reference Marker to Delta Markers

1. In the "Marker" dialog box, select the horizontal "Markers" tab.
2. For the active delta marker that is to refer to the fixed reference marker, select "FXD" from the "Reference Marker" list.

The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

#### 5.4.5.3 How to export a peak list

You can save the results of a marker peak list to an ASCII file.

1. Press [MKR FUNCT].
2. Select "Marker Peak List".
3. Configure the peak search and list settings as described in [Chapter 5.4.4.8, "Marker peak list"](#), on page 423.
4. Set the marker peak list "State" to "On".
5. Press [RUN SINGLE] to perform a single sweep measurement and create a marker peak list.
6. Select "Marker Peak List" to display the "Marker Peak List" dialog box again.
7. If necessary, change the decimal separator to be used for the ASCII export file.
8. Select "Export Peak List".
9. In the file selection dialog box, select the storage location and file name for the export file.

10. Select "Save" to close the dialog box and export the peak list data to the file.

#### 5.4.5.4 How to output the demodulated signal accoustically

For long sweep times you may wish to monitor a measurement accoustically rather than visually to determine when a certain signal level is reached.

1. Set marker 1 to the signal level you want to monitor.
2. Press [Mkr FUNCT].
3. Select "Select Marker Function".
4. Select "Marker Demodulation".
5. Select "Marker Demod Config".

The marker function results are determined immediately according to the default settings.

6. Define how long you want to hear the output signal when the marker value is reached by entering the duration in the "Marker Stop Time" field.  
Alternatively, the audio signal can be output continuously, regardless of the marker value; in this case, set "Continuous Demodulation" to "On".
7. Select the modulation type (AM/FM/PM) of the signal.
8. To avoid listening to noise during continuous output, set "Squelch" to "On" and define the signal level below which the signal is ignored ("Squelch").
9. Set "Marker Demodulation" to "On".
10. **CAUTION!** Risk of hearing damage. To protect your hearing, make sure that the volume setting is not too high before putting on the headphones.  
Plug your headphones into the headphone connector on the front panel of the R&S ESW.
11. Adjust the volume using the rotary knob next to the headphone connector.

During the next or currently running measurement, when the sweep reaches the marker position, the demodulated signal is output as an audio signal via the headphones for the given duration. Or, depending on the configuration, the demodulated signal is continuously output via the headphones, if the signal level exceeds the squelch level.

#### 5.4.6 Measurement example: measuring harmonics using marker functions

This measurement example describes how to measure harmonics using the provided marker functions. Note that this task can be performed much simpler using the Harmonic Distortion measurement (see [Chapter 3.9, "Harmonic distortion measurement"](#), on page 178).

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

|            |         |
|------------|---------|
| Frequency: | 128 MHz |
| Level:     | +15 dBm |

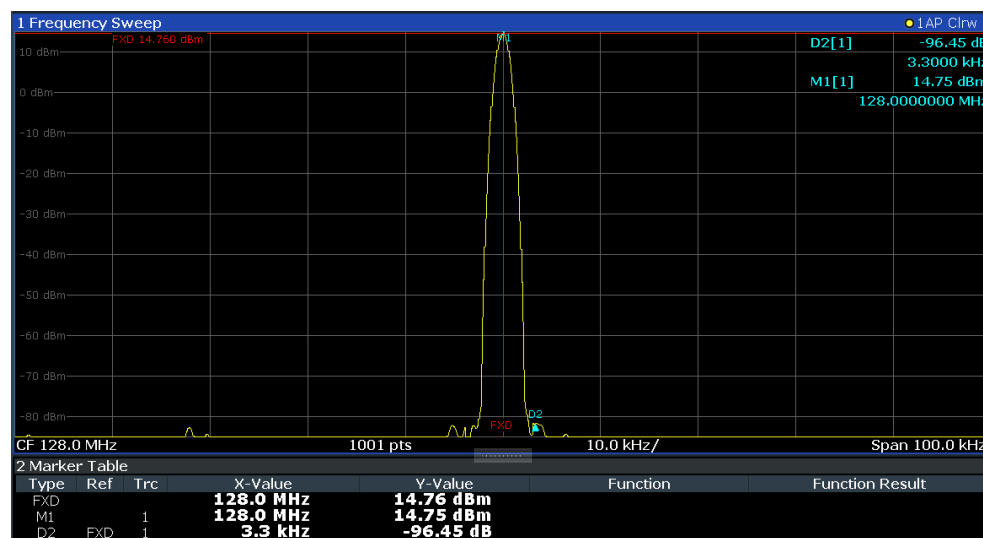
**Procedure:**

1. Preset the R&S ESW.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.
4. Select "Auto Level".

The R&S ESW displays the reference signal with a span of 100 kHz and resolution bandwidth of 1 kHz.

5. Switch on the marker by pressing [MKR].  
The marker is positioned on the trace maximum.
6. Set the measured signal frequency and the measured level as reference values:
  - a) Press [MKR FUNC]
  - b) Press "Reference Fixed".

The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.



**Figure 5-15: Fundamental wave and the frequency and level reference point**

7. Make the step size for the center frequency correspond to the signal frequency: in the "Frequency" configuration dialog box, select "Center Frequency Stepsize" = "Marker".

The step size for the center frequency is now equal to the marker frequency.

8. Move the center frequency to the 2<sup>nd</sup> harmonic of the signal by pressing [UP] (↑).  
The center frequency is set to the 2<sup>nd</sup> harmonic.
9. Select "Auto Level" to ensure the R&S ESW measures the harmonics with a high sensitivity.
10. Place the delta marker on the 2<sup>nd</sup> harmonic: in the "Marker To" menu, select "Peak".  
The delta marker moves to the maximum of the 2<sup>nd</sup> harmonic. The displayed level result is relative to the reference point level (= fundamental wave level).

The other harmonics are measured by repeating steps [step 8](#) to [step 10](#), with the center frequency being incremented or decremented in steps of 128 MHz using the [UP] or [DOWN] keys.

## 5.5 Display and limit lines

Display and limit lines help you analyze a measurement trace.

**Access:** "Overview" > "Analysis" > "Lines"

For remote operation, see [Chapter 6.9.4, "Lines"](#), on page 770 .

- [Display lines](#).....432
- [Limit lines](#).....434

### 5.5.1 Display lines

#### 5.5.1.1 Basics on display lines

Display lines help you analyze a trace – as do markers. The function of a display line is comparable to that of a ruler that can be shifted on the trace in order to mark absolute values. They are used exclusively to visually mark relevant frequencies or points in time (zero span), as well as constant level values. It is not possible to check automatically whether the points are below or above the marked level values - use limit lines for that task (see [Chapter 5.5.2.1, "Basics on limit lines"](#), on page 434).

Two different types of display lines are provided:

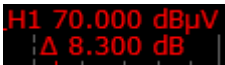
- Two horizontal lines: "Horizontal Line 1" and "Horizontal Line 2".  
These lines are continuous horizontal lines across the entire width of a diagram and can be shifted up and down.
- Four vertical lines: "Vertical Line 1" to "Vertical Line 4"  
These lines are continuous vertical lines across the entire height of the diagram and can be shifted left and right.

Lables

Each line is identified by one of the following abbreviations in the diagrams:

- H1: "Horizontal Line 1"
- H2: "Horizontal Line 2"
- V1: "Vertical Line 1"
- V2: "Vertical Line 2"
- V3: "Vertical Line 3"
- V4: "Vertical Line 4"
- Each label also shows the absolute position of the corresponding line, for example "H1 70.000 dBµV".

If you turn on both horizontal lines or both vertical lines, the label of the first line also shows the distance to the second line, for example "H1 70.000 dBµV, Δ 8.250 dB".



Note that this feature is not supported by all measurements.

5.5.1.2 Display line settings

Access: "Overview" > "Analysis" > "Lines" > "Display Lines"

Four vertical and two horizontal lines can be defined in the display.

| Line Config       |                          |         |
|-------------------|--------------------------|---------|
| Limit Lines       | Display Lines            |         |
| Vertical Line 1   | <input type="checkbox"/> | 0.0 s   |
| Vertical Line 2   | <input type="checkbox"/> | 0.0 s   |
| Vertical Line 3   | <input type="checkbox"/> | 0.0 s   |
| Vertical Line 4   | <input type="checkbox"/> | 0.0 s   |
| Horizontal Line 1 | <input type="checkbox"/> | 0.0 dBm |
| Horizontal Line 2 | <input type="checkbox"/> | 0.0 dBm |

|   |     |
|---|-----|
| Vertical Line <x>.....                    | 433 |
| Horizontal Line 1/ Horizontal Line 2..... | 434 |

Vertical Line <x>

Activates a vertical display line in the diagram at the specified point of the x-axis, depending on the scale of the axis.

If you activate both vertical lines, the label of the first vertical line shows the distance to second vertical line.

Note that the display of the delta value is not supported by all measurements.

Remote command:

[CALCulate<n>:FLINE<dl>](#) on page 771

[CALCulate<n>:TLINE<dl>](#) on page 772

### Horizontal Line 1/ Horizontal Line 2

Activates a horizontal display line (H1 or H2) in the diagram at the specified point of the y-axis.

If you activate both horizontal lines, the label of the first horizontal line shows the distance to second vertical line.

Note that the display of the delta value is not supported by all measurements.

Remote command:

[CALCulate<n>:DLINE<dl>](#) on page 770

[CALCulate<n>:DLINE<dl>](#) on page 770

#### 5.5.1.3 Defining display lines

1. Display lines are configured in the "Lines Config" dialog box. To display this dialog box, press [Lines] and then "Lines Config".
2. Select the "Display Lines" tab.
3. To define a vertical line:
  - a) Select "Vertical Line 1", 2, 3, or 4.
  - b) Enter the x-value at which the line is to be displayed.
4. To define a horizontal line:
  - a) Select "Horizontal Line 1" or 2.
  - b) Enter the y-value at which the line is to be displayed.

#### 5.5.2 Limit lines

Limit lines allow you to check automatically whether the measured points are below or above specified values.

- [Basics on limit lines](#).....434
- [Limit line settings and functions](#).....439
- [How to define limit lines](#).....446
- [Reference: limit line file format](#).....450

##### 5.5.2.1 Basics on limit lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper

limits for interference radiation or spurious waves which are allowed from a device under test (DUT). When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a time slot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The R&S ESW supports limit lines with a maximum of 200 data points. Eight of the limit lines stored in the instrument can be activated simultaneously. The number of limit lines stored in the <instrument> is only limited by the capacity of the storage device used.

Limit line data can also be exported to a file in ASCII (CSV) format for further evaluation in other applications. Limit lines stored in the specified ASCII (CSV) format can also be imported to the R&S ESW for other measurements.

### Compatibility

Limit lines are compatible with the current measurement settings, if the following applies:

- The x unit of the limit line has to be identical to the current setting.
- The y unit of the limit line has to be identical to the current setting with the exception of dB based units; all dB based units are compatible with each other.

### Validity

Only limit lines that fulfill the following conditions can be activated:

- Each limit line must consist of a minimum of 2 and a maximum of 200 data points.
- The frequencies/times for each data point must be defined in ascending order; however, for any single frequency or time, two data points may be entered (to define a vertical segment of a limit line).
- Gaps in frequency or time are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies or times need not necessarily be selectable in R&S ESW. A limit line may also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range representation, negative times may also be entered. The allowed range is -1000 s to +1000 s.



Figure 5-16: Example for an upper limit line

## Limits and Margins

Limit lines define strict values that must not be exceeded by the measured signal. A **margin** is similar to a limit, but less strict and it still belongs to the valid data range. It can be used as a warning that the limit is almost reached. The margin is not indicated by a separate line in the display, but if it is violated, a warning is displayed. Margins are defined as lines with a fixed distance to the limit line.

To check the signal for maximum levels you must define an **upper limit**, whereas to check the signal for minimum levels you must define a **lower limit**.

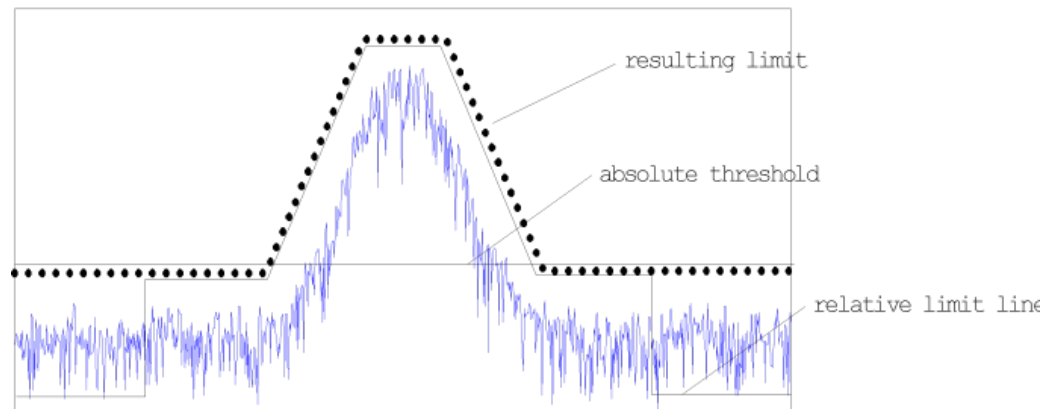
Limits can be defined relative to the reference level, the beginning of the time scale, or the center frequency, or as absolute values.

Relative scaling is suitable, for example, if masks for bursts are to be defined in zero span, or if masks for modulated signals are required in the frequency domain.

## Thresholds

If the y-axis for the limit line data points uses relative scaling, an additional absolute **threshold** can be defined for the limit check. In this case, both the threshold value and the relative limit line must be exceeded before a violation occurs.





### Offsets and Shifting

A configured limit line can easily be moved vertically or horizontally. Two different methods to do so are available:

- An **offset** moves the entire line in the diagram without editing the configured values or positions of the individual data points. This option is only available if relative scaling is used.  
Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally or vertically.
- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

### Limit Check Results

A limit check is automatically performed as soon as any of the limit lines is activated ("Visibility" setting). Only the specified "Traces to be Checked" are compared with the active limit lines. The status of the limit check for each limit line is indicated in the diagram. If a violation occurs, the limit check status is set to "MARG" for a margin violation, or to "Fail" for a limit violation.

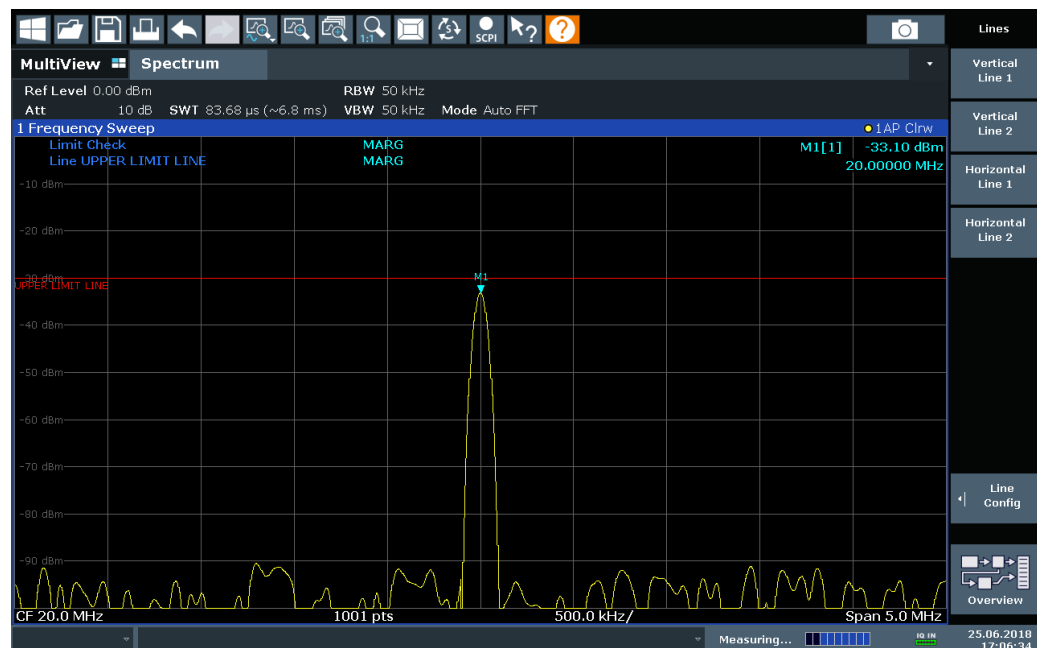


Figure 5-17: Margin violation for limit check

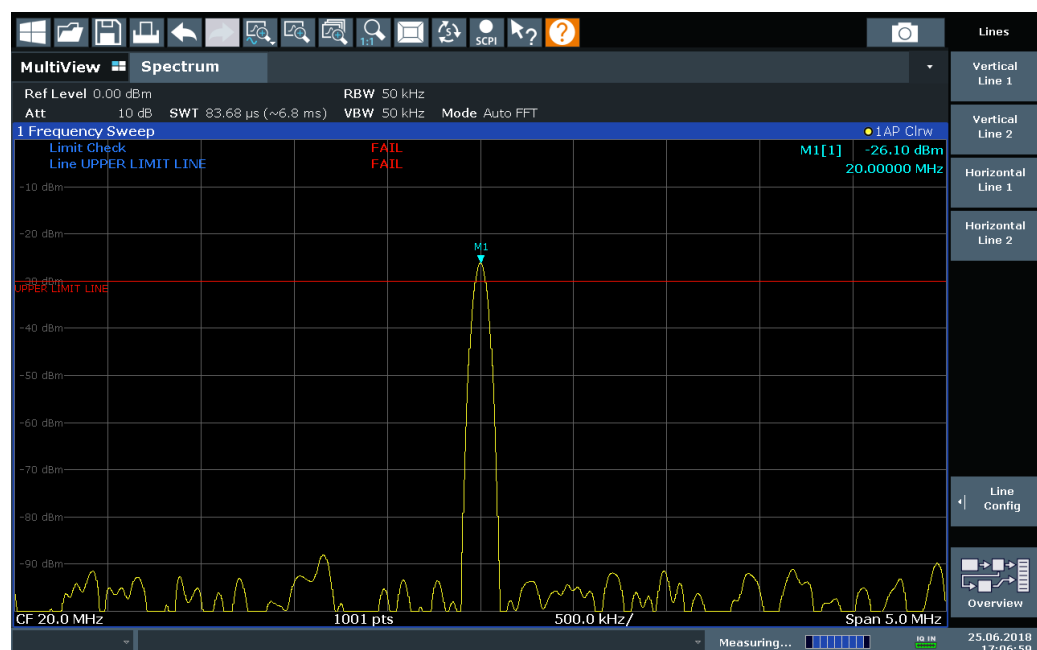


Figure 5-18: Limit violation for limit check



### Storing and Recalling Limit Lines

Limit lines can be stored with the configuration settings so they can be recalled for other measurements at a later time. Note, however, that any changes made to the limit lines *after* storing the configuration file cannot be restored and will be overwritten by the stored values when the configuration file is recalled. Always remember to store the settings again after changing the limit line values.

After recalling measurement settings, the limit line values applied to the measurement may be different to those displayed in the "Limit Lines" dialog box.

For more information see the R&S ESW User Manual, chapter "Data Management".

#### 5.5.2.2 Limit line settings and functions

**Access:** "Overview" > "Analysis" > "Lines"

Up to 8 limit lines can be displayed simultaneously in the R&S ESW. Many more can be stored on the instrument.



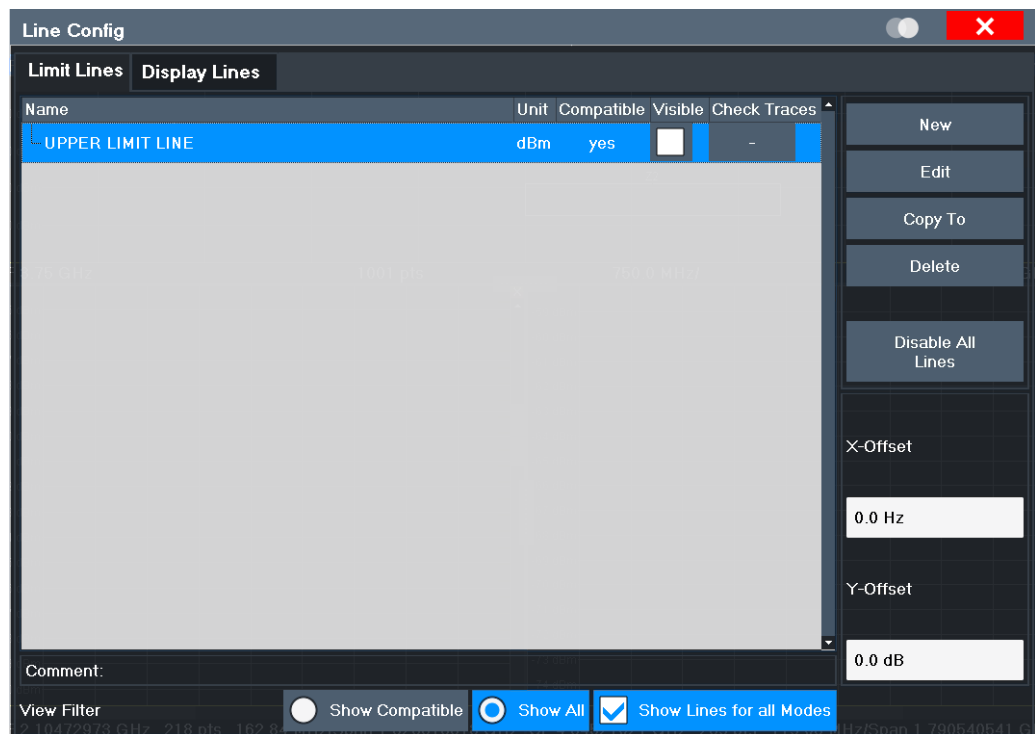
### Stored limit line settings

When storing and recalling limit line settings, consider the information provided in the Data Management chapter of the R&S ESW User Manual.

- [Limit line management](#).....439
- [Limit line details](#).....442

### Limit line management

**Access:** "Overview" > "Analysis" > "Lines" > "Limit Lines"



For the limit line overview, the R&S ESW searches for all stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder. The overview allows you to determine which limit lines are available and can be used for the current measurement.

For details on settings for individual lines see ["Limit line details"](#) on page 442.

For more basic information on limit lines see [Chapter 5.5.2.1, "Basics on limit lines"](#), on page 434.

|   |     |
|---|-----|
| Name.....                                     | 440 |
| Unit.....                                     | 441 |
| Compatibility.....                            | 441 |
| Visibility.....                               | 441 |
| Traces to be Checked.....                     | 441 |
| Comment.....                                  | 441 |
| Included Lines in Overview (View Filter)..... | 441 |
| L Show Lines for all Modes.....               | 441 |
| X-Offset.....                                 | 441 |
| Y-Offset.....                                 | 442 |
| Limit Check.....                              | 442 |
| Create New Line.....                          | 442 |
| Edit Line.....                                | 442 |
| Copy Line.....                                | 442 |
| Delete Line.....                              | 442 |
| Disable All Lines.....                        | 442 |

### Name

The name of the stored limit line.

**Unit**

The unit in which the y-values of the data points of the limit line are defined.

**Compatibility**

Indicates whether the limit line definition is compatible with the current measurement settings.

For more information on which conditions a limit line must fulfill to be compatible, see ["Compatibility"](#) on page 435.

**Visibility**

Displays or hides the limit line in the diagram. Up to 8 limit lines can be visible at the same time. Inactive limit lines can also be displayed in the diagram.

Remote command:

`CALCulate<n>:LIMit<li>:LOWer:STATe` on page 780

`CALCulate<n>:LIMit<li>:UPPer:STATe` on page 785

`CALCulate<n>:LIMit<li>:ACTive?` on page 773

**Traces to be Checked**

Defines which traces are automatically checked for conformance with the limit lines. As soon as a trace to be checked is defined, the assigned limit line is active. One limit line can be activated for several traces simultaneously. If any of the "Traces to be Checked" violate any of the active limit lines, a message is indicated in the diagram.

Remote command:

`CALCulate<n>:LIMit<li>:TRACe<t>:CHECK` on page 782

**Comment**

An optional description of the limit line.

**Included Lines in Overview (View Filter)**

Defines which of the stored lines are included in the overview.

|                   |  |
|-------------------|--|
| "Show Compatible" | Only compatible lines<br>Whether a line is compatible or not is indicated in the <a href="#">Compatibility</a> setting.  |
| "Show All"        | All stored limit lines with the file extension <code>.LIN</code> in the <code>limits</code> subfolder of the main installation folder.<br>(if not restricted by "Show Lines for all Modes" setting). |

**Show Lines for all Modes ← Included Lines in Overview (View Filter)**

If activated (default), limit lines from all applications are displayed. Otherwise, only lines that were created in the Spectrum application are displayed.

Note that limit lines from some applications may include additional properties that are lost when the limit lines are edited in the Spectrum application. In this case a warning is displayed when you try to store the limit line.

**X-Offset**

Shifts a limit line that has been specified for relative frequencies or times (x-axis) horizontally.

This setting does not have any effect on limit lines that are defined by absolute values for the x-axis.

Remote command:

[CALCulate<n>:LIMit<li>:CONTRol:OFFSet](#) on page 775

### Y-Offset

Shifts a limit line that has relative values for the y-axis (levels or linear units such as volt) vertically.

This setting does not have any effect on limit lines that are defined by absolute values for the y-axis.

Remote command:

[CALCulate<n>:LIMit<li>:LOWer:OFFSet](#) on page 779

[CALCulate<n>:LIMit<li>:UPPer:OFFSet](#) on page 784

### Limit Check

Turns limit checks for pre-measurement on and off.

Remote command:

[CALCulate<n>:LIMit<li>:CHECK](#) on page 786

### Create New Line

Creates a new limit line.

### Edit Line

Edit an existing limit line configuration.

### Copy Line

Copy the selected limit line configuration to create a new line.

Remote command:

[CALCulate<n>:LIMit<li>:COPY](#) on page 776

### Delete Line

Delete the selected limit line configuration.

Remote command:

[CALCulate<n>:LIMit<li>:DELeTe](#) on page 777

### Disable All Lines

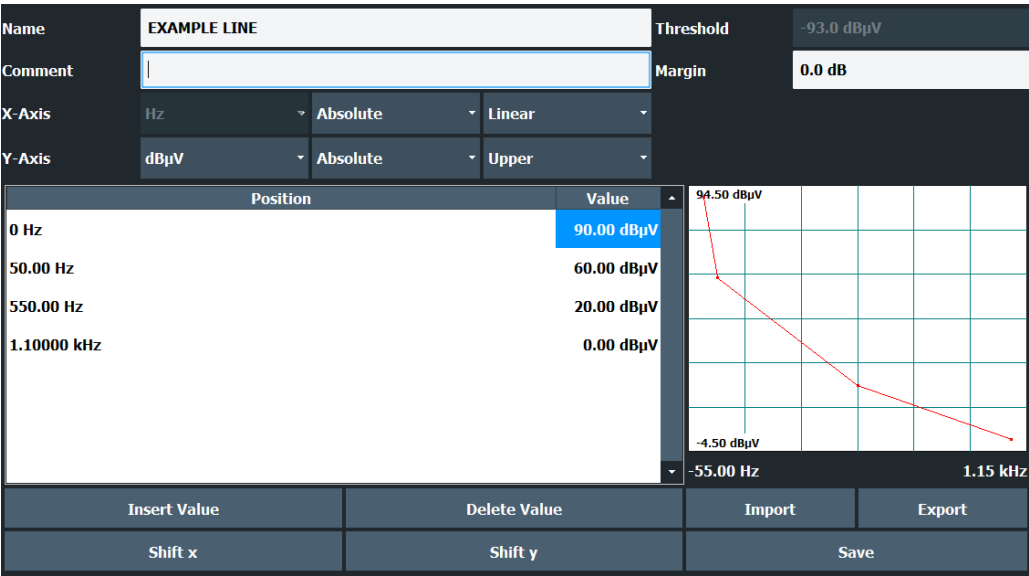
Disable all limit lines in one step.

Remote command:

[CALCulate<n>:LIMit<li>:STATe](#) on page 781

### Limit line details

**Access:** "Overview" > "Analysis" > "Lines" > "Limit Lines" > "New" / "Edit" / "Copy To"



|                      |     |
|----------------------|-----|
| Name.....            | 443 |
| Comment.....         | 443 |
| Threshold.....       | 443 |
| Margin.....          | 444 |
| X-Axis.....          | 444 |
| Y-Axis.....          | 444 |
| Data Points.....     | 444 |
| Insert Value.....    | 445 |
| Delete Value.....    | 445 |
| Shift x.....         | 445 |
| Shift y.....         | 445 |
| Save.....            | 445 |
| Import.....          | 445 |
| L File Explorer..... | 445 |
| Export.....          | 446 |
| L File Explorer..... | 446 |

**Name**  
 Defines the limit line name. All names must be compatible with Windows conventions for file names. The limit line data is stored under this name (with a .LIN extension).

Remote command:  
[CALCulate<n>:LIMit<li>:NAME](#) on page 780

**Comment**  
 Defines an optional comment for the limit line.

Remote command:  
[CALCulate<n>:LIMit<li>:COMMeNt](#) on page 774

**Threshold**  
 Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see ["Thresholds"](#) on page 436.

Remote command:

`CALCulate<n>:LIMit<li>:LOWer:THReshold` on page 780

`CALCulate<n>:LIMit<li>:UPPer:THReshold` on page 785

### Margin

Defines a margin for the limit line. The default setting is 0 dB (i.e. no margin).

For details on margins see "[Limits and Margins](#)" on page 436.

Remote command:

`CALCulate<n>:LIMit<li>:LOWer:MARGIn` on page 778

`CALCulate<n>:LIMit<li>:UPPer:MARGIn` on page 783

### X-Axis

Describes the horizontal axis on which the data points of the limit line are defined.

Includes the following settings:

- Unit:
  - "Hz": for frequency domain
  - "s": for time domain
- Scaling mode: absolute or relative values  
For relative values, the frequencies are referred to the currently set center frequency. In the time domain, the left boundary of the diagram is used as the reference.
- Scaling: linear or logarithmic

Remote command:

`CALCulate<n>:LIMit<li>:CONTrol:MODE` on page 775

`CALCulate<n>:LIMit<li>:CONTrol:DOMain` on page 774

`CALCulate<n>:LIMit<li>:CONTrol:SPACing` on page 776

### Y-Axis

Describes the vertical axis on which the data points of the limit line are defined.

Includes the following settings:

- Level unit
- Scaling mode: absolute or relative (dB/%) values  
Relative limit values refer to the reference level.
- Limit type: upper or lower limit; values must stay above the lower limit and below the upper limit to pass the limit check

Remote command:

`CALCulate<n>:LIMit<li>:UNIT` on page 782

`CALCulate<n>:LIMit<li>:LOWer:MODE` on page 778

`CALCulate<n>:LIMit<li>:UPPer:MODE` on page 783

`CALCulate<n>:LIMit<li>:LOWer:SPACing` on page 779

`CALCulate<n>:LIMit<li>:UPPer:SPACing` on page 784

### Data Points

Each limit line is defined by a minimum of 2 and a maximum of 200 data points. Each data point is defined by its position (x-axis) and value (y-value). Data points must be defined in ascending order. The same position can have two different values.



Remote command:

`CALCulate<n>:LIMit<li>:CONTRol[:DATA]` on page 774

`CALCulate<n>:LIMit<li>:LOWer[:DATA]` on page 777

`CALCulate<n>:LIMit<li>:UPPer[:DATA]` on page 783

### Insert Value

Inserts a data point in the limit line above the selected one in the "Edit Limit Line" dialog box.

### Delete Value

Deletes the selected data point in the "Edit Limit Line" dialog box.

### Shift x

Shifts the x-value of each data point horizontally by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "[X-Offset](#)" on page 441).

Remote command:

`CALCulate<n>:LIMit<li>:CONTRol:SHIFt` on page 776

### Shift y

Shifts the y-value of each data point vertically by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "[Y-Offset](#)" on page 442).

Remote command:

`CALCulate<n>:LIMit<li>:LOWer:SHIFt` on page 779

`CALCulate<n>:LIMit<li>:UPPer:SHIFt` on page 784

### Save

Saves the currently edited limit line under the name defined in the "Name" field.

### Import

Opens a file selection dialog box and loads the limit line from the selected file in .CSV format.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

Note that a valid import file must contain a minimum of required information for the R&S ESW.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 450.

Remote command:

`MMEMory:LOAD<n>:LIMit` on page 786

### File Explorer ← Import

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

**Export**

Opens a file selection dialog box and stores the currently displayed limit line to the defined file in .CSV format.

"File Explorer": Instead of using the file manager of the R&S ESW firmware, you can also use the Microsoft Windows File Explorer to manage files.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 450.

The limit line can be imported again later by the R&S ESW for use in other measurements.

Remote command:

`MMEMory:STORe<n>:LIMit` on page 786

**File Explorer ← Export**

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

**5.5.2.3 How to define limit lines**

**Access:** "Overview" > "Analysis" > "Lines" > "Limit Lines"

**Limit lines for spurious and SEM measurements**

Note that for spurious and SEM measurements, special limit lines can be defined for each frequency range, see [Chapter 3.5.4.2, "Limit lines in SEM measurements"](#), on page 107 and [Chapter 3.6.3.2, "Limit lines in spurious measurements"](#), on page 148. It is strongly recommended that you define limits only via the Sweep List dialog for these measurements, not using [Lines].

Any changes to the special limit lines are automatically overwritten when the sweep list settings are changed.

The following tasks are described here:

- ["How to find compatible limit lines"](#) on page 446
- ["How to activate and deactivate a limit check"](#) on page 447
- ["How to edit existing limit lines"](#) on page 447
- ["How to copy an existing limit line"](#) on page 447
- ["How to delete an existing limit line"](#) on page 447
- ["How to configure a new limit line"](#) on page 448
- ["How to move the limit line vertically or horizontally"](#) on page 449

**How to find compatible limit lines**

- ▶ In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".

All stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder of the instrument that are compatible to the current measurement settings are displayed in the overview.

### How to activate and deactivate a limit check

A limit check is automatically performed as soon as any of the limit lines is activated.

1. To activate a limit check:  
Select the "Check Traces" setting for a limit line in the overview and select the trace numbers to be included in the limit check. One limit line can be assigned to several traces.  
  
The specified traces to be checked are compared with the active limit lines. The status of the limit check is indicated in the diagram.
2. To deactivate a limit line, deactivate all "Traces to be Checked" for it.  
To deactivate all limit lines at once, select "Disable All Lines".  
  
The limit checks for the deactivated limit lines are stopped and the results are removed from the display.

### How to edit existing limit lines

Existing limit line configurations can be edited.

1. In the "Line Config" dialog box, select the limit line.
2. Select "Edit".
3. Edit the line configuration as described in ["How to configure a new limit line"](#) on page 448.
4. Save the new configuration by selecting "Save".  
  
If the limit line is active, the edited limit line is displayed in the diagram.

### How to copy an existing limit line

1. In the dialog box, select the limit line.
2. Select "Line Config" "Copy To".
3. Define a new name to create a new limit with the same configuration as the source line.
4. Edit the line configuration as described in ["How to configure a new limit line"](#) on page 448.
5. Save the new configuration by selecting "Save".  
  
The new limit line is displayed in the overview and can be activated.

### How to delete an existing limit line

1. In the "Line Config" dialog box, select the limit line.

2. Select "Delete".
3. Confirm the message.

The limit line and the results of the limit check are deleted.

### How to configure a new limit line

1. In the "Line Config" dialog box, select "New".  
The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.
3. Define the x-axis configuration:
  - Time domain or frequency domain
  - Absolute or relative limits
  - Linear or logarithmic scaling
4. Define the y-axis configuration:
  - Level unit
  - Absolute or relative limits
  - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:
  - a) Select "Insert Value".
  - b) Define the x-value ("Position") and y-value ("Value") of the first data point.
  - c) Select "Insert Value" again and define the second data point.
  - d) Repeat this to insert all other data points.  
To insert a data point before an existing one, select the data point and then "Insert Value".  
To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".  
To delete a data point, select the entry and then "Delete Value".
6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.  
If necessary, shift the entire line vertically or horizontally by selecting "Shift x" or "Shift y" and defining the shift width.
7. Optionally, define a "Margin" at a fixed distance to the limit line.  
The margin must be within the valid value range and is not displayed in the diagram or preview area.
8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.
9. Save the new configuration by selecting "Save".  
The new limit line is displayed in the overview and can be activated.

### How to move the limit line vertically or horizontally

A configured limit line can easily be moved vertically or horizontally. Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally.

1. In the "Line Config" dialog box, select the limit line.
2. To shift the complete limit line parallel in the horizontal direction, select "X-Offset" and enter an offset value.  
To shift the complete limit line parallel in the vertical direction, select "Y-Offset" and enter an offset value.
3. To shift the individual data points of a limit line by a fixed value (all at once):
  - a) Select "Edit".
  - b) In the "Edit Limit Line" dialog box, select "Shift x" or "Shift y" and define the shift width.
  - c) Save the shifted data points by selecting "Save".

If activated, the limit line is shifted in the diagram.

### How to export a limit line

Limit line configurations can be stored to an ASCII file for evaluation in other programs or to be imported later for other measurements.

1. In the "Line Config" dialog box, select the limit line.
2. Select "New" or "Edit".
3. Define the limit line as described in ["How to configure a new limit line"](#) on page 448.
4. Select "Export" to save the configuration to a file.  
You are asked whether you would like to save the configuration internally on the R&S ESW first.
5. Select a file name and location for the limit line.
6. Select the decimal separator to be used in the file.
7. Select "Save".

The limit line is stored to a file with the specified name and the extension .CSV.  
For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 450.

### How to import a limit line

Limit line configurations that are stored in an ASCII file and contain a minimum of required data can be imported to the R&S ESW.

For details on the required file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 450.

1. In the "Line Config" dialog box, select the limit line.

2. Select "New" or "Edit".
3. Select "Import" to load a limit line from a file.  
You are asked whether you would like to save the current configuration on the R&S ESW first.
4. Select the file name of the limit line.
5. Select the decimal separator that was used in the file.
6. Select "Select".  
The limit line is loaded from the specified file and displayed in the "Edit Limit Line" dialog box.
7. Activate the limit line as described in ["How to activate and deactivate a limit check"](#) on page 447.

#### 5.5.2.4 Reference: limit line file format

Limit line data can be exported to a file in ASCII (CSV) format for further evaluation in other applications. Limit lines stored in the specified ASCII (CSV) format can also be imported to the R&S ESW for other measurements (see ["How to import a limit line"](#) on page 449). This reference describes in detail the format of the export/import files for limit lines. Note that the **bold** data is **mandatory**, all other data is optional.

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 (see ["Decimal Separator"](#) on page 372).

**Table 5-7: ASCII file format for limit line files**

| File contents                        | Description  |
|--------------------------------------|--|
| <b>Header data</b>                   |  |
| <b>sep=</b> ;                        | Separator for individual values (required by Microsoft Excel, for example) |
| <b>Type</b> ;RS_LimitLineDefinition; | Type of data   |
| <b>FileFormatVersion</b> ;1.00;      | File format version  |
| Date;01.Oct 2006;                    | Date of data set storage   |
| OptionID;SpectrumAnalyzer            | Application the limit line was created for                                 |
| <b>Name</b> ;RELFREQ1                | Limit line name  |
| Comment;Defines the upper limit line | Description of limit line  |
| Mode;UPPER                           | Type of limit line (upper, lower)  |
| ThresholdUnit;LEVEL_DBM              | Unit of threshold value  |
| ThresholdValue;-200                  | Threshold value  |
| MarginValue;0                        | Margin value   |
| XAxisScaling;LINEAR                  | Scaling of x-axis linear (LIN) or logarithmic (LOG)                        |

| File contents                                  | Description   |
|--|---|
| XAxisUnit;FREQ_HZ                              | Unit of x values  |
| XAxisScaleMode;ABSOLUTE                        | Scaling of x-axis (absolute or relative)                    |
| YAxisUnit;LEVEL_DB                             | Unit of y values  |
| YAxisScaleMode;ABSOLUTE                        | Scaling of y-axis (absolute or relative)                    |
| NoOfPoints;5                                   | Number of points the line is defined by                     |
| <b>Data section for individual data points</b> |   |
| -4500000000;-50                                | <b>x- and y-values of each data point defining the line</b> |
| -2000000000;-30                                |   |
| -1000000000;0                                  |   |
| 0;-30  |   |
| 2500000000;-50                                 |   |

## 6 Remote commands in the spectrum application

|   |     |
|---|-----|
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| • <a href="#">Application selection</a> .....     | 457 |
| • <a href="#">General window commands</a> .....   | 460 |
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### 6.1 Introduction

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

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

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

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



#### Remote command examples

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

#### 6.1.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**

If not specified otherwise, commands can be used both for setting and for querying parameters.



If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.

- **Parameter usage**

If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.

Parameters required only for setting are indicated as **Setting parameters**.

Parameters required only to refine a query are indicated as **Query parameters**.

Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**

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

- **Asynchronous commands**

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

- **Reset values (\*RST)**

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

- **Default unit**

The default unit is used for numeric values if no other unit is provided with the parameter.

- **Manual operation**

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

### 6.1.2 Long and short form

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

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

**Example:**

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

### 6.1.3 Numeric suffixes

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

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

If you do not quote a suffix for keywords that support one, a 1 is assumed.

**Example:**

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

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

**6.1.4 Optional keywords**

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



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

Optional keywords are emphasized with square brackets.

**Example:**

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

**6.1.5 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`.

**6.1.6 SCPI parameters**

Many commands feature one or more parameters.

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

**Example:**

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

Parameters can have different forms of values.

|   |     |
|---|-----|
| • <a href="#">Numeric values</a> .....    | 455 |
| • <a href="#">Boolean</a> .....           | 456 |
| • <a href="#">Character data</a> .....    | 456 |
| • <a href="#">Character strings</a> ..... | 456 |
| • <a href="#">Block data</a> .....        | 456 |

### 6.1.6.1 Numeric values

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

#### Example:

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

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

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

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

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

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

#### Querying numeric values

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

#### Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

Sometimes, numeric values are returned as text.

- **INF/NINF**  
Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- **NAN**

Not a number. Represents the numeric value 9.91E37. NAN is returned if errors occur.

#### 6.1.6.2 Boolean

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

##### Querying Boolean parameters

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

##### Example:

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

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

#### 6.1.6.3 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 6.1.2, "Long and short form"](#), on page 453.

##### 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

#### 6.1.6.4 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'`

#### 6.1.6.5 Block data

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

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. The data bytes follow. During the transmission of these data bytes, all end or other control signs are ignored until

all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

## 6.2 Common suffixes

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

**Table 6-1: Common suffixes used in remote commands in the Spectrum application**

| Suffix | Value range                               | Description   |
|--------|---|---|
| <m>    | 1..16                                     | Marker  |
| <n>    | 1..16                                     | Window (in the currently selected channel)                  |
| <t>    | 1..6                                      | Trace   |
| <li>   | 1 to 8                                    | Limit line  |
| <i>    | 1..3                                      | Selects one of the analog output channels (1, 2 or Phones). |
| <k>    | 1..8 (Limit line)<br>1   2 (Display line) | Selects a limit or display line.                            |
| <peak> | 1..3000                                   | Selects a peak.   |
| <sr>   | 1..10                                     | Selects a scan range.                                       |



### Selecting windows in multiple channels

Note that the suffix <n> always refers to a window in the currently selected channel.

## 6.3 Application selection

|   |     |
|---|-----|
| <a href="#">INSTrument:CREate:DUPLicate</a> ..... | 457 |
| <a href="#">INSTrument:CREate[:NEW]</a> .....     | 458 |
| <a href="#">INSTrument:CREate:REPLace</a> .....   | 458 |
| <a href="#">INSTrument:DELeTe</a> .....           | 459 |
| <a href="#">INSTrument:LIST?</a> .....            | 459 |
| <a href="#">INSTrument:REName</a> .....           | 459 |
| <a href="#">INSTrument[:SELeCt]</a> .....         | 460 |

### **INSTrument:CREate:DUPLicate**

Duplicates the currently selected channel, i.e creates a new channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer 2").

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

**Example:** `INST:SEL 'Receiver'`  
`INST:CRE:DUPL`  
 Duplicates the channel named 'Receiver' and creates a new channel named 'Receiver 2'.

**Usage:** Event

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

Adds a measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

##### **Parameters:**

<ChannelType> Channel type of the new channel.  
 For a list of available channel types, see [INSTrument:LIST?](#) on page 459.

<ChannelName> String containing the name of the channel.  
 Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

**Example:** `INST:CRE SAN, 'Spectrum 2'`  
 Adds a spectrum display named "Spectrum 2".

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

Replaces a channel with another one.

##### **Setting parameters:**

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

<ChannelType> Channel type of the new channel.  
 For a list of available channel types, see [INSTrument:LIST?](#) on page 459.

<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 459).  
 Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "\*", "?".

**Example:** `INST:CRE:REPL 'Receiver', REC, 'REC2'`  
 Replaces the channel named "Receiver" by a new channel of type "Receiver" named "REC2".

**Usage:** Setting only

**INSTrument:DELeTe** <ChannelName>

Deletes a channel.

If you delete the last channel, the default "Receiver" channel is activated.

**Setting parameters:**

<ChannelName> String containing the name of the channel you want to delete.  
A channel must exist to delete it.

**Example:** `INST:DEL 'Receiver'`  
Deletes the channel with the name 'Receiver'.

**Usage:** Setting only

**INSTrument:LIST?**

Queries all active channels. The query is useful to obtain the names of the existing channels, which are required to replace or delete the channels.

**Return values:**

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

**Example:** `INST:LIST?`  
Result for 2 channels:  
'REC', 'Receiver', 'REC', 'Receiver 2'

**Usage:** Query only

**Table 6-2: Available channel types and default channel names**

| Application                | <ChannelType> Parameter | Default Channel Name*) |
|----------------------------|-------------------------|------------------------|
| Receiver                   | RECeiver                | Receiver               |
| CISPR APD                  | n/a                     | CISPR APD              |
| Real-Time Spectrogram      | RTSG                    | Real-Time Spectrogram  |
| Multi CISPR APD            | MAPD                    | Multi CISPR APD        |
| Spectrum                   | SANalyzer               | Spectrum               |
| I/Q Analyzer               | IQ                      | IQ Analyzer            |
| Real-Time Spectrum         | RTIM                    | Real-Time Spectrum     |
| Analog Modulation Analysis | ADEMod                  | Analog Demod           |

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

**INSTrument:REName** <ChannelName1>, <ChannelName2>

Renames a channel.

**Setting parameters:**

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

<ChannelName2> String containing the new channel name.  
 Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.  
 Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "\*", "?".

**Example:**

```
INST:REN 'Receiver', 'REC'
```

Renames the channel with the name 'Receiver' to 'REC'.

**Usage:**

Setting only

**INSTrument[:SElect] <ChannelType> | <ChannelName>**

Activates a new channel with the defined channel type, or selects an existing channel with the specified name.

Also see

- [INSTrument:CREate\[:NEW\]](#) on page 458

**Parameters:**

<ChannelType> Channel type of the new channel.  
 For a list of available channel types see [INSTrument:LIST?](#) on page 459.

<ChannelName> String containing the name of the channel.

**Example:**

```
INST IQ
```

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

```
INST 'MyIQSpectrum'
```

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

## 6.4 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 460).

|   |     |
|---|-----|
| <a href="#">DISPlay:FORMat</a> .....  | 461 |
| <a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:SElect</a> ..... | 461 |
| <a href="#">DISPlay[:WINDow&lt;n&gt;]:SIZE</a> .....                        | 461 |
| <a href="#">DISPlay:WSElect?</a> .....                                      | 462 |



**DISPlay:FORMat** <Format>

Determines which tab is displayed.

**Parameters:**

&lt;Format&gt;

**SPLit**

Displays the MultiView tab with an overview of all active channels

(See [Chapter 2.3, "R&S multiview"](#), on page 17).

**SINGLE**

Displays the measurement channel that was previously focused.

\*RST: SING

**Example:**

DISP:FORM SPL

**DISPlay[:WINDow<n>][:SUBWindow<w>]:SElect**

Sets the focus on the selected result display window.

This window is then the active window.

For measurements with multiple results in subwindows, the command also selects the subwindow. Use this command to select the (sub)window before querying trace data.

**Suffix:**

&lt;n&gt;

Window

&lt;w&gt;

subwindow

Not supported by all applications

**Example:**

//Put the focus on window 1

DISP:WIND1:SEL

**Example:**

//Put the focus on subwindow 2 in window 1

DISP:WIND1:SUBW2:SEL

**DISPlay[:WINDow<n>]:SIZE** <Size>

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 466).

**Suffix:**

&lt;n&gt;

Window

**Parameters:**

&lt;Size&gt;

**LARGE**

Maximizes the selected window to full screen.

Other windows are still active in the background.

**SMALL**

Reduces the size of the selected window to its original size.

If more than one measurement window was displayed originally, these are visible again.

\*RST: SMAL

**Example:** DISP:WIND2:SIZE LARG

---

### DISPlay:WSElect?

Queries the currently active window (the one that is focused) *in the currently selected measurement channel*.

#### Return values:

<SelectedWindow> Index number of the currently active window.

Range: 1 to 16

**Usage:** Query only

## 6.5 Screen layout

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 460).

|                            |     |
|----------------------------|-----|
| LAYout:ADD[:WINDow]?       | 462 |
| LAYout:CATalog[:WINDow]?   | 464 |
| LAYout:IDENtify[:WINDow]?  | 464 |
| LAYout:MOVE[:WINDow]       | 464 |
| LAYout:REMove[:WINDow]     | 465 |
| LAYout:REPLace[:WINDow]    | 465 |
| LAYout:SPLitter            | 466 |
| LAYout:WINDow<n>:ADD?      | 467 |
| LAYout:WINDow<n>:IDENtify? | 467 |
| LAYout:WINDow<n>:REMove    | 468 |
| LAYout:WINDow<n>:REPLace   | 468 |

---

### LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active channel.

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.

**Query parameters:**

|              |  |
|--------------|--|
| <WindowName> | String containing the name of the existing window the new window is inserted next to.<br>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 <a href="#">LAYout:CATalog[:WINDow]?</a> query. |
| <Direction>  | LEFT   RIGHT   ABOVE   BELOW<br>Direction the new window is added relative to the existing window.   |
| <WindowType> | text value<br>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 ["Diagram"](#) on page 332  
 See ["Marker Table"](#) on page 332  
 See ["Marker Peak List"](#) on page 332  
 See ["Result Summary"](#) on page 333  
 See ["Spectrogram"](#) on page 333

**Table 6-3: <WindowType> parameter values for the spectrum application**

| Parameter value | Window type                 |
|-----------------|-----------------------------|
| DIAGram         | Diagram                     |
| FACCes          | "Fast Access" panel         |
| MTABle          | Marker table                |
| NOTes           | Notes display               |
| PEAKlist        | Marker peak list            |
| PRESelection    | "Preselector" configuration |
| RSUMmary        | "Result summary"            |
| SGRam           | "Spectrogram"               |

**LAYout:CATalog[:WINDow]?**

Queries the name and index of all active windows in the active 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>**

Queries the **index** of a particular display window in the active 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:IDEN:WIND? '2'  
Queries the index of the result display named '2'.  
Response:  
2

**Usage:**              Query only

**LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>****Setting parameters:**

**<WindowName>**      String containing the name of an existing window that is to be moved.  
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 channel, use the [LAYout:CATalog\[:WINDow\]?](#) query.

|                 |  |
|-----------------|--|
| <WindowName>    | String containing the name of an existing window the selected window is placed next to or replaces.<br>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 channel, use the <a href="#">LAYout:CATalog[:WINDow]?</a> query. |
| <Direction>     | LEFT   RIGHT   ABOVE   BELOW   REPLACE<br>Destination the selected window is moved to, relative to the reference window.   |
| <b>Example:</b> | <code>LAY:MOVE '4','1',LEFT</code><br>Moves the window named '4' to the left of window 1.  |
| <b>Example:</b> | <code>LAY:MOVE '1','3',REPL</code><br>Replaces the window named '3' by window 1. Window 3 is deleted.  |
| <b>Usage:</b>   | Setting only   |

---

#### **LAYout:REMove[:WINDow] <WindowName>**

Removes a window from the display in the active channel.

##### **Setting parameters:**

|                 |  |
|-----------------|--|
| <WindowName>    | String containing the name of the window. In the default state, the name of the window is its index. |
| <b>Example:</b> | <code>LAY:REM '2'</code><br>Removes the result display in the window named '2'.                      |
| <b>Usage:</b>   | Setting only   |

---

#### **LAYout:REPLace[:WINDow] <WindowName>,<WindowType>**

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel while keeping its position, index and window name.

To add a new window, use the [LAYout:ADD\[:WINDow\]?](#) command.

##### **Setting parameters:**

|                 |   |
|-----------------|---|
| <WindowName>    | String containing the name of the existing window.<br>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 channel, use the <a href="#">LAYout:CATalog[:WINDow]?</a> query. |
| <WindowType>    | Type of result display you want to use in the existing window.<br>See <a href="#">LAYout:ADD[:WINDow]?</a> on page 462 for a list of available window types.  |
| <b>Example:</b> | <code>LAY:REPL:WIND '1',MTAB</code><br>Replaces the result display in window 1 with a marker table.   |
| <b>Usage:</b>   | Setting only  |

**LAYout:SPLitter** <Index1>, <Index2>, <Position>

Changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

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 does not work, but does not return an error.

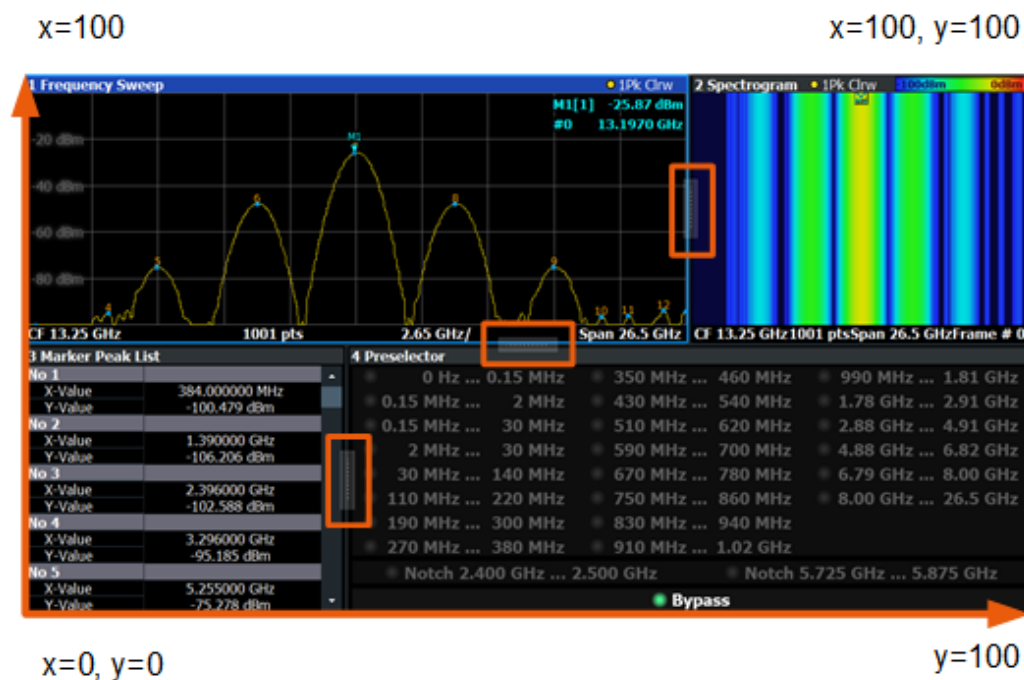


Figure 6-1: SmartGrid coordinates for remote control of the splitters

**Setting 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 6-1.)  
 The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.
- Range: 0 to 100

**Example:** `LAY:SPL 1,3,50`  
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

**Example:** `LAY:SPL 1,4,70`  
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.  
 The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

`LAY:SPL 3,2,70`  
`LAY:SPL 4,1,70`  
`LAY:SPL 2,1,70`

**Usage:** Setting only

### **LAYout:WINDow<n>:ADD? <Direction>,<WindowType>**

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. Unlike [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.

Is always used as a query so that you immediately obtain the name of the new window as a result.

**Suffix:**  
 <n> [Window](#)

#### **Query parameters:**

<Direction> LEFT | RIGHT | ABOVE | BELOW

<WindowType> Type of measurement window you want to add.  
 See [LAYout:ADD\[:WINDow\]?](#) on page 462 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?**

Queries the **name** of a particular display window (indicated by the <n> suffix) in the active 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**

Removes the window specified by the suffix <n> from the display in the active 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>**

Changes the window type of an existing window (specified by the suffix <n>) in the active channel.

The effect 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](#)

**Setting parameters:**

<WindowType> Type of measurement window you want to replace another one with.  
See `LAYout:ADD[:WINDow]?` on page 462 for a list of available window types.

**Example:**

`LAY:WIND2:REPL MTAB`

Replaces the result display in window 2 with a marker table.

**Usage:**

Setting only



## 6.6 Preset

|                                   |     |
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| *RST.....                         | 469 |
| SYSTem:PRESet.....                | 469 |
| SYSTem:PRESet:CHANnel[:EXEC]..... | 469 |

---

### \*RST

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

**Usage:**                      Setting only

---

### SYSTem:PRESet

This command presets the R&S ESW. It is identical to `*RST`.

**Example:**                      `SYST:PRES`

**Usage:**                      Event

---

### SYSTem:PRESet:CHANnel[:EXEC]

Restores the default <instrument> settings in the current channel.

Use `INST:SEL` to select the channel.

**Example:**                      `INST:SEL 'Spectrum2'`  
                                      Selects the channel for "Spectrum2".  
                                      `SYST:PRES:CHAN:EXEC`  
                                      Restores the factory default settings to the "Spectrum2" channel.

**Usage:**                      Event

**Manual operation:**      See "[Preset Channel](#)" on page 223

---

## 6.7 Measurement configuration

### 6.7.1 Measurement control

Commands to control measurements described elsewhere.

- `INITiate<n>:ESpectrum` on page 523
- `INITiate<n>:SPURious` on page 557

|                                   |     |
|-----------------------------------|-----|
| INITiate<mt>[:IMMediate].....     | 470 |
| INITiate<n>:CONMeas.....          | 470 |
| INITiate<n>:CONTinuous.....       | 471 |
| [SENSe:]SWEep:COUNT:CURRent?..... | 472 |

---

### INITiate<mt>[:IMMediate]

The command initiates a new sweep.

For a single sweep, the R&S ESW stops measuring when it has reached the end frequency. When you start a continuous measurement, it stops only if you abort it deliberately.

If you are using trace modes MAXHold, MINHold and AVERage, previous results are reset when you restart the measurement.

- **Single measurements**

Synchronization to the end of the measurement is possible with \*OPC, \*OPC? or \*WAI.

- **Continuous measurements**

Synchronization to the end of the measurement is not possible.

It is thus recommended to use a single measurement for remote controlled measurements, because results like trace data or markers are only valid after synchronization.

#### Suffix:

<mt>                      INITiate1 initiates a bargraph measurement.  
                               INITiate2 initiates a scan.

#### Example:

```
//Start a single scan (with a scan count = 20), and wait until the
measurement is done
INIT2:CONT OFF
SWE:COUN 20
INIT2;*WAI
```

#### Usage:

Event

#### Manual operation:

See ["Frequency Sweep"](#) on page 20  
 See ["Zero Span"](#) on page 20  
 See ["Single Sweep / Run Single"](#) on page 309  
 See ["Continuous Sweep / Run Cont"](#) on page 310

---

### INITiate<n>:CONMeas

Restarts a (single) measurement that has been stopped (using ABORT) or finished in single sweep mode.

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

#### Suffix:

<n>                      irrelevant

**Example:**

```
INIT:CONT OFF
Switches to single sweep mode.
DISP:WIND:TRAC:MODE AVER
Switches on trace averaging.
SWE:COUN 20
Setting the sweep counter to 20 sweeps.
INIT;*WAI
Starts the measurement and waits for the end of the 20 sweeps.
INIT:CONM;*WAI
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.
```

**Usage:** Asynchronous command

**Manual operation:** See ["Continue Single Sweep"](#) on page 310

---

#### INITiate<n>:CONTinuous <State>

Controls the sweep mode for an individual channel.

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

For details on synchronization see [Remote control via SCPI](#).

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

#### Suffix:

<n> 1 | 2  
 INITiate1 selects single or continuous bargraph measurements.  
 INITiate2 selects single or continuous scans.

#### Parameters:

<State> ON | OFF | 0 | 1  
**ON | 1**  
 Continuous sweep  
**OFF | 0**  
 Single sweep  
 \*RST: 1 (some applications can differ)

**Example:**

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

**Manual operation:** See ["Frequency Sweep"](#) on page 20  
 See ["Zero Span"](#) on page 20  
 See ["Single Sweep / Run Single"](#) on page 309  
 See ["Continuous Sweep / Run Cont"](#) on page 310

---

#### [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.

#### Return values:

<CurrentCount>

#### 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

## 6.7.2 Power measurements

The following commands work for several power measurements.

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:POWER&lt;sb&gt;:MODE</a>    | 472 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:POWER&lt;sb&gt;:RESult?</a> | 473 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:POWER&lt;sb&gt;:SElect</a>  | 474 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:POWER&lt;sb&gt;[:STATe]</a> | 475 |
| <a href="#">[SENSe:]POWER:ACHannel:PRESet</a>                                       | 475 |
| <a href="#">[SENSe:]POWER:ACHannel:PRESet:RLEVel</a>                                | 476 |
| <a href="#">[SENSe:]POWER:TRACe</a>   | 476 |

---

#### CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE <Mode>

Selects the trace display mode for power measurements.

#### Suffix:

|      |                        |
|------|------------------------|
| <n>  | <a href="#">Window</a> |
| <m>  | <a href="#">Marker</a> |
| <sb> | irrelevant             |

#### Parameters:

|        |   |
|--------|---|
| <Mode> | WRITE   MAXHold                                 |
|        | <b>WRITE</b>                                    |
|        | The power is calculated from the current trace. |

**MAXHold**

The power is calculated from the current trace and compared with the previous power value using a maximum algorithm.

**Manual operation:** See ["Power Mode"](#) on page 60

**CALCulate<n>:MARKer<m>:FUNCTION:Power<sb>:RESult? <Measurement>**

Queries the results of power measurements.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

|      |   |
|------|---|
| <n>  | irrelevant  |
| <m>  | irrelevant  |
| <sb> | Sub block in a Multi-standard radio measurement;<br>MSR ACLR: 1 to 5<br>Multi-SEM: 1 to 3<br>for all other measurements: irrelevant |

**Parameters:**

<Measurement>

**ACPower | MCACpower**

ACLR measurements (also known as adjacent channel power or multicarrier adjacent channel measurements).

Returns the power for every active transmission and adjacent channel. The order is:

- power of the transmission channels
- power of adjacent channel (lower, upper)
- power of alternate channels (lower, upper)

**MSR ACLR results:**

For MSR ACLR measurements, the order of the returned results is slightly different:

- power of the transmission channels
- total power of the transmission channels for each sub block
- power of adjacent channels (lower, upper)
- power of alternate channels (lower, upper)
- power of gap channels (lower1, upper1, lower2, upper2)

The unit of the return values depends on the scaling of the y-axis:

- logarithmic scaling returns the power in the current unit
- linear scaling returns the power in W

**GACLR**

For MSR ACLR measurements only: returns a list of ACLR values for each gap channel (lower1, upper1, lower2, upper2)

**MACM**

For MSR ACLR measurements only: returns a list of CACLR values for each gap channel (lower1, upper1, lower2, upper2)

**CN**

Carrier-to-noise measurements.

Returns the C/N ratio in dB.

**CNO**

Carrier-to-noise measurements.

Returns the C/N ratio referenced to a 1 Hz bandwidth in dBm/Hz.

**CPOWer**

Channel power measurements.

Returns the channel power. The unit of the return values depends on the scaling of the y-axis:

- logarithmic scaling returns the power in the current unit
- linear scaling returns the power in W

For SEM measurements, the return value is the channel power of the reference range (in the specified sub block).

**PPOWer**

Peak power measurements.

Returns the peak power. The unit of the return values depends on the scaling of the y-axis:

- logarithmic scaling returns the power in the current unit
- linear scaling returns the power in W

For SEM measurements, the return value is the peak power of the reference range (in the specified sub block).

Note that this result is only available if the power reference type is set to peak power (see [\[SENSe:\]ESpectrum<sb>:RTYPE](#) on page 540).

**OBANdwidth | OBWidth**

Occupied bandwidth.

Returns the occupied bandwidth in Hz.

**COBandwidth | COBWidth**

<Centroid frequency>, <Frequency offset>

See [Chapter 3.4.2, "OBW results"](#), on page 96

**Manual operation:** See ["C/N"](#) on page 93

See ["C/N0"](#) on page 93

---

**CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:SElect <MeasType>**

Selects a power measurement and turns the measurement on.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

<sb> irrelevant

**Parameters:**

<MeasType>

**ACPower | MCACpower**

Adjacent channel leakage ratio (ACLR), also known as adjacent channel power or multicarrier adjacent channel.

The R&S ESW performs the measurement on the trace selected with [\[SENSe:\]POWer:TRACe](#).

**CPOWer**

Channel power measurement with a single carrier.

The R&S ESW performs the measurement on the trace selected with [\[SENSe:\]POWer:TRACe](#).

**OBANdwidth | OBWidth**

Occupied bandwidth measurement.

The R&S ESW performs the measurement on the trace that marker 1 is positioned on.

**CN**

Carrier-to-noise ratio measurement.

**CNO**

Carrier-to-noise ratio measurement referenced to 1 Hz bandwidth

**Manual operation:** See ["C/N"](#) on page 93  
See ["C/N0"](#) on page 93

**CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>[:STATe] <State>**

Turns a power measurement off. To switch on the power measurement again, use [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:SElect](#) on page 474.

A standard frequency sweep is activated.

**Suffix:**

<n> irrelevant

<m> irrelevant

<sb> irrelevant

**Parameters:**

<State> OFF

**Manual operation:** See ["C/N"](#) on page 93  
See ["C/N0"](#) on page 93

**[SENSe:]POWer:ACHannel:PRESet <Measurement>**

Determines the ideal span, bandwidths and detector for the current power measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Parameters:**

|                          |   |
|--------------------------|---|
| <Measurement>            | <b>ACPower   MCACpower</b>  |
|                          | ACLR measurement  |
|                          | <b>CPOWer</b>   |
|                          | channel power measurement   |
|                          | <b>OBANdwidth   OBWidth</b>   |
|                          | Occupied bandwidth measurement  |
|                          | <b>CN</b>   |
|                          | Carrier to noise ratio  |
|                          | <b>CNO</b>  |
|                          | Carrier to noise ration referenced to a 1 Hz bandwidth                |
| <b>Manual operation:</b> | See <a href="#">"Optimized Settings (Adjust Settings)"</a> on page 60 |
|                          | See <a href="#">"Adjust Settings"</a> on page 93                      |
|                          | See <a href="#">"Adjust Settings"</a> on page 98                      |

---

**[SENSe:]POWer:ACHannel:PRESet:RLEVel**

This command determines the ideal reference level for the current measurement.

This automatic routine makes sure that the that the signal power level does not overload the R&S ESW or limit the dynamic range by too small a S/N ratio.

To determine the best reference level, the R&S ESW aborts current measurements and performs a series of test sweeps. After it has finished the test, it continues with the actual measurement.

To get a valid result, you have to perform a complete sweep with synchronization to the sweep end. This is only possible in single sweep mode.

---

**[SENSe:]POWer:TRACe <TraceNumber>**

Selects the trace channel power measurements are performed on.

For the measurement to work, the corresponding trace has to be active.

**Parameters:**

|               |        |        |
|---------------|--------|--------|
| <TraceNumber> | Range: | 1 to 6 |
|               | *RST:  | 1      |

**Example:**

POW:TRAC 2  
Assigns the measurement to trace 2.

**Manual operation:** See ["Selected Trace"](#) on page 59



### 6.7.3 Channel power and ACLR

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#### 6.7.3.1 Measurement configuration management

|  |     |
|--|-----|
| CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet.....            | 477 |
| CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANdard:CATalog?..... | 478 |
| CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANdard:DELeTe.....   | 478 |
| CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANdard:SAVE.....     | 478 |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet <Standard>**

Loads a measurement configuration.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

If the "Multi-Standard Radio" standard is selected (see ["Standard"](#) on page 57), different commands are required to configure ACLR measurements (see [Chapter 6.7.3.7, "Configuring multi-standard radio \(MSR\) ACLR measurements"](#), on page 493).

#### **Suffix:**

|      |                        |
|------|------------------------|
| <n>  | <a href="#">Window</a> |
| <m>  | <a href="#">Marker</a> |
| <sb> | irrelevant             |

#### **Parameters:**

|            |  |
|------------|--|
| <Standard> | For more information see <a href="#">Chapter 3.2.9, "Reference: predefined CP/ACLR standards"</a> , on page 88.<br>If you want to load a customized configuration, the parameter is a string containing the file name. |
|------------|--|

**Manual operation:** See ["Predefined Standards"](#) on page 57  
See ["User Standards"](#) on page 57

**CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANDard:CATalog?**

Queries all xml files containing ACLR standards in the  
C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\acp\_std directory.  
Note that subdirectories are not searched.

**Suffix:**

|      |   |
|------|---|
| <n>  | <a href="#">Window</a>  |
| <m>  | <a href="#">Marker</a>  |
| <sb> | Sub block in a Multi-standard radio measurement;<br>MSR ACLR: 1 to 5<br>Multi-SEM: 1 to 3<br>for all other measurements: irrelevant |

**Return values:**

<Standards> List of standard files.

**Usage:** Query only

**Manual operation:** See "[User Standards](#)" on page 57

**CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANDard:DELeTe  
<Standard>**

Deletes a file containing an ACLR standard.

**Suffix:**

|      |                        |
|------|------------------------|
| <n>  | <a href="#">Window</a> |
| <m>  | <a href="#">Marker</a> |
| <sb> | irrelevant             |

**Parameters:**

<Standard> String containing the file name of the standard.

**Manual operation:** See "[User Standards](#)" on page 57

**CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANDard:SAVE <Standard>**

Saves the current ACLR measurement configuration as a new ACLR standard.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

**Suffix:**

|      |                        |
|------|------------------------|
| <n>  | <a href="#">Window</a> |
| <m>  | <a href="#">Marker</a> |
| <sb> | irrelevant             |

**Parameters:**

<Standard> String containing the file name. The file format is xml.

**Manual operation:** See ["User Standards"](#) on page 57

### 6.7.3.2 Channel configuration

|   |     |
|---|-----|
| [SENSe:]POWer:ACHannel:ACPairs.....                 | 479 |
| [SENSe:]POWer:ACHannel:BANDwidth:ACHannel.....      | 479 |
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| [SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]..... | 480 |
| [SENSe:]POWer:ACHannel:NAME:ACHannel.....           | 480 |
| [SENSe:]POWer:ACHannel:NAME:ALternate<ch>.....      | 481 |
| [SENSe:]POWer:ACHannel:NAME:CHANnel<ch>.....        | 481 |
| [SENSe:]POWer:ACHannel:SPACing:ALternate<ch>.....   | 481 |
| [SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>.....     | 482 |
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| [SENSe:]POWer:ACHannel:TXCHannel:COUNt.....         | 482 |

---

#### [SENSe:]POWer:ACHannel:ACPairs <ChannelPairs>

Defines the number of pairs of adjacent and alternate channels.

##### Parameters:

<ChannelPairs>      Range:      0 to 12  
                              \*RST:        1

**Manual operation:** See ["Number of channels: Tx, Adj"](#) on page 58  
 See ["Number of Adjacent Channels \(Adj Count\)"](#) on page 73

---

#### [SENSe:]POWer:ACHannel:BANDwidth:ACHannel <Bandwidth>

Defines the channel bandwidth of the adjacent channels.

The adjacent channels are the first channels to the left and right of the transmission channels. If you set the channel bandwidth for these channels, the R&S ESW sets the bandwidth of the alternate channels to the same value (not for MSR signals).

For asymmetrical MSR signals, this command defines the bandwidth of the lower adjacent channel. To configure the bandwidth for the upper adjacent channel, use the [\[SENSe:\]POWer:ACHannel:BANDwidth:UACHannel](#) command.

Steep-edged channel filters are available for fast ACLR measurements.

##### Parameters:

<Bandwidth>      Range:      100 Hz to 1000 MHz  
                              \*RST:        14 kHz  
                              Default unit: Hz

**Manual operation:** See ["Channel Bandwidth"](#) on page 62  
 See ["Adjacent Channel Bandwidths"](#) on page 74

---

#### [SENSe:]POWer:ACHannel:BANDwidth:ALternate<ch> <Bandwidth>

Defines the channel bandwidth of the alternate channels.

For MSR signals, this command defines the bandwidth of the lower alternate channels in asymmetrical configurations. To configure the bandwidth for the upper alternate channel, use the `[SENSe:]POWer:ACHannel:BANDwidth:UALternate<ch>` command.

If you set the channel bandwidth for the first alternate channel, the R&S ESW sets the bandwidth of the other alternate channels to the same value, but not the other way round (not for MSR signals). The command works hierarchically: to set a bandwidth of the 3rd and 4th channel, you have to set the bandwidth of the 3rd channel first.

Steep-edged channel filters are available for fast ACLR measurements.

**Suffix:**

<ch>                      1..n  
Alternate channel number

**Parameters:**

<Bandwidth>            Range:        100 Hz to 1000 MHz  
                             \*RST:        14 kHz  
                             Default unit: Hz

**Manual operation:**   See "Channel Bandwidth" on page 62  
                             See "Adjacent Channel Bandwidths" on page 74

**[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>] <Bandwidth>**

Defines the channel bandwidth of the transmission channels.

Steep-edged channel filters are available for fast ACLR measurements.

**Suffix:**

<ch>                      1..n  
Tx channel number

**Parameters:**

<Bandwidth>            Range:        100 Hz to 1000 MHz  
                             \*RST:        14 kHz  
                             Default unit: Hz

**Manual operation:**   See "Channel Bandwidth" on page 62  
                             See "Channel Bandwidth" on page 93  
                             See "Channel Bandwidth" on page 98

**[SENSe:]POWer:ACHannel:NAME:ACHannel <Name>**

Defines a name for the adjacent channel.

For MSR ACLR measurements, this command defines the name for the lower adjacent channel in asymmetric channel definitions. To define the name for the upper adjacent channel use the `[SENSe:]POWer:ACHannel:NAME:UACHannel` command.

**Parameters:**

<Name>                    String containing the name of the channel  
                             \*RST:        ADJ

**Manual operation:** See "Channel Names" on page 64

---

**[SENSe:]POWer:ACHannel:NAME:ALternate<ch> <Name>**

Defines a name for an alternate channel.

For MSR ACLR measurements, this command defines the name for the lower alternate channel in asymmetric channel definitions. To define the name for the upper alternate channels use the `[SENSe:]POWer:ACHannel:NAME:UALternate<ch>` command.

**Suffix:**

<ch>                      1..n  
Alternate channel number

**Parameters:**

<Name>                      String containing the name of the channel  
\*RST:                      ALT<1...11>

**Manual operation:** See "Channel Names" on page 64

---

**[SENSe:]POWer:ACHannel:NAME:CHANnel<ch> <Name>**

Defines a name for a transmission channel.

**Suffix:**

<ch>                      1..n  
Tx channel number

**Parameters:**

<Name>                      String containing the name of the channel  
\*RST:                      TX<1...12>

**Manual operation:** See "Channel Names" on page 64

---

**[SENSe:]POWer:ACHannel:SPACing:ALternate<ch> <Spacing>**

Defines the distance from transmission channel to alternate channels.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first sub block to the lower alternate channel. To configure the spacing for the upper alternate channel in asymmetrical configurations, use the `[SENSe:]POWer:ACHannel:SPACing:UALternate<ch>` command.

If you set the channel spacing for the first alternate channel, the R&S ESW adjusts the spacing of alternate channels of a lower order, but not the other way round (not for MSR signals). The command works hierarchically: to set a distance from the transmission channel to the 2nd and 3rd alternate channel, you have to define a spacing for the 2nd alternate channel first.

**Suffix:**

<ch>                      1..n  
Alternate channel number

**Parameters:**

<Spacing>      Range:      100 Hz to 2000 MHz  
                   \*RST:      40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...  
                   Default unit: Hz

**Manual operation:**    See ["Channel Spacings"](#) on page 62  
                               See ["Adjacent Channel Spacings"](#) on page 74

**[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch> <Spacing>**

Defines the distance between transmission channels.

If you set the channel spacing for a transmission channel, the R&S ESW sets the spacing of the lower transmission channels to the same value, but not the other way round. The command works hierarchically: to set a distance between the 2nd and 3rd and 3rd and 4th channel, you have to set the spacing between the 2nd and 3rd channel first.

**Suffix:**

<ch>                    1..n  
                              Tx channel number

**Parameters:**

<Spacing>      Range:      14 kHz to 2000 MHz  
                   \*RST:      20 kHz  
                   Default unit: Hz

**Manual operation:**    See ["Channel Spacings"](#) on page 62

**[SENSe:]POWer:ACHannel:SPACing[:ACHannel] <Spacing>**

Defines the distance from transmission channel to adjacent channel.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first sub block to the lower adjacent channel. To configure the spacing for the upper adjacent channel in asymmetrical configurations, use the [\[SENSe:\]POWer:ACHannel:SPACing:UACHannel](#) command.

A change of the adjacent channel spacing causes a change in the spacing of all alternate channels below the adjacent channel (not for MSR signals).

**Parameters:**

<Spacing>      Range:      100 Hz to 2000 MHz  
                   \*RST:      14 kHz  
                   Default unit: Hz

**Manual operation:**    See ["Channel Spacings"](#) on page 62  
                               See ["Adjacent Channel Spacings"](#) on page 74

**[SENSe:]POWer:ACHannel:TXChannel:COUNT <Number>**

Defines the number of transmission channels.

The command works for measurements in the frequency domain.

**Parameters:**

<Number>                      Range:        1 to 18  
                                      \*RST:        1

**Manual operation:**    See "Number of channels: Tx, Adj" on page 58

**6.7.3.3 Weighting filters**

|  |     |
|--|-----|
| [SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel.....        | 483 |
| [SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTErnate<ch>.....   | 483 |
| [SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch>.....     | 484 |
| [SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL].....           | 484 |
| [SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel.....      | 484 |
| [SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTErnate<ch>..... | 484 |
| [SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch>.....   | 485 |
| [SENSe:]POWer:ACHannel:FILTer[:STATe][:ALL].....         | 485 |

**[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel <Alpha>**

Defines the roll-off factor for the adjacent channel weighting filter.

For asymmetrical MSR signals, this command defines the roll-off factor for the lower adjacent channel. To configure the factor for the upper adjacent channel, use the [SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel command.

**Parameters:**

<Alpha>                      Roll-off factor  
                                      Range:        0 to 1  
                                      \*RST:        0.22

**Manual operation:**    See "Weighting Filters" on page 64  
                                      See "Weighting Filters" on page 74

**[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTErnate<ch> <Alpha>**

Defines the roll-off factor for the alternate channel weighting filter.

For asymmetrical MSR signals, this command defines the roll-off factor for the lower alternate channels. To configure the factor for the upper alterante channels, use the [SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTErnate<ch> command.

**Suffix:**

<ch>                          1..n  
                                      Alternate channel number

**Parameters:**

<Alpha>                      Roll-off factor  
                                      Range:        0 to 1  
                                      \*RST:        0.22

**Manual operation:**    See "Weighting Filters" on page 64  
                                      See "Weighting Filters" on page 74

---

**[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> <Alpha>**

Defines the roll-off factor for the transmission channel weighting filter.

**Suffix:**

<ch>                      1..n  
Tx channel number

**Parameters:**

<Alpha>                      Roll-off factor  
Range:              0 to 1  
\*RST:              0.22

**Manual operation:**    See ["Weighting Filters"](#) on page 64

---

**[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] <Value>**

Defines the alpha value for the weighting filter for all channels.

**Parameters:**

<Value>                      \*RST:              0.22

**Example:**                      POW:ACH:FILT:ALPH:ALL 0.35

---

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel <State>**

Turns the weighting filter for the adjacent channel on and off.

For asymmetrical MSR signals, this command turns the weighting filter for the lower adjacent channel on and off. To configure the filter state for the upper adjacent channel, use the [\[SENSe:\]POWer:ACHannel:FILTer\[:STATe\]:UACHannel](#) command.

**Parameters:**

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

**Manual operation:**    See ["Weighting Filters"](#) on page 64  
See ["Weighting Filters"](#) on page 74

---

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTErnate<ch> <State>**

Turns the weighting filter for an alternate channel on and off.

For asymmetrical MSR signals, this command turns the weighting filter for the lower alternate channels on and off. To configure the filter state for the upper alternate channels, use the [\[SENSe:\]POWer:ACHannel:FILTer\[:STATe\]:UALTErnate<ch>](#) command.

**Suffix:**

<ch>                      1..n  
Alternate channel number



**Parameters:**

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

**Manual operation:** See ["Weighting Filters"](#) on page 64  
 See ["Weighting Filters"](#) on page 74

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> <State>**

Turns the weighting filter for a transmission channel on and off.

**Suffix:**

<ch> 1..n  
 Tx channel number

**Parameters:**

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

**Manual operation:** See ["Weighting Filters"](#) on page 64

**[SENSe:]POWer:ACHannel:FILTer[:STATe][:ALL] <State>**

Turns the weighting filters for all channels on and off.

**Parameters:**

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

#### 6.7.3.4 Reference channel

|  |     |
|--|-----|
| <a href="#">[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE.....</a>        | 485 |
| <a href="#">[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO.....</a>   | 485 |
| <a href="#">[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual.....</a> | 486 |

**[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE**

This command sets the channel power as the reference for relative ACLR measurements.

**Example:** POW:ACH:REF:AUTO ONCE

**Usage:** Event

**Manual operation:** See ["Setting a fixed reference for Channel Power measurements \(Set CP Reference\)"](#) on page 60

**[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO <RefChannel>**

Selects the reference channel for relative measurements.

You need at least one channel for the command to work.

**Parameters:**

|                 |  |
|-----------------|--|
| <RefChannel>    | MINimum   MAXimum   LHIGhest   |
| <b>MINimum</b>  | Transmission channel with the lowest power   |
| <b>MAXimum</b>  | Transmission channel with the highest power  |
| <b>LHIGhest</b> | Lowest transmission channel for lower adjacent channels and highest transmission channel for upper adjacent channels |

**Example:**

POW:ACH:REF:TXCH:AUTO MAX  
Selects the channel with the peak power as reference channel.

**Manual operation:** See "Reference Channel" on page 59

---

**[SENSe:]POWer:ACHannel:REference:TXCHannel:MANual <ChannelNumber>**

Defines a reference channel for relative ACLR measurements.

You need at least one channel for the command to work.

Note that this command is not available for MSR ACLR measurements (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Parameters:**

|                 |                |
|-----------------|----------------|
| <ChannelNumber> | Range: 1 to 18 |
| *RST:           | 1              |

**Manual operation:** See "Reference Channel" on page 59

### 6.7.3.5 Limit check



The results of the limit checks are also indicated in the **STATus:QUESTionable:ACLR status register**.

For more information see the **STATus:QUESTionable:ACPLimit** Register in the R&S ESW user manual.

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ACHannel:ABSolute</a> .....                    | 487 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ACHannel:ABSolute:STATe</a> .....              | 487 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ACHannel[:RELative]</a> .....                  | 488 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ACHannel[:RELative]:STATe</a> .....            | 488 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ACHannel:RESult?</a> .....                     | 489 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ALTErnate&lt;ch&gt;:ABSolute</a> .....         | 489 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ALTErnate&lt;ch&gt;:ABSolute:STATe</a> .....   | 490 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ALTErnate&lt;ch&gt;[:RELative]</a> .....       | 490 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ALTErnate&lt;ch&gt;[:RELative]:STATe</a> ..... | 491 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:ALTErnate&lt;ch&gt;:RESult?</a> .....          | 491 |
| <a href="#">CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower[:STATe]</a> .....                              | 492 |

---

**CALCulate<n>:LIMit<li>:ACPpower:ACHannel:ABSolute** <LowerLimit>[, <UpperLimit>]

Defines the absolute limit of the adjacent channels.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

<n> irrelevant

<li> irrelevant

**Parameters:**

<LowerLimit> The limit of the lower adjacent channel.  
 Range: -200 dBm to 200 dBm  
 \*RST: -200 dBm  
 Default unit: dBm

<UpperLimit> The limit of the upper adjacent channel.  
 Range: -200 dBm to 200 dBm  
 \*RST: -200 dBm  
 Default unit: dBm

**Manual operation:** See ["Limit Check"](#) on page 63  
 See ["Limit Checking"](#) on page 75

---

**CALCulate<n>:LIMit<li>:ACPpower:ACHannel:ABSolute:STATe** <State>[, <State>]

This command turns the absolute limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit<li>:ACPpower\[:STATe\]](#).

**Suffix:**

<n> irrelevant

<li> irrelevant

**Parameters:**

<State> ON | OFF | 1 | 0  
 Absolute limit check for lower adjacent channel  
 \*RST: 0

<State> ON | OFF | 1 | 0  
 Absolute limit check for upper adjacent channel  
 \*RST: 0

**Manual operation:** See ["Limit Check"](#) on page 63  
 See ["Limit Checking"](#) on page 75

---

**CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative] <LowerLimit>[, <UpperLimit>]**

Defines the relative limit of the adjacent channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

<n> irrelevant

<li> irrelevant

**Parameters:**

<LowerLimit> The limit of the lower adjacent channel.

Range: 0 dB to 100 dB

\*RST: 0 dB

Default unit: dB

<UpperLimit> The limit of the upper adjacent channel.

Range: 0 dB to 100 dB

\*RST: 0 dB

Default unit: dB

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

---

**CALCulate<n>:LIMit<li>:ACPower:ACHannel[:RELative]:STATe <State>[, <State>]**

This command turns the relative limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit<li>:ACPower\[:STATe\]](#).

**Suffix:**

<n> irrelevant

<li> irrelevant

**Parameters:**

<State> ON | OFF | 1 | 0

Relative limit check for lower adjacent channel

\*RST: 0

<State> ON | OFF | 1 | 0

Relative limit check for upper adjacent channel

\*RST: 0

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

**CALCulate<n>:LIMit<li>:ACPpower:ACHannel:RESult?**

Queries the state of the limit check for the adjacent channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> irrelevant

<li> irrelevant

**Return values:**

<LowerACH> text value

The state of the limit check for the lower adjacent channels.

**PASSED**

Limit check has passed.

**FAIL**

Limit check has failed.

<UpperACH> text value

The state of the limit check for the upper adjacent channels.

**PASSED**

Limit check has passed.

**FAIL**

Limit check has failed.

**Example:**

```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

**Usage:** Query only

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

**CALCulate<n>:LIMit<li>:ACPpower:ALternate<ch>:ABSolute <LowerLimit>[, <UpperLimit>]**

Defines the absolute limit of the alternate channels.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

<n> irrelevant

<li> irrelevant

<ch> 1..n  
Alternate channel number

**Parameters:**

|              |   |
|--------------|---|
| <LowerLimit> | The limit of the lower adjacent channel.<br>Range: -200 dBm to 200 dBm<br>*RST: -200 dBm<br>Default unit: dBm |
| <UpperLimit> | The limit of the upper adjacent channel.<br>Range: -200 dBm to 200 dBm<br>*RST: -200 dBm<br>Default unit: dBm |

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

**CALCulate<n>:LIMit<li>:ACPpower:ALternate<ch>:ABSolute:STATe** <State>[, <State>]

This command turns the absolute limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit<li>:ACPpower\[:STATe\]](#).

**Suffix:**

|      |                                  |
|------|----------------------------------|
| <n>  | irrelevant                       |
| <li> | irrelevant                       |
| <ch> | 1..n<br>Alternate channel number |

**Parameters:**

|         |   |
|---------|---|
| <State> | ON   OFF   1   0<br>Absolute limit check for lower alternate channel<br>*RST: 0 |
| <State> | ON   OFF   1   0<br>Absolute limit check for upper alternate channel<br>*RST: 0 |

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

**CALCulate<n>:LIMit<li>:ACPpower:ALternate<ch>[:RELative]** <LowerLimit>[, <UpperLimit>]

Defines the relative limit of the alternate channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

|     |            |
|-----|------------|
| <n> | irrelevant |
|-----|------------|

<li> irrelevant

<ch> 1..n  
Alternate channel number

**Parameters:**

<LowerLimit> The limit of the lower alternate channel.  
Range: 0 dB to 100 dB  
\*RST: 0 dB  
Default unit: dB

<UpperLimit> The limit of the upper alternate channel.  
Range: 0 dB to 100 dB  
\*RST: 0 dB  
Default unit: dB

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

**CALCulate<n>:LIMit<li>:ACPpower:ALternate<ch>[:RELative]:STATe <State>[, <State>]**

This command turns the relative limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit<li>:ACPpower\[:STATe\]](#).

**Suffix:**

<n> irrelevant

<li> irrelevant

<ch> 1..n  
Alternate channel number

**Parameters:**

<State> ON | OFF | 1 | 0  
Relative limit check for lower alternate channel  
\*RST: 0

<State> ON | OFF | 1 | 0  
Relative limit check for upper alternate channel  
\*RST: 0

**Manual operation:** See ["Limit Check"](#) on page 63  
See ["Limit Checking"](#) on page 75

**CALCulate<n>:LIMit<li>:ACPpower:ALternate<ch>:RESult?**

Queries the state of the limit check for the adjacent or alternate channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

|      |                          |
|------|--------------------------|
| <n>  | irrelevant               |
| <li> | irrelevant               |
| <ch> | Alternate channel number |

**Return values:**

|             |  |
|-------------|--|
| <LowerChan> | text value<br>The state of the limit check for the lower alternate or adjacent channels. |
|-------------|--|

**PASSED**

Limit check has passed.

**FAIL**

Limit check has failed.

|             |  |
|-------------|--|
| <UpperChan> | text value<br>The state of the limit check for the upper alternate or adjacent channels. |
|-------------|--|

**PASSED**

Limit check has passed.

**FAIL**

Limit check has failed.

**Example:**

```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED, PASSED
```

**Usage:**

Query only

**CALCulate<n>:LIMit<li>:ACPpower[:STATe] <State>**

Turns the limit check for ACLR measurements on and off.

In addition, limits must be defined and activated individually for each channel (see `CALCulate<n>:LIMit<li>:ACPpower:ACHannel[:RELative]:STATe`, `CALCulate<n>:LIMit<li>:ACPpower:ALternate<ch>[:RELative]:STATe`, `CALCulate<n>:LIMit<li>:ACPpower:GAP<gap>[:AUTO]:ABSolute:STATe`, `CALCulate<n>:LIMit<li>:ACPpower:GAP<gap>[:AUTO]:ACLR[:RELative]:STATe` and `CALCulate<n>:LIMit<li>:ACPpower:GAP<gap>[:AUTO][:CACLR][:RELative]:STATe`).

**Suffix:**

|      |            |
|------|------------|
| <n>  | irrelevant |
| <li> | irrelevant |



**Parameters:**

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

**Manual operation:** See "Limit Check" on page 63  
 See "Limit Checking" on page 69  
 See "Limit Checking" on page 75

**6.7.3.6 Defining general ACLR characteristics**

Commands to define general ACLR characteristics described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE`
- `[SENSe:]POWER:ACHannel:PRESet`
- `[SENSe:]POWER:ACHannel:PRESet:RLEVel`
- `[SENSe:]POWER:TRACe`

`[SENSe:]POWER:HSPeet`..... 493

**[SENSe:]POWER:HSPeet <State>**

Turns high speed ACLR and channel power measurements on and off.

If on, the R&S ESW performs a measurement on each channel in the time domain. It returns to the frequency domain when the measurement is done.

In some telecommunications standards, high speed measurements use weighting filters with characteristic or steep-edged channel filters for band limitation.

**Parameters:**

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

**Example:** `POW:HSP ON`

**Manual operation:** See "Fast ACLR" on page 59

**6.7.3.7 Configuring multi-standard radio (MSR) ACLR measurements**

When you are performing multi-standard radio ACLR measurements, you have to configure channels differently. In that case, use the remote commands described here instead.

Commands to configure MSR ACLR measurements described elsewhere.

- `CALCulate<n>:LIMit<li>:ACPower[:STATe]`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:PRESet`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult:PHZ`
- `[SENSe:]POWER:ACHannel:MODE`
- `[SENSe:]POWER:ACHannel:PRESet`

- [SENSe:]POWER:ACHannel:REfERENCE:TXChannel:AUTO
- [SENSe:]POWER:TRACe

|  |     |
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| CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute:STATe.....         | 495 |
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| [SENSe:]POWER:ACHannel:FILTer:ALPHa:UALTernate<ch>.....                    | 500 |
| [SENSe:]POWER:ACHannel:FILTer[:STATe]:GAP<gap>[:AUTO].....                 | 501 |
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---

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute** <Limit>[,  
<Reserved>]

Defines the absolute limit of the specified gap (CACLR) channel.

If you define both an absolute limit and a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

|       |                                     |
|-------|-------------------------------------|
| <n>   | irrelevant                          |
| <li>  | irrelevant                          |
| <gap> | 1   2<br>Gap (CACLR) channel number |

**Parameters:**

|            |   |
|------------|---|
| <Limit>    | Defines the absolute limit of the specified gap channel.<br>Default unit: dBm |
| <Reserved> | Ignored.  |

**Example:** `CALC:LIM:ACP:GAP2:ABS 44.2dBm`

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ABSolute:STATe <State>**

Turns the absolute limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

**Suffix:**

|       |                                     |
|-------|-------------------------------------|
| <n>   | irrelevant                          |
| <li>  | irrelevant                          |
| <gap> | 1   2<br>Gap (CACLR) channel number |

**Parameters:**

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

**Example:** `CALC:LIM:ACP:GAP1:ABS:STAT ON`

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative] <Limit>[, <UpperLimit>]**

Defines the relative limit for the ACLR power in the specified gap channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

|       |                                     |
|-------|-------------------------------------|
| <n>   | irrelevant                          |
| <li>  | irrelevant                          |
| <gap> | 1   2<br>Gap (CACLR) channel number |

**Parameters:**

|              |   |
|--------------|---|
| <Limit>      | Defines the relative limit for the ACLR power in the specified gap channel in dB.<br>Default unit: DB |
| <UpperLimit> | Ignored.<br>Default unit: DB  |

**Example:** `CALC:LIM:ACP:GAP1:ACLR:REL 3dB`

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO]:ACLR[:RELative]:STATe**  
**<State>**

Turns the relative limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

**Suffix:**

|       |                                     |
|-------|-------------------------------------|
| <n>   | irrelevant                          |
| <li>  | irrelevant                          |
| <gap> | 1   2<br>Gap (CACLR) channel number |

**Parameters:**

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

**Example:** `CALC:LIM:ACP:GAP1:ACLR:REL:STAT ON`

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLR][:RELative]**  
**<Limit>, <UpperLimit>**

Defines the relative limit of the specified gap (CACLR) channel. The reference value for the relative limit is the measured channel power.

If you define both an absolute limit and a relative limit, the R&S ESW uses the lower value for the limit check.

**Suffix:**

|       |                                     |
|-------|-------------------------------------|
| <n>   | irrelevant                          |
| <li>  | irrelevant                          |
| <gap> | 1   2<br>Gap (CACLR) channel number |

**Parameters:**

|         |  |
|---------|--|
| <Limit> | Defines the relative limit of the specified gap channel in dB.<br>Default unit: DB |
|---------|--|

<UpperLimit> Optional: Defines the relative upper limit of the specified gap channel.

Default unit: dB

**Example:** `CALC:LIM:ACP:GAP1:REL 3dB,0`

---

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:AUTO][:CACLR][:RELative]:STATe<State>**

Turns the relative limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<li>:ACPower[:STATe]`.

**Suffix:**

<n> irrelevant

<li> irrelevant

<gap> 1 | 2  
Gap (CACLR) channel number

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:** `CALC:LIM:ACP:GAP1:REL:STAT ON`

---

**CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLR]:RESult?**

The command returns the limit check results for the upper and lower gap (CACLR) channels for the selected gap in an MSR ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry.

**Suffix:**

<n> irrelevant

<li> irrelevant

<gap> 1 | 2  
Gap (CACLR) channel number

**Return values:**

<LowerGap\_AB>, Limit check results for the CACLR power in the upper and lower  
<UpperGap\_AB> gap channels for the selected gap. Results are only returned for  
[,<LowerGap\_BC>, the available sub blocks.

<UpperGap\_BC>, **PASSED**  
 <LowerGap\_CD>, Limit check has passed.  
 <UpperGap\_CD>, **FAIL**  
 <LowerGap\_DE>, Limit check has failed.  
 <UpperGap\_DE>, **NONE**  
 <LowerGap\_EF>, No results available, e.g. because limit checking was deactiva-  
 <UpperGap\_EF>, ted  
 <LowerGap\_FG>  
 <UpperGap\_FG>  
 <LowerGap\_GH>  
 <UpperGap\_GH>]

**Example:**

```

INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:RES?
PASSED,PASSED
  
```

**Usage:** Query only

#### [SENSe:]POWer:ACHannel:AGCHannels <State>

Activates or deactivates gap channels in an MSR signal.

For more information see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

#### Parameters:

<State> ON | OFF | 1 | 0  
**ON | 1**  
 The gap channels are displayed and channel power results are calculated and displayed in the Result Summary.  
**OFF | 0**  
 The gap channels are not displayed in the diagram and channel power results are not calculated nor displayed in the Result Summary.  
 \*RST: 1

**Manual operation:** See ["Activate Gaps"](#) on page 76

#### [SENSe:]POWer:ACHannel:BWIDth:GAP<gap> <Bandwidth>

#### [SENSe:]POWer:ACHannel:BANDwidth:GAP<gap>[:AUTO] <Bandwidth>

Defines the bandwidth of the MSR gap (CACLR) channel in all sub block gaps.

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:PRESet](#) on page 477).

#### Suffix:

<gap> 1 | 2  
 Gap (CACLR) channel number

**Parameters:**

<Bandwidth>            numeric value in Hz  
                              \*RST:        3.84 MHz  
                              Default unit: Hz

**Example:**

SENS:POW:ACH:BAND:GAP2 5MHZ

**Manual operation:**    See ["Gap Channel Bandwidths"](#) on page 78

[SENSe:]POWer:ACHannel:BWIDth:UACHannel <Bandwidth>

[SENSe:]POWer:ACHannel:BANDwidth:UACHannel <Bandwidth>

Defines the channel bandwidth of the upper adjacent channel in asymmetrical configurations.

The adjacent channel is the first pair of channels next to the transmission channels. To configure the bandwidth for the lower adjacent channel, use the [\[SENSe:\]POWer:ACHannel:BANDwidth:ACHannel](#) command.

Steep-edged channel filters are available for fast ACLR measurements.

**Parameters:**

<Bandwidth>            Range:        100 Hz to 1000 MHz  
                              \*RST:        14 kHz  
                              Default unit: Hz

**Manual operation:**    See ["Adjacent Channel Bandwidths"](#) on page 74

[SENSe:]POWer:ACHannel:BWIDth:UALTernate<ch> <Bandwidth>

[SENSe:]POWer:ACHannel:BANDwidth:UALTernate<ch> <Bandwidth>

Defines the channel bandwidth of the upper alternate channels in asymmetrical configurations. To configure the bandwidth for the lower alternate channel, use the [\[SENSe:\]POWer:ACHannel:BANDwidth:ALTernate<ch>](#) command.

Steep-edged channel filters are available for fast ACLR measurements.

**Suffix:**

<ch>                      1..n  
                              Alternate channel number

**Parameters:**

<Bandwidth>            Range:        100 Hz to 1000 MHz  
                              \*RST:        14 kHz  
                              Default unit: Hz

**Manual operation:**    See ["Adjacent Channel Bandwidths"](#) on page 74

[SENSe:]POWer:ACHannel:FILTer:ALPHA:GAP<gap>[:AUTO] <Alpha>

Defines the roll-off factor for the specified gap (CACLR) channel's weighting filter in all sub block gaps.

**Suffix:**

<gap> 1 | 2  
Gap (CACLR) channel number

**Parameters:**

<Alpha> Roll-off factor  
Range: 0 to 1  
\*RST: 0.22

**Example:** SENS:POW:ACH:FILT:ALPH:GAP2 0.2

**Manual operation:** See ["Weighting Filters"](#) on page 78

**[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLoCk<sb>:CHANnel<ch> <Alpha>**

Defines the roll-off factor for the specified transmission channel's weighting filter.

**Suffix:**

<sb> 1 to 5  
sub block number  
  
<ch> 1..n  
Tx channel number

**Parameters:**

<Alpha> Roll-off factor  
Range: 0 to 1  
\*RST: 0.22

**Manual operation:** See ["Weighting Filters"](#) on page 72

**[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel <Alpha>**

Defines the roll-off factor for the upper adjacent channel weighting filter for asymmetrical MSR signals. To configure the factor for the upper adjacent channel, use the [\[SENSe:\]POWer:ACHannel:FILTer:ALPHa:ACHannel](#) command.

**Parameters:**

<Alpha> Roll-off factor  
Range: 0 to 1  
\*RST: 0.22

**Manual operation:** See ["Weighting Filters"](#) on page 74

**[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch> <Alpha>**

Defines the roll-off factor for the upper alternate channels' weighting filter for asymmetrical MSR signals. To configure the factor for the upper alternate channels, use the [\[SENSe:\]POWer:ACHannel:FILTer:ALPHa:ALTernate<ch>](#) command.

**Suffix:**

<ch> 1..n  
Alternate channel number



**Parameters:**

<Alpha>                      Roll-off factor  
                                     Range:        0 to 1  
                                     \*RST:        0.22

**Manual operation:**    See ["Weighting Filters"](#) on page 74

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:GAP<gap>[:AUTO] <State>**

Turns the weighting filter for the specified gap (CACLR) channel in all sub block gaps on and off.

**Suffix:**

<gap>                        1 | 2  
                                     Gap (CACLR) channel number

**Parameters:**

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

**Example:**                SENS:POW:ACH:FILT:GAP2 ON

**Manual operation:**    See ["Weighting Filters"](#) on page 78

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:SBLock<sb>:CHANnel<ch> <State>**

Turns the weighting filter for the specified transmission channel on and off.

**Suffix:**

<sb>                        1 to 5  
                                     sub block number  
  
 <ch>                        1..n  
                                     Tx channel number

**Parameters:**

<State>                      ON | OFF | 1 | 0  
                                     \*RST:        W-CDMA: 1, other technologies: 0

**Manual operation:**    See ["Weighting Filters"](#) on page 72

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel <State>**

Turns the weighting filter for the upper adjacent channel on and off for asymmetrical MSR signals. To configure the factor for the lower adjacent channel, use the [\[SENSe:\]POWer:ACHannel:FILTer\[:STATe\]:ACHannel](#) command.

**Parameters:**

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

**Manual operation:**    See ["Weighting Filters"](#) on page 74

---

**[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch> <State>**

Turns the weighting filter for the upper alternate channels on and off for asymmetrical MSR signals. To configure the factor for the lower alternate channels, use the [\[SENSe:\]POWer:ACHannel:FILTer\[:STATe\]:ALTernate<ch>](#) command.

**Suffix:**

<ch> 1..n  
Alternate channel number

**Parameters:**

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

**Manual operation:** See ["Weighting Filters"](#) on page 74

---

**[SENSe:]POWer:ACHannel:GAP<gap>[:AUTO]:MSIZe <Bandwidth>**

If the gap between the sub blocks does not exceed the specified bandwidth, the gap channels are not displayed in the diagram, and the gap channel results are not calculated in the result summary.

**Suffix:**

<gap> 1 | 2  
Gap channel number

**Parameters:**

<Bandwidth> numeric value in Hz  
\*RST: gap1: 5 MHz; gap2: 10 MHz  
Default unit: Hz

**Example:**

POW:ACH:GAP2:MSIZ 5 MHz  
Gap channel 2 is only evaluated if the gap is wider than 5 MHz.

**Manual operation:** See ["Minimum gap size to show Gap 1/ Minimum gap size to show Gap 2"](#) on page 77

---

**[SENSe:]POWer:ACHannel:NAME:UACHannel <Name>**

Defines the name for the upper adjacent channel in asymmetrical MSR channel definitions. To define the name for the lower adjacent channel use the [\[SENSe:\]POWer:ACHannel:NAME:ACHannel](#) command.

**Parameters:**

<Name> String containing the name of the channel  
\*RST: ADJ

**[SENSe:]POWer:ACHannel:NAME:UALternate<ch> <Name>**

Defines the name for the specified upper alternate channel in asymmetrical MSR channel definitions. To define the name for the lower adjacent channels use the [\[SENSe:\]POWer:ACHannel:NAME:ALternate<ch>](#) command.

**Suffix:**

<ch> 1..n  
Alternate channel number

**Parameters:**

<Name> String containing the name of the channel  
\*RST: ALT<1...11>

**[SENSe:]POWer:ACHannel:SBCount <Number>**

Defines the number of sub blocks, i.e. groups of transmission channels in an MSR signal.

For more information see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

**Parameters:**

<Number> Range: 1 to 5  
\*RST: 1

**Manual operation:** See ["Number of Sub Blocks"](#) on page 67

**[SENSe:]POWer:ACHannel:SBLock<sb>:BWIDth[:CHANnel<ch>] <Bandwidth>**  
**[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth[:CHANnel<ch>]**  
 <Bandwidth>

Defines the bandwidth of the specified MSR Tx channel.

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Suffix:**

<sb> 1 to 5  
sub block number  
  
<ch> 1..n  
Tx channel number

**Parameters:**

<Bandwidth> Bandwidth in Hz  
Default unit: Hz

**Manual operation:** See ["Tx Channel Bandwidth"](#) on page 72

**[SENSe:]POWer:ACHannel:SBLock<sb>:CENTer[:CHANnel<ch>] <Frequency>**

Defines the (absolute) center frequency of the specified MSR Tx channel.

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

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Suffix:**

<sb> 1 to 5  
sub block number

<ch> 1..n  
Tx channel number

**Parameters:**

<Frequency> absolute frequency in Hz  
Default unit: Hz

**Manual operation:** See ["Tx Center Frequency"](#) on page 71

**[SENSe:]POWer:ACHannel:SBLock<sb>:FREQuency:CENTer** <Frequency>

Defines the center of the specified MSR sub block. Note that the position of the sub block also affects the position of the adjacent gap (CACLR) channels.

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Suffix:**

<sb> 1 to 5  
sub block number

**Parameters:**

<Frequency> absolute frequency in Hz  
Default unit: Hz

**Manual operation:** See ["Sub Block / Center Freq"](#) on page 71

**[SENSe:]POWer:ACHannel:SBLock<sb>:NAME[:CHANnel<ch>]** <Name>

Defines the name of the specified MSR Tx channel.

Is for MSR signals only.

In MSR ACLR measurements, the default TX channel names correspond to the specified technology, followed by a consecutive number. The assigned sub block (A,B,C,D,E,F,G,H) is indicated as a prefix (e.g. A: WCDMA1).

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Suffix:**

<sb> 1 to 5  
sub block number

<ch> 1 to 18  
Tx channel number

**Parameters:**

<Name> String containing the name of the channel

**Example:**

POW:ACH:SBL2:NAME:CHAN2?

Result:

'B:WCDMA'

**Manual operation:** See ["Tx Channel Definition"](#) on page 71

**[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth <Bandwidth>**

Defines the bandwidth of the individual MSR sub block. Note that sub block ranges also affect the position of the adjacent gap channels (CACLR).

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Suffix:**

<sb> 1 to 5  
sub block number

**Parameters:**

<Bandwidth> Bandwidth in Hz  
Default unit: Hz

**Manual operation:** See ["RF Bandwidth"](#) on page 71

**[SENSe:]POWer:ACHannel:SBLock<sb>:TECHnology[:CHANnel<ch>]  
<Standard>**

Defines the technology used for transmission by the specified MSR Tx channel.

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

**Suffix:**

<sb> 1 to 5  
sub block number

<ch> 1..n  
Tx channel number

**Parameters:**

<Standard> Technology used for transmission  
**GSM**  
Transmission according to GSM standard  
**WCDMa**  
Transmission according to W-CDMA standard

LTE\_1\_40 | LTE\_3\_00 | LTE\_5\_00 | LTE\_10\_00 | LTE\_15\_00 |  
LTE\_20\_00

Transmission according to LTE standard for different channel  
bandwidths

NR5G\_fr1\_5 | NR5G\_fr1\_10 | NR5G\_fr1\_15 | NR5G\_fr1\_20 |  
NR5G\_fr1\_25 | NR5G\_fr1\_30 | NR5G\_fr1\_40 | NR5G\_fr1\_50 |  
NR5G\_fr1\_60 | NR5G\_fr1\_70 | NR5G\_fr1\_80 | NR5G\_fr1\_90 |  
NR5G\_fr1\_100 | NR5G\_fr2\_50 | NR5G\_fr2\_100 |  
NR5G\_fr2\_200 | NR5G\_fr2\_400

Transmission according to new radio 5G standard

#### USER

User-defined transmission; no automatic preconfiguration possible

**Manual operation:** See ["Technology Used for Transmission"](#) on page 71

**[SENSe:]POWer:ACHannel:SBLOCK<sb>:TXCHannel:COUNT <Number>**

Defines the number of transmission channels the specific sub block contains.

Is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:PRESet](#) on page 477).

#### Suffix:

<sb>                      1 to 5  
                              sub block number

#### Parameters:

<Number>                Range:        1 to 18  
                              \*RST:        1

**Manual operation:** See ["Number of Tx Channels \(Tx Count\)"](#) on page 71

**[SENSe:]POWer:ACHannel:SPACing:GAP<gap>[:AUTO] <Spacing>**

Defines the distance from sub block to the specified gap channel.

In "Auto" gap mode, channels in the upper gap are identical to those in the lower gap. Thus, only 2 gap channels are configured.

The spacing for gap channels is defined in relation to the outer edges of the surrounding sub blocks, i.e.

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

(See also [Figure 3-24](#) and [Figure 3-26](#).)

#### Suffix:

<gap>                    1 | 2  
                              Gap channel number

**Parameters:**

<Spacing>                      numeric value in Hz  
                                      \*RST:            2.5 MHz  
                                      Default unit: Hz

**Example:**

SENS:POW:ACH:SPAC:GAP2 5MHZ

**Manual operation:**    See ["Gap Channel Spacing"](#) on page 77

**[SENSe:]POWer:ACHannel:SPACing:UACHannel <Spacing>**

Defines the distance from the transmission channel to the upper adjacent channel.

For MSR signals, this command defines the distance from the CF of the last Tx channel in the last sub block to the upper adjacent channel in asymmetrical configurations. To configure the spacing for the lower adjacent channel use the [\[SENSe:\]POWer:ACHannel:SPACing\[:ACHannel\]](#) command.

**Parameters:**

<Spacing>                      Range:            100 Hz to 2000 MHz  
                                      \*RST:            14 kHz  
                                      Default unit: Hz

**Manual operation:**    See ["Adjacent Channel Spacings"](#) on page 74

**[SENSe:]POWer:ACHannel:SPACing:UALternate<ch> <Spacing>**

Defines the distance from transmission channel to the upper alternate channels.

For MSR signals, this command defines the distance from the CF of the last Tx channel in the last sub block to the upper alternate channel in asymmetrical configurations. To configure the spacing for the lower alternate channel, use the [\[SENSe:\]POWer:ACHannel:SPACing:ALternate<ch>](#) command.

**Suffix:**

<ch>                              1..n  
                                      Alternate channel number

**Parameters:**

<Spacing>                      Range:            100 Hz to 2000 MHz  
                                      \*RST:            40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...  
                                      Default unit: Hz

**Manual operation:**    See ["Adjacent Channel Spacings"](#) on page 74

**[SENSe:]POWer:ACHannel:SSEtup <State>**

Defines whether adjacent channels are defined symmetrically or not.

For more information see [Chapter 3.2.3.4, "Measurement on multi-standard radio \(MSR\) signals"](#), on page 50.

**Parameters:**

<State>                      ON | OFF | 1 | 0

**ON | 1**  
The upper and lower adjacent and alternate channels are defined symmetrically. This is the default behaviour and corresponds to the behavior in firmware versions before 2.10.

**OFF | 0**  
The upper and lower channels can be configured differently.

\*RST:                      1

**Manual operation:**    See ["Symmetrical Adjacent Setup"](#) on page 69

### 6.7.3.8 ACLR measurement control

Commands to perform ACLR measurements described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:SElect`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>[:STATE]`
- `INITiate<mt>[:IMMediate]`

### 6.7.3.9 Measurement results

Commands to analyze ACLR results described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?`
- `TRACe<n>[:DATA]`
- `CALCulate<n>:LIMit<li>:ACPower:ACHannel:RESult?`
- `CALCulate<n>:LIMit<li>:ACPower:ALternate<ch>:RESult?`
- `CALCulate<n>:LIMit<li>:ACPower:GAP<gap>[:CACLR]:RESult?`

|  |     |
|--|-----|
| <code>CALCulate&lt;n&gt;:LIMit&lt;li&gt;:ACPower:GAP&lt;gap&gt;:ACLR:RESult?</code> .....  | 508 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:POWER&lt;sb&gt;:RESult:PHZ</code> .....  | 509 |
| <code>[SENSe:]POWER:ACHannel:MODE</code> .....   | 510 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:POWER&lt;sb&gt;:RESult:UNIT</code> ..... | 510 |

---

#### **CALCulate<n>:LIMit<li>:ACPower:GAP<gap>:ACLR:RESult?**

The command returns the ACLR power limit check results for the selected gap channel in an MSR ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry.



**Suffix:**

|       |                                     |
|-------|-------------------------------------|
| <n>   | 1..n                                |
| <lj>  | 1..n<br>irrelevant                  |
| <gap> | 1   2<br>Gap (CACLR) channel number |

**Return values:**

<LowerGap\_AB>  
 <UpperGap\_AB>  
 <LowerGap\_BC>  
 <UpperGap\_BC>  
 <LowerGap\_CD>  
 <UpperGap\_CD>  
 <LowerGap\_DE>  
 <UpperGap\_DE>

**Example:**

```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:ACLR:RES?
PASSED, PASSED
```

**Usage:**

Query only

**CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult:PHZ <State>**

Selects the unit the R&S ESW returns results for power measurements.

You can query results with `CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?`.

**Suffix:**

|      |            |
|------|------------|
| <n>  | Window     |
| <m>  | Marker     |
| <sb> | irrelevant |

**Parameters:**

<State> ON | OFF | 1 | 0  
**ON | 1**  
 Channel power density in dBm/Hz  
**OFF | 0**  
 Channel power in dBm  
 \*RST: 0

**Example:**

```
CALC:MARK:FUNC:POW:RES:PHZ ON
Output of results referred to the channel bandwidth.
```

**Manual operation:** See "Channel power level and density (Power Unit)" on page 60

---

**[SENSe:]POWer:ACHannel:MODE <Mode>**

Selects the way the R&S ESW displays the power of adjacent channels.

You need at least one adjacent channel for the command to work.

**Parameters:**

|                 |  |
|-----------------|--|
| <Mode>          | ABSolute   RELative  |
| <b>ABSolute</b> | Shows the absolute power of all channels   |
| <b>RELative</b> | Shows the power of adjacent and alternate channels in relation to the transmission channel |
| *RST:           | RELative   |

**Manual operation:** See "[Absolute and Relative Values \(ACLR Mode\)](#)" on page 59

---

**CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult:UNIT <Measurement>**

LTE and 5G applications only.

Selects the unit the R&S ESW returns results for power measurements.

You can query results with `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?`.

**Suffix:**

|      |                        |
|------|------------------------|
| <n>  | <a href="#">Window</a> |
| <m>  | irrelevant             |
| <sb> | irrelevant             |

**Parameters:**

|               |   |
|---------------|---|
| <Measurement> | <b>ABS</b><br>Channel power in dBm              |
|               | <b>PHZ</b><br>Channel power density in dBm/Hz   |
|               | <b>MPHZ</b><br>Channel power density in dBm/MHz |
| *RST:         | ABS   |

**Example:** `//Select unit for power measurements  
CALC:MARK:FUNC:POW:RES:UNIT PHZ`

**Manual operation:** See "[Channel power level and density \(Power Unit\)](#)" on page 60

### 6.7.3.10 Programming examples for channel power measurements

The following programming examples are meant to demonstrate the most important commands to perform channel power measurements in a remote environment.

- [Example: configuring and performing an ACLR measurement.....](#)511
- [Example: configuring and performing an MSR ACLR measurement.....](#)513
- [Example: configuring and performing an asymmetrical MSR ACLR measurement .....](#)515

### Example: configuring and performing an ACLR measurement

In this example we will configure and perform an adjacent-channel power measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S ESW performs the measurement optimally with the predefined settings, without further configuration.

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

//-----Preparing the measurement-----

//Activate adjacent-channel power measurement.
CALC:MARK:FUNC:POW:SEL ACP
//Select the user standard "GSM"
CALC:MARK:FUNC:POW:PRES GSM

//-----Setting Up Channels-----
//Create one transmission channel.
POW:ACH:TXCH:COUN 1
//Name the first transmission channel 'TX Channel'.
POW:ACH:NAME:CHAN1 'TX Channel'
//Create two adjacent channels - one adjacent channel and one alternate channel.
POW:ACH:ACP 2
//Name the adjacent channel 'ABC'
POW:ACH:NAME:ACH 'ABC'
//Name the first alternate channel 'XYZ'.
POW:ACH:NAME:ALT1 'XYZ'
//Define a bandwidth of 30 kHz for the transmission channel.
POW:ACH:BWID:CHAN1 30kHz
//Define a bandwidth of 30 kHz for the adjacent channel.
POW:ACH:BWID:ACH 30kHz
//Define a bandwidth of 30 kHz for the first alternate channel.
POW:ACH:BWID:ALT1 30kHz
//Define a distance of 33 kHz from the center of the transmission channel to the
//center of the adjacent channel.
//Also adjust the distance to the alternate channels (66 kHz).
POW:ACH:SPAC 33kHz
//Define a distance of 100 kHz from the center of the transmission channel to the
//center of the first alternate channel.
POW:ACH:SPAC:ALT1 100kHz

//-----Selecting a Reference Channel--
//Select relative display of the channel power.
```

```

POW:ACH:MODE REL
//Define transmission channel 1 as the reference channel.
POW:ACH:REF:TXCH:MAN 1

//-----Saving the settings as a user standard-----
//Save the user standard with the name "my_aclr_standard".
//Weighting filters can only be defined for user-defined standards.
CALC:MARK:FUNC:POW:STAN:SAVE 'my_aclr_standard'

//-----Defining Weighting Filters-----
//Define a roll-off factor of 0.35 for the weighting filter of the first
//transmission channel.
POW:ACH:FILT:ALPH:CHAN1 0.35
//Turn the weighting filter for the first transmission channel on.
POW:ACH:FILT:CHAN1 ON
//Define a roll-off factor of 0.35 for the weighting filter of the adjacent
//channel.
POW:ACH:FILT:ALPH:ACH 0.35
//Turn the weighting filter for the adjacent channel on.
POW:ACH:FILT:ACH ON
//Define a roll-off factor of 0.35 for the weighting filter of the first
//alternate channel.
POW:ACH:FILT:ALPH:ALT1 0.35
//Turn the weighting filter for the first alternate channel on.
POW:ACH:FILT:ALT1 ON

//-----Working with Limits-----
//Define a relative limit of 30 dB below the power of the reference channel
//for both adjacent channels.
CALC:LIM:ACP:ACH 30DB,30DB
//Define a relative limit of 25 dB below the power of the reference channel
//for the first alternate channels.
CALC:LIM:ACP:ALT1 25DB,25DB
//Define an absolute limit of -35 dBm for both adjacent channels.
CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM
//Turn the ACLR limit check on.
CALC:LIM:ACP ON
//Turn the relative limit check for adjacent channels on.
CALC:LIM:ACP:ACH:STAT ON
//Turn the absolute limit check for adjacent channels on.
CALC:LIM:ACP:ACH:ABS:STAT ON
//Turn the absolute limit check for the first alternate channel on.
CALC:LIM:ACP:ALT1:ABS:STAT ON

//-----Performing the Measurement-----
//Determine the ideal ACLR measurement configuration.
POW:ACH:PRES ACP;*WAI
//Determine the ideal reference level for the measurement.
POW:ACH:PRES:RLEV;*WAI
//Initiate a new measurement and waits until the sweep has finished.

```

```

INIT;*WAI

//-----Limit Check-----
//Query the results of the limit check for the adjacent channels.
CALC:LIM:ACP:ACH:RES?
//Query the results of the limit check for the first alternate channels.
CALC:LIM:ACP:ALT1:RES?

//-----Retrieving Results-----
//Query the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? ACP

```

### Example: configuring and performing an MSR ACLR measurement

This example demonstrates how to configure and perform an ACLR measurement on a multi-standard radio signal in a remote environment.

```

//-----Preparing the measurement -----
//Reset the instrument
*RST

// Select ACLR measurement
:CALCulate:MARKer:FUNCTION:POWer:SElect ACPower

// Select MSR Standard :CALCulate:MARKer:FUNCTION:POWer:PRESet MSR

//Configure general measurement settings
:SENSe:FREQuency:CENter 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3

//----- Configuring Sub block A

:SENSe:POWer:ACHannel:SBLock1:TXChannel:COUNt 3
:SENSe:POWer:ACHannel:SBLock1:FREQuency:CENter 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:RFBWidth 12MHZ

:SENSe:POWer:ACHannel:SBLock1:CENter:CHANnel1 1.226GHZ
:SENSe:POWer:ACHannel:SBLock1:CENter:CHANnel2 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:CENter:CHANnel3 1.234GHZ

:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel1 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel2 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel3 GSM

:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel1 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel2 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel3 2.5MHZ

```

```
//----- Configuring Sub block B

:SENSe:POWer:ACHannel:SBLoCk2:TXCHannel:COUnT 1
:SENSe:POWer:ACHannel:SBLoCk2:FREQuency:CENTer 1.255GHZ
:SENSe:POWer:ACHannel:SBLoCk2:RFBWidth 4MHZ

:SENSe:POWer:ACHannel:SBLoCk2:CENTer:CHANnel1 1.255GHZ

:SENSe:POWer:ACHannel:SBLoCk2:TECHnology:CHANnel1 LTE_1_40

:SENSe:POWer:ACHannel:SBLoCk2:BANDwidth:CHANnel1 3.25MHZ

//----- Configuring Sub block C

:SENSe:POWer:ACHannel:SBLoCk3:TXCHannel:COUnT 2
:SENSe:POWer:ACHannel:SBLoCk3:FREQuency:CENTer 1.268GHZ
:SENSe:POWer:ACHannel:SBLoCk3:RFBWidth 8MHZ

:SENSe:POWer:ACHannel:SBLoCk3:CENTer:CHANnel1 1.266GHZ
:SENSe:POWer:ACHannel:SBLoCk3:CENTer:CHANnel2 1.270GHZ

:SENSe:POWer:ACHannel:SBLoCk3:BANDwidth:CHANnel1 2.75MHZ
:SENSe:POWer:ACHannel:SBLoCk3:BANDwidth:CHANnel2 2.75MHZ

//----- Configuring ADJ channels

:SENSe:POWer:ACHannel:BANDwidth:ACHannel 1.60MHZ
:SENSe:POWer:ACHannel:BANDwidth:ALternate1 1.60MHZ

:SENSe:POWer:ACHannel:SPACing:ACHannel 3MHZ
:SENSe:POWer:ACHannel:SPACing:ALternate1 5MHZ

//----- Configuring gap (CACLR) channels

:SENSe:POWer:ACHannel:SPACing:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2 5.0MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1 2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2 2.0MHZ

//-----Performing the Measurement-----

//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//-----Retrieving Results-----
```

```
//Return the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? MCAC
//Results:
//Transmission channels in sub block A
//-13.2346727385,-13.2346723793,-13.2390131759,
//Transmission channels in sub block B
//-17.0863336597,
//Transmission channels in sub block C
//-13.2390127767,-13.2390134744,
//Totals for each sub block
//-8.4649064021,-17.0863336597,-10.2287131689,
//Adjacent channels
//-67.9740721019,-67.9740728014,-0.00434041734,-0.00434041734,
//CACLR channels
//-0.52933512766,-64.9990115835,-64.5012521492,-0.33507330922,
//-64.4924159646,-0.52932552499,-0.52932552495,-64.4934163414
```

### Example: configuring and performing an asymmetrical MSR ACLR measurement

This example demonstrates how to configure and perform an ACLR measurement on an asymmetrical multi-standard radio signal in a remote environment.

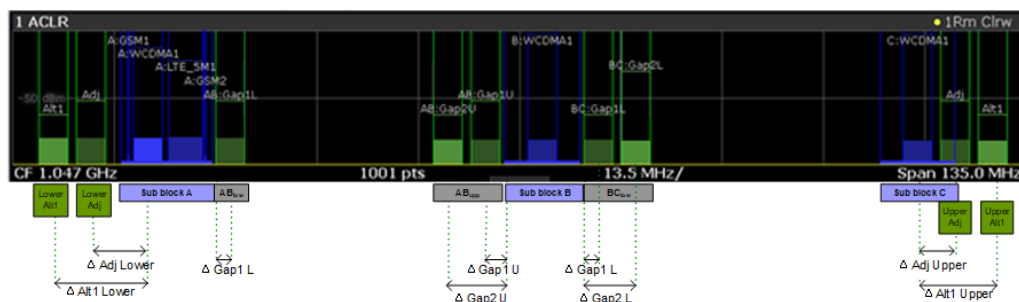


Figure 6-2: Asymmetrical MSR signal structure

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

// Select ACLR measurement
:CALCulate:MARKer:FUNCTION:POWer:SElect ACPower

// Select MSR Standard
:CALCulate:MARKer:FUNCTION:POWer:PRESet MSR

//Configure general measurement settings
:SENSe:FREQuency:CENTer 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3

//----- Configuring Sub block A
```

```
:SENSe:POWer:ACHannel:SBLock1:TXCHannel:COUNt 3
:SENSe:POWer:ACHannel:SBLock1:FREQuency:CENter 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:RFBWidth 12MHZ

:SENSe:POWer:ACHannel:SBLock1:CENter:CHANnel1 1.226GHZ
:SENSe:POWer:ACHannel:SBLock1:CENter:CHANnel2 1.230GHZ
:SENSe:POWer:ACHannel:SBLock1:CENter:CHANnel3 1.234GHZ

:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel1 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel2 WCDMA
:SENSe:POWer:ACHannel:SBLock1:TECHnology:CHANnel3 GSM

:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel1 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel2 2.5MHZ
:SENSe:POWer:ACHannel:SBLock1:BANDwidth:CHANnel3 2.5MHZ

//----- Configuring Sub block B

:SENSe:POWer:ACHannel:SBLock2:TXCHannel:COUNt 1
:SENSe:POWer:ACHannel:SBLock2:FREQuency:CENter 1.255GHZ
:SENSe:POWer:ACHannel:SBLock2:RFBWidth 4MHZ

:SENSe:POWer:ACHannel:SBLock2:CENter:CHANnel1 1.255GHZ

:SENSe:POWer:ACHannel:SBLock2:TECHnology:CHANnel1 LTE_1_40

:SENSe:POWer:ACHannel:SBLock2:BANDwidth:CHANnel1 3.25MHZ

//----- Configuring Sub block C

:SENSe:POWer:ACHannel:SBLock3:TXCHannel:COUNt 2
:SENSe:POWer:ACHannel:SBLock3:FREQuency:CENter 1.268GHZ
:SENSe:POWer:ACHannel:SBLock3:RFBWidth 8MHZ

:SENSe:POWer:ACHannel:SBLock3:CENter:CHANnel1 1.266GHZ
:SENSe:POWer:ACHannel:SBLock3:CENter:CHANnel2 1.270GHZ

:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel1 2.75MHZ
:SENSe:POWer:ACHannel:SBLock3:BANDwidth:CHANnel2 2.75MHZ

//----- Configuring ADJ channels

:SENSe:POWer:ACHannel:BANDwidth:ACHannel 1.60MHZ
:SENSe:POWer:ACHannel:BANDwidth:ALternate1 1.60MHZ

:SENSe:POWer:ACHannel:SPACing:ACHannel 3MHZ
:SENSe:POWer:ACHannel:SPACing:ALternate1 5MHZ
```



```

//----- Configuring gap channels manually
:SENSe:POWer:ACHannel:AGCHannels ON
:SENSe:POWer:ACHannel:GAP:MODE MAN

//----- Configuring AB gap channels
// 1 lower, 2 upper

:SENSe:POWer:ACHannel:GCH:GAP1:MAN:LOW AB, ON
:SENSe:POWer:ACHannel:GCH:GAP1:MAN:UPP AB, ON
:SENSe:POWer:ACHannel:GCH:GAP2:MAN:UPP AB, ON

:SENSe:POWer:ACHannel:SPACing:GAP1:MAN:LOW AB,2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP1:MAN:UPP AB,2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2:MAN:UPP AB,4.2MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1:MAN:LOW AB,2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP1:MAN:UPP AB,2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2:MAN:UPP AB,2.0MHZ

:SENSe:POWer:ACHannel:FILTer:STATe:GAP1:MAN:LOW AB,ON
:SENSe:POWer:ACHannel:FILTer:STATe:GAP1:MAN:UPP AB,ON
:SENSe:POWer:ACHannel:FILTer:STATe:GAP2:MAN:UPP AB,ON

:SENSe:POWer:ACHannel:FILTer:ALPha:GAP1:MAN:LOW AB,0.25
:SENSe:POWer:ACHannel:FILTer:ALPha:GAP1:MAN:UPP AB,0.25
:SENSe:POWer:ACHannel:FILTer:ALPha:GAP2:MAN:UPP AB,0.25

//Limit check
:CALC:LIM:ACP ON
:CALC:LIM:ACP:GAP1:MAN:UPP:ABS:STAT AB,ON
:CALC:LIM:ACP:GAP1:MAN:UPP:ABS AB,3DBM
:CALC:LIM:ACP:GAP2:MAN:UPP:ABS:STAT AB,ON
:CALC:LIM:ACP:GAP2:MAN:UPP:ABS AB,3DBM

//----- Configuring BC gap channels
// 2 lower, 0 upper

:SENSe:POWer:ACHannel:GCH:GAP1:MAN:LOW AB, ON
:SENSe:POWer:ACHannel:GCH:GAP2:MAN:LOW AB, ON

:SENSe:POWer:ACHannel:SPACing:GAP1:MAN:LOW BC,2.0MHZ
:SENSe:POWer:ACHannel:SPACing:GAP2:MAN:LOW BC,4.2MHZ

:SENSe:POWer:ACHannel:BANDwidth:GAP1:MAN:LOW BC,2.0MHZ
:SENSe:POWer:ACHannel:BANDwidth:GAP2:MAN:LOW BC,2.0MHZ

//Limit check
:CALC:LIM:ACP ON
:CALC:LIM:ACP:GAP1:MAN:LOW:ABS:STAT BC,ON
:CALC:LIM:ACP:GAP1:MAN:LOW:ABS BC,3DBM

```

```

:CALC:LIM:ACP:GAP1:MAN:LOW:CACL:REL:STAT BC,ON
:CALC:LIM:ACP:GAP1:MAN:LOW:CACL:REL BC,-3DB

:CALC:LIM:ACP:GAP2:MAN:LOW:ACLR:REL:STAT BC,ON
:CALC:LIM:ACP:GAP2:MAN:LOW:ACLR:REL BC,-3DB

//-----Performing the Measurement-----

//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//-----Retrieving Results-----

//Return the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? MCAC
//Results:
//Transmission channels in sub block A
//-13.2346727385,-13.2346723793,-13.2390131759,
//Transmission channels in sub block B
//-17.0863336597,
//Transmission channels in sub block C
//-13.2390127767,-13.2390134744,
//Totals for each sub block
//-8.4649064021,-17.0863336597,-10.2287131689,
//Adjacent channels
//-67.9740721019,-67.9740728014,-0.00434041734,-0.00434041734,
//CACL channels (AB2L, BC1U, BC2U invalid)
//-0.52933512766,-64.9990115835 9.91e37,-0.33507330922,
//-64.4924159646, 9.91e37,-0.52932552495, 9.91e37

//Limit check
CALC:LIM:ACP:GAP1:ACLR:RES?
//Result for gap 1 channels: ABGap1L,ABGap1U,BCGap1L, ( BCGap1U invalid )
//PASSED,PASSED,PASSED,NONE
CALC:LIM:ACP:GAP2:ACLR:RES?
//Result for gap 2 channels: (ABGap2L invalid ),ABGap2U,BCGap2L, ( BCGap2U invalid )
//NONE,PASSED,PASSED,NONE

```

#### 6.7.4 Carrier-to-noise ratio

Commands to perform carrier-to-noise measurements described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:SElect`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>[:STATe]`
- `[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]`

- [\[SENSe:\]POWer:ACHannel:PRESet](#)

### Programming example: Measuring the carrier-to-noise ratio

```
//-----Preparing the measurement-----
*RST
//Reset the instrument
FREQ:CENt 800MHz
//Sets the center frequency to the carrier frequency of 800 MHz.
CALC:MARK:FUNC:POW:SEL CN
//Activates carrier-to-noise ratio measurement.
POW:ACH:PRESet CN
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRESet:RLEV
//Determines the ideal reference level for the measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
// Now turn off the carrier signal and repeat the measurement:
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:MARK:FUNC:POW:RES? CN
//Returns the carrier-to-noise ratio.
```

## 6.7.5 Occupied bandwidth

- [Configuring the measurement](#).....519
- [Programming example: OBW measurement](#)..... 520

### 6.7.5.1 Configuring the measurement

Commands to configure the channel described elsewhere.

- [\[SENSe:\]POWer:ACHannel:BANDwidth\[:CHANnel<ch>\]](#)
- [\[SENSe:\]POWer:ACHannel:PRESet](#)
- [\[SENSe:\]POWer:ACHannel:PRESet:RLEVel](#)

Commands to configure search limits described elsewhere.

- [CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#)
- [CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#)
- [CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#)

Commands to perform the measurement described elsewhere.

- [CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>:SElect](#)

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>[:STATe]`

Commands to retrieve results described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNCtion:POWer<sb>:RESult?`

|  |     |
|--|-----|
| <code>[SENSe:]POWer:BWIDth</code> .....    | 520 |
| <code>[SENSe:]POWer:BANDwidth</code> ..... | 520 |

---

**[SENSe:]POWer:BWIDth <Percentage>**

**[SENSe:]POWer:BANDwidth <Percentage>**

Selects the percentage of the total power that defines the occupied bandwidth.

**Parameters:**

|              |                           |
|--------------|---------------------------|
| <Percentage> | Range: 10 PCT to 99.9 PCT |
|              | *RST: 99 PCT              |
|              | Default unit: PCT         |

**Example:** POW:BAND 95PCT

**Manual operation:** See "[% Power Bandwidth](#)" on page 97

### 6.7.5.2 Programming example: OBW measurement

This programming example demonstrates the measurement example described in [Chapter 3.4.5, "Measurement example"](#), on page 100 in a remote environment.

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

//-----Configuring the Measurement-----
//Set the center frequency to 800 MHz.
FREQ:CENT 800MHz
//Set the reference level to -10 dBm.
DISP:TRAC:Y:RLEV -10dBm
//Activate occupied bandwidth measurement.
CALC:MARK:FUNC:POW:SEL OBW
//Set the percentage of power to 99%.
POW:BWID 99PCT
//Set the channel bandwidth to 21 kHz.
POW:ACH:BAND 21kHz
//Optimize the instrument settings according to the channel bandwidth.
POW:ACH:PRES OBW
//Determine the ideal reference level for the measurement.
POW:ACH:PRES:RLEV
//Set the trace detector to positive peak.
DET APE

//-----Performing the Measurement-----
//Select single sweep mode.INIT:CONT OFF

//Initiate a new measurement and waits until the sweep has finished.
```

```
INIT;*WAI
```

```
//-----Retrieving Results-----  
//Return the occupied bandwidth.  
CALC:MARK:FUNC:POW:RES? OBW
```

## 6.7.6 Spectrum emission mask (SEM)

|   |     |
|---|-----|
| • Measurement configuration management..... | 521 |
| • Measurement control.....                  | 522 |
| • Multi SEM measurement configuration.....  | 523 |
| • Sweep list configuration.....             | 525 |
| • Reference range configuration.....        | 539 |
| • Power class configuration.....            | 541 |
| • MSR SEM measurement configuration.....    | 546 |
| • List evaluation.....                      | 552 |
| • Measurement control.....                  | 553 |
| • Result retrieval.....                     | 553 |
| • Example: SEM measurement.....             | 553 |

### 6.7.6.1 Measurement configuration management

|   |     |
|---|-----|
| CALCulate<n>:LIMit<li>:ESPectrum<sb>:RESTore..... | 521 |
| [SENSe:]ESPectrum<sb>:PRESet[:STANdard].....      | 521 |
| [SENSe:]ESPectrum<sb>:PRESet:RESTore.....         | 522 |
| [SENSe:]ESPectrum<sb>:PRESet:STORe.....           | 522 |

---

#### CALCulate<n>:LIMit<li>:ESPectrum<sb>:RESTore

Restores the predefined limit lines for the selected Spectrum Emission Mask standard.

All modifications made to the predefined limit lines are lost and the factory-set values are restored.

##### Suffix:

|      |   |
|------|---|
| <n>  | irrelevant                                    |
| <li> | irrelevant                                    |
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |

##### Example:

```
CALC:LIM:ESP:REST
```

Resets the limit lines for the current Spectrum Emission Mask standard to the default setting.

---

#### [SENSe:]ESPectrum<sb>:PRESet[:STANdard] <Standard>

Loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is C:\R\_S\INSTR\sem\_std.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Standard> String containing the file name.  
If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

**Manual operation:** See ["Standard / MSR Settings"](#) on page 122  
See ["Load Standard"](#) on page 129

**[SENSe:]ESpectrum<sb>:PRESet:REStore**

Restores the default configurations of predefined SEM standards.

Note that the command will overwrite customized standards that have the same name as predefined standards.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Manual operation:** See ["Restore Standard Files"](#) on page 130

**[SENSe:]ESpectrum<sb>:PRESet:StORe <Standard>**

Saves the current SEM measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is C:\R\_S\INSTR\sem\_std.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Standard> String containing the file name.  
You can save the file in a subdirectory of the directory mentioned above. In that case, you have to include the relative path to the file.

**Manual operation:** See ["Save Standard"](#) on page 130

**6.7.6.2 Measurement control**

|   |     |
|---|-----|
| <a href="#">INITiate&lt;n&gt;:ESpectrum</a> ..... | 523 |
| <a href="#">[SENSe:]SWEep:MODE</a> .....          | 523 |

**INITiate<n>:ESpectrum**

Initiates a Spectrum Emission Mask measurement.

**Suffix:**

<n> irrelevant

**Usage:**

Asynchronous command

**[SENSe:]SWEep:MODE <Mode>**

Selects the spurious emission and spectrum emission mask measurements.

You can select other measurements with

- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>[:STATe]`

**Parameters:**

<Mode> LIST | AUTO | ESpectrum

**AUTO**

Turns on basic spectrum measurements.

**ESpectrum**

Turns on spectrum emission mask measurements.

**LIST**

Turns on spurious emission measurements.

\*RST: AUTO

**Example:**

`SWE:MODE ESP`

**6.7.6.3 Multi SEM measurement configuration**

|   |     |
|---|-----|
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:MLCalc</code> ..... | 523 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:SCENter</code> .....                | 524 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:SCOunt</code> .....                 | 524 |

**[SENSe:]ESpectrum<sb>:RANGe<ri>:MLCalc <Function>**

Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details see "[Limit calculation for individual ranges](#)" on page 112.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Function> NONE | MAX | SUM

**NONE**

(reference ranges only:) the limit of the reference range is used;  
Reference ranges always use the function "NONE".

**SUM**

sum of the two limit lines (calculated for linear powers) is used

**MAX**

maximum of the two limit lines is used

\*RST: SUM (reference range: NONE)

**Manual operation:** See ["Multi-Limit Calc <n>"](#) on page 120

**[SENSe:]ESpectrum<sb>:SCENter <Frequency>**

Defines the center frequency of the selected sub block in a Multi-SEM measurement.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Frequency> Frequency within the currently defined global span (see  
[\[SENSe:\]FREQUENCY:SPAN](#) on page 654 and [\[SENSe:\]FREQUENCY:CENter](#) on page 652).

Range: 1 to 3

\*RST: 1

Default unit: Hz

**Example:** ESP1:SCEN 1GHZ

**Manual operation:** See ["Sub Block / Center Freq"](#) on page 122

**[SENSe:]ESpectrum<sb>:SCOut <Subblocks>**

Defines the number of sub blocks in the SEM measurement.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Subblocks> Number of sub blocks in the SEM measurement.

Range: 1 to 3

\*RST: 1

**Example:** ESP:SCO 2

**Manual operation:** See ["Sub Block Count"](#) on page 122



#### 6.7.6.4 Sweep list configuration

Commands to configure sweep lists described elsewhere.

- `CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:LIMit[:STATe]`

|  |     |
|--|-----|
| <code>[SENSe:]ESpectrum&lt;sb&gt;:HSPeEd</code>  | 525 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:BANDwidth:RESolution</code>                    | 526 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:BANDwidth:VIDeo</code>                         | 526 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:COUNT?</code>                                  | 527 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:DELete</code>                                  | 527 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:FILTer:TYPE</code>                             | 527 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;[:FREquency]:START</code>                       | 528 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;[:FREquency]:STOP</code>                        | 528 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:INPut:ATTenuation</code>                       | 529 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:INPut:ATTenuation:AUTO</code>                  | 529 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:INPut:GAIN:STATe</code>                        | 530 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:INPut:GAIN:LNA:STATe</code>                    | 530 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:INPut:GAIN[:VALue]</code>                      | 531 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:INSert</code>                                  | 531 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:ABSolute:START</code>          | 531 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:ABSolute:STOP</code>           | 532 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:START</code>          | 532 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:START:ABS</code>      | 533 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:START:FUNCTION</code> | 533 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:STOP</code>           | 534 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:STOP:ABS</code>       | 535 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:STOP:FUNCTION</code>  | 535 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:STATe</code>                   | 536 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:POINts:MINimum[:VALue]</code>                  | 537 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:RLEVel</code>                                  | 537 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:SWEep:TIME</code>                              | 537 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:SWEep:TIME:AUTO</code>                         | 538 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:TRANSDucer</code>                              | 538 |
| <code>[SENSe:]ESpectrum&lt;sb&gt;:SSETup</code>  | 539 |

---

#### `[SENSe:]ESpectrum<sb>:HSPeEd <State>`

Turns high speed mode for SEM measurements on and off.

For more information including restrictions see [Chapter 3.5.4.3, "Fast SEM measurements"](#), on page 109.

#### Suffix:

`<sb>` 1 to 3  
Subblock in a multi-SEM measurement

#### Parameters:

`<State>` ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off

**ON | 1**

Switches the function on

**Example:** ESP:HSP ON**Manual operation:** See "Fast SEM" on page 117**[SENSe:]ESpectrum<sb>:RANGe<ri>:BANdwidth:RESolution <RBW>**

Defines the resolution bandwidth for a SEM range.

In case of high speed measurements, the resolution bandwidth has to be identical for all ranges.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<RBW> Resolution bandwidth.  
Refer to the specifications document for available resolution bandwidths.

\*RST: 30.0 kHz

Default unit: Hz

**Manual operation:** See "RBW" on page 118**[SENSe:]ESpectrum<sb>:RANGe<ri>:BANdwidth:VIDeo <VBW>**

Defines the video bandwidth for a SEM range.

In case of high speed measurements, the video bandwidth has to be identical for all ranges.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<VBW> Video bandwidth.  
Refer to the specifications document for available video bandwidths.

\*RST: 10.0 MHz

Default unit: Hz

**Manual operation:** See "VBW" on page 118

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:COUNT?**

Queries the number of ranges in the sweep list.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <ri> | irrelevant                                    |

**Return values:**

|          |                                     |
|----------|-------------------------------------|
| <Ranges> | Number of ranges in the sweep list. |
|----------|-------------------------------------|

**Usage:** Query only

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:DELeTe**

Removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <ri> | Selects the measurement range.                |

**Manual operation:** See ["Delete Range"](#) on page 121

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:FILTer:TYPE <FilterType>**

This command selects the filter type for an SEM range.

In case of high speed measurements, the filter has to be identical for all ranges.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <ri> | 1...30<br>Selects the measurement range.      |

**Parameters:**

|              |   |
|--------------|---|
| <FilterType> | <b>CFILter</b><br>Channel filters<br>Available in the Spectrum application.<br><b>NORMal</b><br>3 dB Gaussian filters<br>Available in the Spectrum application.<br><b>P5</b><br>5-pole filters<br>Available for FFT sweeps in the Spectrum application. |
|--------------|---|

**RRC**

RRC filters

**CISPr | PULSe**

6 dB CISPR filter

Return value for query is always `PULS`.**MIL**

6 dB MIL standard filter

\*RST: Depends on application

**Manual operation:** See ["Filter Type"](#) on page 117**[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:START** <Frequency>

Defines the start frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S ESW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the SEM sweep list covers, the R&S ESW will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see [Chapter 3.5.4.1, "Ranges and range settings"](#), on page 105.**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Frequency> Numeric value. Note that the minimum frequency range of a SEM range is 20 Hz.

\*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)  
Default unit: Hz

**Manual operation:** See ["Range Start / Range Stop"](#) on page 117**[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:STOP** <Frequency>

Defines the stop frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S ESW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the SEM sweep list covers, the R&S ESW will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see [Chapter 3.5.4.1, "Ranges and range settings"](#), on page 105.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <ri> | 1..n<br>Selects the measurement range.        |

**Parameters:**

|             |  |
|-------------|--|
| <Frequency> | Numeric value.<br>*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)<br>Default unit: Hz |
|-------------|--|

**Manual operation:** See ["Range Start / Range Stop"](#) on page 117

**[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation <Attenuation>**

Defines the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <ri> | 1..n<br>Selects the measurement range.        |

**Parameters:**

|               |  |
|---------------|--|
| <Attenuation> | Numeric value.<br>Refer to the specifications document for the attenuation range.<br>*RST: 10 dB<br>Default unit: dB |
|---------------|--|

**Manual operation:** See ["RF Attenuation"](#) on page 118

**[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO <State>**

Turns automatic selection of the input attenuation for a SEM range on and off.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <ri> | 1..n<br>Selects the measurement range.        |

**Parameters:**

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

**Example:**

ESP:RANG2:INP:ATT:AUTO OFF  
 Deactivates the RF attenuation auto mode for range 2.

**Manual operation:** See ["RF Att Mode"](#) on page 118

**[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATe <State>**

Turns the preamplifier for a SEM range on and off.

In case of high speed measurements, the state of the preamplifier has to be identical for all ranges.

Note that it is not possible to turn on the preamplifier and the [optional low noise preamplifier](#) at the same time.

**Suffix:**

<sb> 1 to 3  
 Subblock in a multi-SEM measurement  
 <ri> 1..n  
 Selects the measurement range.

**Parameters:**

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

**Manual operation:** See ["Preamp"](#) on page 119  
 See ["Preamp"](#) on page 152

**[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:LNA:STATe <State>**

This command turns the optional low noise amplifier (LNA) for a SEM range on and off.

In case of high speed measurements, the state of the low noise preamplifier has to be identical for all ranges.

Note that it is not possible to turn on the [preamplifier](#) and the low noise preamplifier at the same time.

**Suffix:**

<sb> 1 to 3  
 Subblock in a multi-SEM measurement  
 <ri> 1..30  
 Selects the measurement range.

**Parameters:**

<State> ON | OFF  
 \*RST: OFF

**Example:** `ESP:RANG2:INP:GAIN:LNA:STAT ON`  
Turns on the low noise preamplifier in the second SEM range.

**Manual operation:** See ["Preamp"](#) on page 119  
See ["Preamp"](#) on page 152

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN[:VALue] <Gain>**

This command selects the gain for a SEM range.

In case of high speed measurements, the level of the preamplifier has to be identical for all ranges.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..30  
Selects the measurement range.

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:INSert <Mode>**

Inserts a new SEM range and updates the range numbers accordingly.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the SEM range.

**Parameters:**

<Mode> AFTER | BEFore

**AFTer**  
Inserts a range after the selected range.

**BEFore**  
Inserts a range before the selected range.

**Manual operation:** See ["Insert before Range / Insert after Range"](#) on page 121

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:START <Level>**

Defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

<li> 1..n  
Power class for which the limit is defined.

**Parameters:**

<Level> Absolute limit at the start frequency of a SEM range.  
Range: -400 to 400  
\*RST: -13  
Default unit: dBm

**Example:** SENSE:ESpectrum:RANGE:LIMit:ABSolute:START -10  
For a detailed example see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See ["Abs Limit Start / Stop <n>"](#) on page 119

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:ABSolute:STOP <Level>**

Defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

<li> 1..n  
Power class for which the limit is defined.

**Parameters:**

<Level> Absolute limit at the stop frequency of a SEM range.  
Range: -400 to 400  
\*RST: -13  
Default unit: dBm

**Example:** SENSE:ESpectrum:RANGE:LIMit:ABSolute:STOP -15  
For a detailed example see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See ["Abs Limit Start / Stop <n>"](#) on page 119

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt <Level>**

Defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit regardless of the limit check mode.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement



<ri> 1..n  
Selects the SEM range.

<li> 1..n  
Power class for which the limit is defined.

**Parameters:**

<Level> Relative limit at the start frequency of a SEM range.  
Range: -400 to 400  
\*RST: -50  
Default unit: dBc

**Example:** SENS:ESP:RANG:LIM:REL:STAR -10

**Manual operation:** See ["Rel Limit Start / Stop <n>"](#) on page 119

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:ABS <Level>**

Defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see ["Relative limit line functions"](#) on page 108.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the SEM range.

<li> 1..n  
Power class for which the limit is defined.

**Parameters:**

<Level> Absolute limit at the start frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see [\[SENSe:\]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCTION](#) on page 533).  
Range: -400 to 400  
\*RST: -13  
Default unit: dBm

**Example:** SENSe:ESpectrum:RANGe:LIMit:RELative:STARt:ABSolute -10

For a detailed example see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See ["Rel Limit Start / Stop <n>"](#) on page 119

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STARt:FUNCTION <Function>**

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

|                          |   |
|--------------------------|---|
| <ri>                     | 1..n<br>Selects the SEM range.  |
| <li>                     | 1..n<br>Power class for which the limit is defined.   |
| <b>Parameters:</b>       |   |
| <Function>               | OFF   MAX<br>Defines the function to be used to determine the relative limit line start value<br><b>MAX</b><br>The maximum of the relative <i>and</i> the absolute level is used as the limit start value. Use the <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:START</code> and <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:START:ABS</code> commands to define these values.<br><b>OFF</b><br>No function is used, the relative limit line is defined by a fixed relative start value. Use the <code>[SENSe:]ESpectrum&lt;sb&gt;:RANGe&lt;ri&gt;:LIMit&lt;li&gt;:RELative:START</code> command to define this value.<br>*RST:        OFF |
| <b>Example:</b>          | SENSE:ESpectrum:RANGe:LIMit:RELative:START:<br>FUNCTION MAX<br>For a detailed example see <a href="#">Chapter 6.7.6.11, "Example: SEM measurement"</a> , on page 553.   |
| <b>Manual operation:</b> | See <a href="#">"Rel Limit Start / Stop &lt;n&gt;"</a> on page 119  |

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP <Level>**

Defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit anytime and regardless of the limit check mode.

**Suffix:**

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement       |
| <ri> | 1..n<br>Selects the SEM range.                      |
| <li> | 1..n<br>Power class for which the limit is defined. |

**Parameters:**

|         |  |
|---------|--|
| <Level> | Relative limit at the stop frequency of a SEM range.<br>Range:        -400 to 400<br>*RST:        -50<br>Default unit: dBc |
|---------|--|

**Example:** `SENSe:ESpectrum:RANge:LIMit:RELative:STOP -15`  
 For a detailed example see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See ["Rel Limit Start / Stop <n>"](#) on page 119

**[SENSe:]ESpectrum<sb>:RANge<ri>:LIMit<li>:RELative:STOP:ABS <Level>**

Defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see ["Relative limit line functions"](#) on page 108.

**Suffix:**

**<sb>** 1 to 3  
Subblock in a multi-SEM measurement

**<ri>** 1..n  
Selects the SEM range.

**<li>** 1..n  
Power class for which the limit is defined.

**Parameters:**

**<Level>** Absolute limit at the stop frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see [\[SENSe:\]ESpectrum<sb>:RANge<ri>:LIMit<li>:RELative:STOP:FUNCTION](#) on page 535).

Range: -400 to 400  
 \*RST: -13  
 Default unit: dBm

**Example:** `SENSe:ESpectrum:RANge:LIMit:RELative:STOP:ABSolute -15`  
 For a detailed example see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See ["Rel Limit Start / Stop <n>"](#) on page 119

**[SENSe:]ESpectrum<sb>:RANge<ri>:LIMit<li>:RELative:STOP:FUNCTION <Function>**

Enables the use of a function when defining the relative limit for a SEM range.

**Suffix:**

**<sb>** 1 to 3  
Subblock in a multi-SEM measurement

**<ri>** 1..n  
Selects the SEM range.

**<li>** 1..n  
Power class for which the limit is defined.

**Parameters:**

**<Function>** OFF | MAX

Defines the function to be used to determine the relative limit line stop value

#### MAX

The maximum of the relative *and* the absolute level is used as the limit stop value. Use the `[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP` and `[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP:ABS` commands to define these values.

#### OFF

No function is used, the relative limit line is defined by a fixed relative stop value. Use the `[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:RELative:STOP` command to define this value.

\*RST: OFF

#### Example:

```
SENSe:ESpectrum:RANGe:LIMit:RELative:STOP:
FUNction MAX
```

For a detailed example see [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See "Rel Limit Start / Stop <n>" on page 119

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit<li>:STATe <State>**

Selects the limit check mode for *all* SEM ranges (<range> is irrelevant).

#### Suffix:

|      |   |
|------|---|
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement       |
| <ri> | 1..n<br>Selects the SEM range.                      |
| <li> | 1..n<br>Power class for which the limit is defined. |

#### Parameters:

<State> ABSolute | RELative | AND | OR

#### ABSolute

Checks only the absolute limits defined.

#### RELative

Checks only the relative limits. Relative limits are defined as relative to the measured power in the reference range.

#### AND

Combines the absolute and relative limit. The limit check fails when both limits are violated.

#### OR

Combines the absolute and relative limit. The limit check fails when one of the limits is violated.

\*RST: RELative

**Manual operation:** See "[Limit Check <n>](#)" on page 119

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:POINTs:MINimum[:VALue] <SweepPoint>**

Defines the minimum number of sweep points for the range.

**Suffix:**

<sb>                      1 to 3  
Subblock in a multi-SEM measurement

<ri>                      Selects the measurement range.

**Parameters:**

<SweepPoint>           Minimum number of sweep points per range

Range:                1 to 32001

\*RST:                1

**Example:**                SENSE1:ESpectrum:RANGe3:POINTs:MIN:VALue 400

**Manual operation:** See "[Min Sweep Points](#)" on page 120

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:RLEVel <RefLevel>**

Defines the reference level for a SEM range.

In case of high speed measurements, the reference level has to be identical for all ranges.

**Suffix:**

<sb>                      1 to 3  
Subblock in a multi-SEM measurement

<ri>                      1..n  
Selects the measurement range.

**Parameters:**

<RefLevel>               Reference level.  
Refer to the specifications document for the reference level range.

\*RST:                0 dBm  
Default unit: dBm

**Manual operation:** See "[Ref Level](#)" on page 118

---

**[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME <SweepTime>**

Defines the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

**Suffix:**

<sb>                      1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<SweepTime> Sweep time.  
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the specifications document for more information.  
Default unit: s

**Manual operation:** See ["Sweep Time"](#) on page 118

**[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO <State>**

Turns automatic selection of the sweep time for a SEM range on and off.

In case of high speed measurements, the sweep time has to be identical for all ranges.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

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

**Example:**

ESP:RANG3:SWE:TIME:AUTO OFF  
Deactivates the sweep time auto mode for range 3.

**Manual operation:** See ["Sweep Time Mode"](#) on page 118

**[SENSe:]ESpectrum<sb>:RANGe<ri>:TRANsducer <Transducer>**

Selects a transducer factor for a SEM range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Transducer> String containing the transducer file name, including the path information.

**Manual operation:** See ["Transducer Factor"](#) on page 119

---

**[SENSe:]ESpectrum<sb>:SSEtUp <State>**

Enables or disables symmetrical configuration of the range settings.

See [Chapter 3.5.4.1, "Ranges and range settings"](#), on page 105.

**Suffix:**

<sb>                      1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<State>                      ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off  
**ON | 1**  
Switches the function on  
\*RST:                      0

**Manual operation:** See ["Symmetrical Setup"](#) on page 121

#### 6.7.6.5 Reference range configuration

|  |     |
|--|-----|
| <a href="#">[SENSe:]ESpectrum&lt;sb&gt;:BWID</a> .....               | 539 |
| <a href="#">[SENSe:]ESpectrum&lt;sb&gt;:FILTer[:RRC]:ALPHA</a> ..... | 539 |
| <a href="#">[SENSe:]ESpectrum&lt;sb&gt;:FILTer[:RRC]:STATe</a> ..... | 540 |
| <a href="#">[SENSe:]ESpectrum&lt;sb&gt;:RRANge?</a> .....            | 540 |
| <a href="#">[SENSe:]ESpectrum&lt;sb&gt;:RTYPE</a> .....              | 540 |

---

**[SENSe:]ESpectrum<sb>:BWID <Bandwidth>**

Defines the channel bandwidth of the reference range.

The bandwidth is available if the power reference is the channel power.

**Suffix:**

<sb>                      1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Bandwidth>                      minimum span ≤ value ≤ span of reference range  
\*RST:                      3.84 MHz  
Default unit: Hz

**Manual operation:** See ["Tx Bandwidth"](#) on page 124

---

**[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHA <Alpha>**

Defines the roll-off factor for the RRC filter.

The RRC filter is available if the power reference is the channel power.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Alpha> Range: 0 to 1  
\*RST: 0.22

**Manual operation:** See ["Alpha:"](#) on page 124

**[SENSe:]ESpectrum<sb>:FILTer[:RRC][:STATe] <State>**

Turns the RRC filter in the reference range on and off.

The RRC filter is available if the power reference is the channel power.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

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

**Manual operation:** See ["RRC Filter State"](#) on page 124

**[SENSe:]ESpectrum<sb>:RRANge?**

Queries the reference range.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Return values:**

<RefRange> Number of the current reference range.  
Range: 1 to 30

**Usage:** Query only

**[SENSe:]ESpectrum<sb>:RTYPE <Type>**

Defines the type of the power reference.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Type> PEAK | CPOWER

**PEAK**

Measures the highest peak within the reference range.



**CPOWer**

Measures the channel power within the reference range (integral bandwidth method).

\*RST: CPOWer

**Manual operation:** See "Power Reference Type" on page 123

**6.7.6.6 Power class configuration**

|  |     |
|--|-----|
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:LIMits.....                   | 541 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:MODE.....                     | 542 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:COUNT.....         | 542 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:LIMit[:STATe]..... | 543 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MAXimum.....       | 544 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MINimum.....       | 544 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>[:EXCLusive].....   | 545 |
| CALCulate<n>:LIMit<li>:ESpectrum<sb>:VALue.....                    | 545 |

---

**CALCulate<n>:LIMit<li>:ESpectrum<sb>:LIMits <Max1>,<Max2>,<Max3>**

This command sets or queries up to 4 power classes in one step. You can only define values for the number of power classes defined by [CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:COUNT](#) on page 542.

**Suffix:**

|      |   |
|------|---|
| <n>  | irrelevant                                    |
| <li> | irrelevant                                    |
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |

**Setting parameters:**

|        |  |
|--------|--|
| <Max1> | <p>Defines the value range for power class 1 as -200 to &lt;Max1&gt;.</p> <p>Only available for <code>CALC:LIM:ESP:PCL:COUNT &gt;=2</code></p> <p>If only 2 power classes are defined, the value range for power class 2 is defined as &lt;Max1&gt; to 200.</p> <p>Range: -199 to + 199</p> <p>Default unit: DBM</p>                               |
| <Max2> | <p>Defines the value range for power class 2 as &lt;Max1&gt; to &lt;Max2&gt;.</p> <p>Only available for <code>CALC:LIM:ESP:PCL:COUNT &gt;=3</code></p> <p>If only 3 power classes are defined, the value range for power class 3 is defined as &lt;Max2&gt; to 200.</p> <p>Range: -199 to + 199, &lt;Max2&gt; must be higher than &lt;Max1&gt;</p> |

**<Max3>** Defines the value range for power class 3 as <Max2> to <Max3>.  
 The value range for power class 4 is defined as <Max3> to 200.  
 Only available for `CALC:LIM:ESP:PCL:COUNT = 4`  
 Range: -199 to + 199, <Max3> must be higher than <Max2>

**Example:** `CALC:LIM:ESP:LIM -50,50,70`  
 Defines the following power classes:  
 <-200, -50>  
 <-50, 50>  
 <50, 70>  
 <70, 200>  
 Query:  
`CALC:LIM:ESP:LIM?`  
 Response:  
 -200,-50,50,70,200

---

#### **CALCulate<n>:LIMit<li>:ESpectrum<sb>:MODE <Mode>**

Which limit line is to be used for an SEM measurement depends on the power class the input signal power belongs to. This command defines whether the power class is determined automatically or manually.

##### **Suffix:**

<n> irrelevant  
 <li> irrelevant  
 <sb> 1 to 3  
 Subblock in a multi-SEM measurement

##### **Parameters:**

<Mode> **AUTO**  
 The power class (and thus the limit line) is assigned dynamically according to the currently measured channel power.  
**MANUAL**  
 One of the specified power classes is selected manually for the entire measurement. The selection is made with the `CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>[:EXCLUSIVE]` command.  
 \*RST: AUTO

**Example:** `CALC:LIM:ESP:MODE AUTO`  
 Activates automatic selection of the limit line.

---

#### **CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:COUNT <NoPowerClasses>**

Sets the number of power classes to be defined.

Must be executed before any new power class values can be defined using  
`CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MAXimum` and  
`CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MINimum`.

**Suffix:**

|      |   |
|------|---|
| <n>  | irrelevant                                    |
| <li> | irrelevant                                    |
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <pc> | irrelevant                                    |

**Parameters:**

|                  |        |
|------------------|--------|
| <NoPowerClasses> | 1 to 4 |
| *RST:            | 1      |

**Example:**

`CALC:LIM:ESP:PCL:COUN 2`  
 Two power classes can be defined.

**Manual operation:** See ["Adding or Removing a Power Class"](#) on page 125

**CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:LIMit[:STATe] <State>**

Selects the limit check mode for each power class.

**Suffix:**

|      |   |
|------|---|
| <n>  | irrelevant                                    |
| <li> | irrelevant                                    |
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <pc> | 1..n<br>power class                           |

**Parameters:**

<State> ABSolute | RELative | AND | OR

**ABSolute**

Evaluates only limit lines with absolute power values

**RELative**

Evaluates only limit lines with relative power values

**AND**

Evaluates limit lines with relative and absolute power values. A negative result is returned if both limits fail.

**OR**

Evaluates limit lines with relative and absolute power values. A negative result is returned if at least one limit failed.

\*RST: REL

**Example:**

`CALC:LIM:ESP:PCL:LIM ABS`

**Manual operation:** See ["Used Power Classes:"](#) on page 125

**CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MAXimum <Level>**

Defines the upper limit of a particular power class.

Note:

- The last power class always has an upper limit of 200 dBm.
- The upper limit of a power class must always be the same as the lower limit of the subsequent power class.
- The power class must already exist (see [CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:COUNT](#) on page 542).

**Suffix:**

|      |   |
|------|---|
| <n>  | irrelevant                                    |
| <li> | irrelevant                                    |
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <pc> | 1..n<br>power class                           |

**Parameters:**

|         |   |
|---------|---|
| <Level> | Range: -199.9 dBm to 200 dBm<br>Default unit: dBm |
|---------|---|

**Example:**

CALC:LIM:ESP:PCL1:MAX -40 dBm  
Sets the maximum power value of the first power class to -40 dBm.

**Manual operation:** See "[PMin/ PMax](#)" on page 125

**CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:MINimum <Level>**

Defines the lower limit of a particular power class.

Note:

- The first power class always has a lower limit of -200 dBm.
- The lower limit of a power class must always be the same as the upper limit of the previous power class.
- The power class must already exist (see [CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>:COUNT](#) on page 542).

**Suffix:**

|      |   |
|------|---|
| <n>  | irrelevant                                    |
| <li> | irrelevant                                    |
| <sb> | 1 to 3<br>Subblock in a multi-SEM measurement |
| <pc> | 1..n<br>power class                           |

**Parameters:**

<Level>                      Range:        -200 dBm to 199.9 dBm  
                                     Default unit: dBm

**Example:**

CALC:LIM:ESP:PCL2:MIN -40 dBm

Sets the minimum power value of the second power class to -40 dBm.

**Manual operation:**    See "PMin/ PMax" on page 125

**CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>[:EXCLusive] <State>**

Selects the power class used by the measurement if CALCulate<n>:LIMit<li>:ESpectrum<sb>:MODE is set to manual.

Note that:

- You can only use power classes for which limits are defined.

**Suffix:**

<n>                              irrelevant  
 <li>                              irrelevant  
 <sb>                              1 to 3  
                                     Subblock in a multi-SEM measurement  
 <pc>                              1..n  
                                     power class

**Parameters:**

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

**Example:**

CALC:LIM:ESP:PCL1 ON

Activates the first defined power class.

**Manual operation:**    See "Used Power Classes:" on page 125

**CALCulate<n>:LIMit<li>:ESpectrum<sb>:VALue <Power>**

Activates the manual limit line selection as and specifies the expected power as a value. Depending on the entered value, the associated predefined limit lines is selected.

Has the same effect as a combination of the CALC:LIM:ESP:MODE MAN and the CALCulate<n>:LIMit<li>:ESpectrum<sb>:PCLass<pc>[:EXCLusive] commands; however, the power class to be used is not defined directly, but via the expected power. As opposed to CALC:LIM:ESP:MODE AUTO, the power class is not re-assigned to the input signal power dynamically, but only once when the command is executed.

**Suffix:**

<n>                              irrelevant

<lj> irrelevant

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Power> integer

Range: -200 to 199

\*RST: 0

**Example:**

CALC:LIM:ESP:VAL 33

Activates manual selection of the limit line and selects the limit line for P = 33.

**6.7.6.7 MSR SEM measurement configuration**

|   |     |
|---|-----|
| [SENSe:]ESpectrum<sb>:MSR:APPLY.....        | 546 |
| [SENSe:]ESpectrum<sb>:MSR:BAND.....         | 547 |
| [SENSe:]ESpectrum<sb>:MSR:BCATegory.....    | 547 |
| [SENSe:]ESpectrum<sb>:MSR:CLASs.....        | 548 |
| [SENSe:]ESpectrum<sb>:MSR:GSM:CARRier.....  | 549 |
| [SENSe:]ESpectrum<sb>:MSR:GSM:CPResent..... | 549 |
| [SENSe:]ESpectrum<sb>:MSR:LTE:CPResent..... | 550 |
| [SENSe:]ESpectrum<sb>:MSR:MPOWer.....       | 550 |
| [SENSe:]ESpectrum<sb>:MSR:RFBWidth.....     | 551 |

**[SENSe:]ESpectrum<sb>:MSR:APPLY**

Configures the SEM sweep list according to the MSR settings defined by previous commands.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Example:**

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Apply to SEM"](#) on page 128

**[SENSe:]ESpectrum<sb>:MSR:BAND <Range>**

Defines the frequency range of the bands used by the base station.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Range> LOW | HIGH  
**LOW**  
≤ 3 GHz  
**HIGH**  
> 3 GHz  
\*RST: LOW

**Example:**

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Bands"](#) on page 127

**[SENSe:]ESpectrum<sb>:MSR:BCATegory <Category>**

Defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Category> 1 | 2 | 3  
**1**  
2 carriers: LTE FDD and W-CDMA  
**2**  
3 carriers: LTE FDD, W-CDMA and GSM/EDGE  
**3**  
2 carriers: LTE TDD and TD-SCDMA  
\*RST: 1

**Example:**

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Band Category"](#) on page 126

---

### [SENSe:]ESpectrum<sb>:MSR:CLASs <Class>

Defines the class of the base station according to its sending range.

#### Suffix:

<sb> 1 to 3  
Subblock in a multi-SEM measurement

#### Parameters:

<Class> WIDE | MEDium | LOCAl  
**WIDE**  
Wide Area  
**MEDium**  
Medium Range  
**LOCAl**  
Local Area  
**\*RST:** WIDE

**Example:**

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Base Station Class"](#) on page 127



**[SENSe:]ESpectrum<sb>:MSR:GSM:CARRier <Power>**

Defines the power of the GSM carrier (if available, see [\[SENSe:\]ESpectrum<sb>:MSR:GSM:CPResent](#) on page 549).

Is only available for band category 2 (see [\[SENSe:\]ESpectrum<sb>:MSR:BCATegory](#) on page 547).

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Power> Range: 0 dBm to 100 dBm  
\*RST: 39.0 dBm  
Default unit: dBm

**Example:**

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//GSM/Edge present
ESP2:MSR:GSM:CPR ON
//Power of the GSM carrier is 20dBm
ESP2:MSR:GSM:CARR 20
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Power Gsm Carrier"](#) on page 128

**[SENSe:]ESpectrum<sb>:MSR:GSM:CPResent <State>**

Defines whether a GSM/Edge carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

Is only available for band category 2 (see [\[SENSe:\]ESpectrum<sb>:MSR:BCATegory](#) on page 547).

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

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

**Example:**

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//GSM/Edge present
ESP2:MSR:GSM:CPR ON
//Power of the GSM carrier is 20dBm
ESP2:MSR:GSM:CARR 20
```

**Manual operation:** See ["Carrier Adjacent to RF Bandwidth Edge"](#) on page 127

#### [SENSe:]ESpectrum<sb>:MSR:LTE:CPResent <State>

Defines whether an LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

Is only available for band category 2 (see [\[SENSe:\]ESpectrum<sb>:MSR:BCATegory](#) on page 547).

#### Suffix:

<sb> 1 to 3  
Subblock in a multi-SEM measurement

#### Parameters:

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

**Example:**

```
//Select the band category 2
ESP2:MSR:BCAT BC2
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//LTE present
ESP2:MSR:LTE:CPR ON
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Carrier Adjacent to RF Bandwidth Edge"](#) on page 127

#### [SENSe:]ESpectrum<sb>:MSR:MPOWER <Power>

Defines the maximum output power of the base station.

This setting is only available for base stations with a medium range base station class (see [\[SENSe:\]ESpectrum<sb>:MSR:CLASs](#) on page 548).

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Power> Range: 0 dBm to 100 dBm  
Increment: 1 dB  
Default unit: dBm

**Example:**

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
```

**Manual operation:** See ["Base Station Maximum Output Power"](#) on page 127

**[SENSe:]ESpectrum<sb>:MSR:RFBWidth <Bandwidth>**

Defines the RF bandwidth of the base station for MSR measurements.

**Suffix:**

<sb> 1 to 3  
Subblock in a multi-SEM measurement

**Parameters:**

<Bandwidth> Bandwidth in Hz  
\*RST: 10.0 MHz  
Default unit: Hz

**Example:**

```
//Select the band category 1
ESP2:MSR:BCAT 1
//Set the base station class to medium range
ESP2:MSR:CLAS MED
//Set the maximum output power to 10 dBm.
ESP2:MSR:MPOW 10
//Set the frequency range of the base station to > 3 GHz
ESP2:MSR:BAND:HIGH
//Set the base station RF bandwidth to 20 MHz
ESP2:MSR:RFBW 20MHZ
//Calculate limits for MSR SEM
ESP2:MSR:APPL
```

**Manual operation:** See ["Base Station RF Bandwidth"](#) on page 127

### 6.7.6.8 List evaluation

Commands to configure the list evaluation described elsewhere.

- `MMEMory:STORe<n>:LIST`

|  |     |
|--|-----|
| <code>CALCulate&lt;n&gt;:ESpectrum:PSEarch:AUTO</code> .....           | 552 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PEAKsearch:AUTO</code> .....        | 552 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PSEarch[:IMMEDIATE]</code> .....    | 552 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PEAKsearch[:IMMEDIATE]</code> ..... | 552 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PSEarch:MARGIN</code> .....         | 552 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PEAKsearch:MARGIN</code> .....      | 552 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PSEarch:PSHOW</code> .....          | 553 |
| <code>CALCulate&lt;n&gt;:ESpectrum:PEAKsearch:PSHOW</code> .....       | 553 |

---

**`CALCulate<n>:ESpectrum:PSEarch:AUTO <State>`**

**`CALCulate<n>:ESpectrum:PEAKsearch:AUTO <State>`**

Turns the list evaluation on and off.

**Suffix:**

<n> [Window](#)

**Parameters:**

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

**Example:**

`CALC:ESP:PSE:AUTO OFF`  
Deactivates the list evaluation.

**Manual operation:** See "[List Evaluation State \(result summary\)](#)" on page 131

---

**`CALCulate<n>:ESpectrum:PSEarch[:IMMEDIATE]`**

**`CALCulate<n>:ESpectrum:PEAKsearch[:IMMEDIATE]`**

Initiates a list evaluation.

**Suffix:**

<n> [Window](#)

---

**`CALCulate<n>:ESpectrum:PSEarch:MARGIN <Threshold>`**

**`CALCulate<n>:ESpectrum:PEAKsearch:MARGIN <Margin>`**

Defines the threshold of the list evaluation.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Margin> Range: -200 to 200  
\*RST: 200  
Default unit: dB

**Example:** `CALC:ESP:PSE:MARG 100`  
Sets the margin to 100 dB.

**Manual operation:** See "[Margin](#)" on page 131

**CALCulate<n>:ESpectrum:PSEarch:PSHow <State>**  
**CALCulate<n>:ESpectrum:PEAKsearch:PSHow <State>**

Turns the peak labels in the diagram on and off.

Peak labels are blue squares.

**Suffix:**  
<n> [Window](#)

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

**Example:** `CALC:ESP:PSE:PSH ON`  
Marks all peaks with blue squares.

**Manual operation:** See "[Show Peaks](#)" on page 131

#### 6.7.6.9 Measurement control

Commands to perform SEM measurements described elsewhere.

- `INITiate<n>:ESpectrum`
- `INITiate<mt>[:IMMediate]`
- `[SENSe:]SWEep:MODE`

#### 6.7.6.10 Result retrieval

Commands to retrieve results described elsewhere.

- `CALCulate<n>:LIMit<li>:FAIL?`
- `CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>:RESult?`
- `TRACe<n>[:DATA]`
- `TRACe<n>[:DATA]:MEMory?`
- `TRACe<n>[:DATA]:X?`

#### 6.7.6.11 Example: SEM measurement

In this example we will configure and perform an SEM measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S ESW performs the measurement optimally with the predefined settings, without further configuration.

```

//-----Preparing the measurement -----
//Reset the instrument
*RST

//----- Preparing the measurement-----
//Activate SEM Measurement
SWE:MODE ESP

//Selects single sweep mode.
//SEM has to be in single sweep mode to be configured and no sweep operation
//may be running!
// If required, a sweep stop can be ensured by INIT:IMM;*WAI
INIT:CONT OFF


//----- Managing Measurement Configurations-----
//Load the 3GPP configuration stored in the file '3GPP_UL.xml'
ESP:PRES 'WCDMA\3GPP\UL\3GPP_UL.xml'


//----- Defining the Reference Range-----
//Query the current reference range.
ESP:RRAN?
//Select the channel power as the power reference.
ESP:RTYP CPOW
//Define a channel bandwidth of 4 MHz for the power reference.
ESP:BWID 4 MHZ
//Use an RRC filter with a roll-off factor of 0.5 when measuring
//the reference power.
ESP:FILT:RRC ON
ESP:FILT:ALPH 0.5


//----- Configuring Power Classes-----
//Define 3 power classes.
CALC:LIM:ESP:PCL:COUN 3
//Define the value ranges of the three power classes as [dBm]:
//power class 1: -200 to -100
//power class 2: -100 to 0
//power class 3: 0 to 200
CALC:LIM:ESP:LIM -100,0
//Define an absolute limit check for class 1.
CALC:LIM:ESP:PCL1:LIM ABS
//Define a relative limit check for class 2.
CALC:LIM:ESP:PCL2:LIM REL
//Define a manual selection of the power class.
CALC:LIM:ESP:MODE MAN
//Activate the use of the second power class for the entire measurement.
CALC:LIM:ESP:PCL2 ON


//----- Configuring a Sweep List-----
//Insert a range after range 2.

```

```

ESP:RANG2:INS AFT
//Insert a range before range 1.
ESP:RANG1:INS BEF
//Query the number of measurement ranges in the sweep list (currently 11).
ESP:RANG:COUNT?
//Delete the 11th range.
ESP:RANG5:DEL

//Define a stop frequency of -9 MHz for range 1.
ESP:RANG1:STOP -10000000

//Define a start frequency of -10 MHz for range 2.
ESP:RANG2:STAR -9000000

//Switch off Fast SEM mode so the ranges can be configured individually.
ESP:HSP OFF

//Define a resolution bandwidth of 1 MHz for range 2.
ESP:RANG2:BAND:RES 1000000

//Select an RRC filter for range 2.
ESP:RANG2:FILT:TYPE RRC

//Define a video bandwidth of 5 MHz for range 2.
ESP:RANG2:BAND:VID 5000000
//Define a sweep time of 1 second for range 2.
ESP:RANG2:SWE:TIME 1
//Define a reference level of 0 dBm for range 2.
ESP:RANG2:RLEV 0
//Define an input attenuation of 10 dB for range 2.
ESP:RANG2:INP:ATT 10

// Create a transducer that can be used.
// It has to cover the corresponding frequency range

SENSE1:CORRection:TRANSDUCER:SElect 'Transducer'
SENSE1:CORRection:TRANSDUCER:UNIT 'DB'
SENSE1:CORRection:TRANSDUCER:COMMeNt 'Test Transducer'
// Frequency Span 0 MHz bis 20 Ghz
SENSE1:CORRection:TRANSDUCER:DATA 0e6,5, 20e9,3

//Include a transducer called 'transducer' for range 2.
ESP:RANG2:TRAN 'Transducer'

//----- Configuring the limit check-----

//Check the absolute and relative limits for all ranges in power class 1 and
//fails if both limits are violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant. They are

```

```

//defined here to demonstrate the use of the MAX function for relative limits.
ESP:RANG:LIM1:STAT AND
//Enable the use of maximum function for relative limit start. If the value
//exceeds the larger of the absolute (-13 dBm) and relative (-10 dBc) start
//values, the check fails.
ESP:RANG2:LIM1:REL:STAR:FUNC MAX
ESP:RANG2:LIM1:REL:STAR -10
ESP:RANG2:LIM1:REL:STAR:ABS -13
ESP:RANG2:LIM1:REL:STOP:FUNC MAX
ESP:RANG2:LIM1:REL:STOP -10
ESP:RANG2:LIM1:REL:STOP:ABS -13

//Check the absolute and relative limits for all ranges in power class 2 and
//fails if either limit is violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant.
ESP:RANG:LIM2:STAT OR
//Define an absolute limit of 10 dBm for the entire range 2 for power class 2.
ESP:RANG2:LIM2:ABS:STAR 10
ESP:RANG2:LIM2:ABS:STOP 10
//Define a relative limit of -20 dBc for the entire range 2 for power class 2.
ESP:RANG2:LIM2:REL:STAR -20
ESP:RANG2:LIM2:REL:STOP -20

//----- Configuring List Evaluation-----
//Activate list evaluation, i.e. the peak is determined for each range
//after each sweep.
CALC:ESP:PSE:AUTO ON
//Define a peak threshold of 10 dB.
CALC:ESP:PSE:MARG 10dB

//----- Managing Measurement Configurations-----

//Save the current configuration in a new file named '3GPP_UL_User'
//in the same directory so the standard is not overwritten.
ESP:PRES:STOR 'WCDMA\3GPP\UL\3GPP_UL_User.xml'

//----- Performing the measurement-----
//One sweep
INIT:ESP

//----- Checking the Results-----
//Query the result of the limit check for all ranges.
CALC:LIM:FAIL?
//Query the peak for each range of the SEM measurement as a list.
TRAC:DATA? LIST

```



## 6.7.7 Spurious emissions

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### 6.7.7.1 Measurement initialization

Note that you have to initialize the measurement before you can configure the sweep list or the list evaluation.

|                           |     |
|---------------------------|-----|
| INITiate<n>:SPURious..... | 557 |
|---------------------------|-----|

---

#### INITiate<n>:SPURious

Initiates a Spurious Emission measurement.

#### Suffix:

<n>

**Usage:** Asynchronous command

### 6.7.7.2 Sweep list configuration



In remote operation, it is not possible to configure the sweep list while a sweep is running.

Commands to configure sweep lists described elsewhere.

- [SENSe:] SWEep:MODE

|  |     |
|--|-----|
| [SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution.....   | 558 |
| [SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo.....        | 558 |
| [SENSe:]LIST:RANGe<ri>:BREak.....                  | 558 |
| [SENSe:]LIST:RANGe<ri>:COUNT?.....                 | 559 |
| [SENSe:]LIST:RANGe<ri>:DELeTe.....                 | 559 |
| [SENSe:]LIST:RANGe<ri>:DETector.....               | 559 |
| [SENSe:]LIST:RANGe<ri>:FILTer:TYPE.....            | 560 |
| [SENSe:]LIST:RANGe<ri>[:FREQuency]:START.....      | 561 |
| [SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP.....       | 561 |
| [SENSe:]LIST:RANGe<ri>:INPut:ATTenuation.....      | 561 |
| [SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO..... | 562 |
| [SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATE.....       | 562 |
| [SENSe:]LIST:RANGe<ri>:INPut:GAIN[:VALue].....     | 562 |
| [SENSe:]LIST:RANGe<ri>:LIMit:START.....            | 563 |
| [SENSe:]LIST:RANGe<ri>:LIMit:STATE.....            | 563 |

|   |     |
|---|-----|
| [SENSe:]LIST:RANGe<ri>:LIMit:STOP.....      | 563 |
| [SENSe:]LIST:RANGe<ri>:POINts[:VALue].....  | 564 |
| [SENSe:]LIST:RANGe<ri>:RLEVel.....          | 564 |
| [SENSe:]LIST:RANGe<ri>:SWEep:TIME.....      | 564 |
| [SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO..... | 565 |
| [SENSe:]LIST:RANGe<ri>:TRANsducer.....      | 565 |

---

### [SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution <RBW>

Defines the resolution bandwidth for a spurious emission measurement range.

#### Suffix:

<ri> 1..n  
Selects the measurement range.

#### Parameters:

<RBW> Resolution bandwidth.  
Refer to the specifications document for available resolution bandwidths.  
Default unit: Hz

**Example:** LIST:RANG2:BAND:RES 3KHZ

**Manual operation:** See "RBW" on page 151

---

### [SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo <VBW>

Defines the video bandwidth for a spurious emission measurement range.

#### Suffix:

<ri> 1..n  
Selects the measurement range.

#### Parameters:

<VBW> Video bandwidth.  
Refer to the specifications document for available video bandwidths.  
Default unit: Hz

**Example:** LIST:RANG2:BAND:VID 3KHZ

**Manual operation:** See "VBW" on page 151

---

### [SENSe:]LIST:RANGe<ri>:BREak <State>

Controls the sweep for all ranges.

#### Suffix:

<ri> irrelevant

#### Parameters:

<State>

**ON | 1**

The R&S ESW stops after measuring one range, and the status bit number 10 in the `STAT:OPER` register is set.

To continue with the next range, use `INITiate<n>:CONMeas`.

**OFF | 0**

The R&S ESW sweeps all ranges in one go.

\*RST: 0

**Example:** `LIST:RANG2:BRE ON`

**Manual operation:** See "[Stop After Sweep](#)" on page 152

**[SENSe:]LIST:RANGe<ri>:COUNT?**

Queries the number of ranges in the sweep list.

**Suffix:**

<ri> irrelevant

**Return values:**

<Ranges> Number of ranges in the sweep list.

**Example:** `LIST:RANG:COUN?`

**Usage:** Query only

**[SENSe:]LIST:RANGe<ri>:DELeTe**

Removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Example:** `LIST:RANG2:DEL`

**[SENSe:]LIST:RANGe<ri>:DETector <Detector>**

This command selects the detector for a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Detector> **APEak**  
Autopeak

**NEGative**

minimum peak detector

**POSitive**

peak detector

**SAMPlE**

sample detector

**RMS**

RMS detector

**AVERage**

average detector

\*RST: RMS

**Example:** LIST:RANG2:DET AVER**Manual operation:** See "[Detector](#)" on page 151**[SENSe:]LIST:RANGe<ri>:FILTeR:TYPE <FilterType>**

This command selects the filter type for a spurious emission measurement range.

**Suffix:**

<ri> 1..30  
 Selects the measurement range.

**Parameters:**

&lt;FilterType&gt;

**CFILter**

Channel filters

Available in the Spectrum application.

**NORMal**

3 dB Gaussian filters

Available in the Spectrum application.

**P5**

5-pole filters

Available for FFT sweeps in the Spectrum application.

**RRC**

RRC filters

**CISPr | PULSe**

6 dB CISPR filter

Return value for query is always PULS.

**MIL**

6 dB MIL standard filter

\*RST: Depends on application

**Example:** LIST:RANG2:FILT:TYPE NORM**Manual operation:** See "[Filter Type](#)" on page 151

**[SENSe:]LIST:RANGe<ri>[:FREQuency]:STARt <Frequency>**

Defines the start frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S ESW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the R&S ESW will adjust the start frequency of the first range and the stop frequency of the last range to the span

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Frequency> Numeric value.  
\*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)  
Default unit: Hz

**Example:** LIST:RANG2:STAR 2MHZ

**Manual operation:** See "[Range Start / Range Stop](#)" on page 150

**[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP <Frequency>**

Defines the stop frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S ESW will not measure the ranges that are outside the span - results may be invalid.
- greater than the span the sweep list covers, the R&S ESW will adjust the start frequency of the first range and the stop frequency of the last range to the span

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Frequency> Numeric value.  
\*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)  
Default unit: Hz

**Example:** LIST:RANG2:STOP 5MHZ

**Manual operation:** See "[Range Start / Range Stop](#)" on page 150

**[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation <Attenuation>**

Defines the input attenuation for a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Attenuation> Numeric value.  
Refer to the specifications document for the attenuation range.  
\*RST: 10 dB  
Default unit: dB

**Example:** LIST:RANG2:INP:ATT 5

**Manual operation:** See ["RF Attenuation"](#) on page 152

**[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO <State>**

Turns automatic selection of the input attenuation for a spurious emission measurement range on and off.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

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

**Example:** LIST:RANG2:INP:ATT:AUTO ON

**Manual operation:** See ["RF Attenuation Mode"](#) on page 152

**[SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATe <State>**

Turns the preamplifier for a spurious emission measurement range on and off.

Note that it is not possible to turn on the preamplifier and the [optional low noise preamplifier](#) at the same time.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

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

**Example:** LIST:RANG2:INP:GAIN:STAT ON

**[SENSe:]LIST:RANGe<ri>:INPut:GAIN[:VALue] <Gain>**

This command selects the preamplification level for the range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Example:** LIST:RANG2:INP:GAIN 15

**[SENSe:]LIST:RANGe<ri>:LIMit:STARt <Level>**

Defines an absolute limit for a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Level> Absolute limit at the start frequency of a SEM range.  
Range: -400 to 400  
\*RST: 13  
Default unit: dBm

**Example:** LIST:RANG2:LIM:STAR 200

**Manual operation:** See ["Abs Limit Start/ Abs Limit Stop"](#) on page 153

**[SENSe:]LIST:RANGe<ri>:LIMit:STATe <State>**

Turns the limit check for all spurious emission measurement ranges on and off.

**Suffix:**

<ri> irrelevant

**Parameters:**

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

**Example:** LIST:RANG2:LIM:STAT ON

**Manual operation:** See ["Limit Check"](#) on page 153

**[SENSe:]LIST:RANGe<ri>:LIMit:STOP <Level>**

Defines an absolute limit for a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Level> Absolute limit at the stop frequency of a SEM range.  
Range: -400 to 400  
\*RST: 13  
Default unit: dBm

**Example:** LIST:RANG2:LIM:STOP 200

**Manual operation:** See ["Abs Limit Start/ Abs Limit Stop"](#) on page 153

---

**[SENSe:]LIST:RANGe<ri>:POINTs[:VALue]** <Points>

Defines the number of sweep points in a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Points> For more information on sweep points see [Chapter 4.6.1.8, "How much data is measured: sweep points and sweep count"](#), on page 303.  
\*RST: 1001

**Example:** LIST:RANG2:POIN 1000

**Manual operation:** See ["Sweep Points"](#) on page 152

---

**[SENSe:]LIST:RANGe<ri>:RLEVel** <RefLevel>

Defines the reference level for a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<RefLevel> Reference level.  
Refer to the specifications document for the reference level range.  
\*RST: 0 dBm  
Default unit: dBm

**Example:** LIST:RANG2:RLEV 1DBM

**Manual operation:** See ["Reference Level"](#) on page 152

---

**[SENSe:]LIST:RANGe<ri>:SWEep:TIME** <SweepTime>

Defines the sweep time for a spurious emission measurement range.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<SweepTime> Sweep time.  
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the specifications document for more information.



**Example:** `LIST:RANG2:SWE:TIME 2MS`

**Manual operation:** See ["Sweep Time"](#) on page 151

**[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO <State>**

Turns automatic selection of the sweep time for a spurious emission measurement range on and off.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

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

**Example:** `LIST:RANG2:SWE:TIME:AUTO ON`

**Manual operation:** See ["Sweep Time Mode"](#) on page 151

**[SENSe:]LIST:RANGe<ri>:TRANsducer <Transducer>**

Selects a transducer factor for a spurious emission measurement range.

Note the following prerequisites for the selected transducer:

- The transducer must cover at least the span of the range.
- The x-axis has to be linear.
- The unit has to be dB.

**Suffix:**

<ri> 1..n  
Selects the measurement range.

**Parameters:**

<Transducer> String containing the transducer file name. Do not include a file extension or the file path.  
The file must be located in the C:\R\_S\INSTR\trd directory.

**Example:** `LIST:RANG2:TRAN 'MYTRANS'`

**Manual operation:** See ["Transducer"](#) on page 153

### 6.7.7.3 List evaluation

Commands to configure the list evaluation described elsewhere.

- [MMEMory:STORe<n>:LIST](#)

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:ESpectrum:PEAKsearch:DETails</a> ..... | 566 |
| <a href="#">CALCulate&lt;n&gt;:PSEarch:AUTO</a> .....                 | 566 |
| <a href="#">CALCulate&lt;n&gt;:PEAKsearch:AUTO</a> .....              | 566 |
| <a href="#">CALCulate&lt;n&gt;:PSEarch:MARGIN</a> .....               | 566 |
| <a href="#">CALCulate&lt;n&gt;:PEAKsearch:MARGIN</a> .....            | 566 |

|  |     |
|--|-----|
| CALCulate<n>:PSEarch:PSHow.....        | 567 |
| CALCulate<n>:PEAKsearch:PSHow.....     | 567 |
| CALCulate<n>:PSEarch:SUBRanges.....    | 567 |
| CALCulate<n>:PEAKsearch:SUBRanges..... | 567 |

---

### CALCulate<n>:ESpectrum:PEAKsearch:DEtails <State>

Configures how detailed the list in the Result Summary is.

#### Suffix:

<n> [Window](#)

#### Parameters:

<State> ON | OFF | 1 | 0  
**ON | 1**  
 Includes all detected peaks (up to a maximum defined by [CALCulate<n>:PEAKsearch:SUBRanges](#) on page 567).  
**OFF | 0**  
 Includes only one peak per range.  
 \*RST: 0

#### Example:

CALC:ESP:PSE:DET ON  
 CALC:PSE:SUBR 10  
 Includes up to 10 peaks per range in the list.

**Manual operation:** See ["Details"](#) on page 155

---

### CALCulate<n>:PSEarch:AUTO <State>

### CALCulate<n>:PEAKsearch:AUTO <State>

Turns the list evaluation  
 on and off.

#### Suffix:

<n> [Window](#)

#### Parameters:

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

#### Example:

CALC:PSE:AUTO OFF  
 Deactivates the list evaluation.

**Manual operation:** See ["List Evaluation State"](#) on page 154

---

### CALCulate<n>:PSEarch:MARGin <Threshold>

### CALCulate<n>:PEAKsearch:MARGin <Margin>

Defines the threshold of the list evaluation.

#### Suffix:

<n> [Window](#)

**Parameters:**

<Margin>                      Range:        -200 to 200  
                                       Default unit: dB

**Example:**

CALC:PSE:MARG 100  
 Sets the threshold to 100 dB.

**Manual operation:**    See "[Margin](#)" on page 155

**CALCulate< n>:PSEarch:PSHow <State>**

**CALCulate< n>:PEAKsearch:PSHow <State>**

Turns the peak labels in the diagram on and off.

Peak labels are blue squares.

**Suffix:**

<n>                                [Window](#)

**Parameters:**

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

**Example:**

CALC:PSE:PSH ON  
 Marks all peaks with blue squares.

**Manual operation:**    See "[Show Peaks](#)" on page 154

**CALCulate< n>:PSEarch:SUBRanges <NumberPeaks>**

**CALCulate< n>:PEAKsearch:SUBRanges <NumberPeaks>**

Defines the number of peaks included in the peak list.

After this number of peaks has been found, the R&S ESW stops the peak search and continues the search in the next measurement range.

**Suffix:**

<n>                                [Window](#)

**Parameters:**

<NumberPeaks>              Range:        1 to 50  
                                       \*RST:        25

**Example:**

CALC:PSE:SUBR 10  
 Sets 10 peaks per range to be stored in the list.

**Manual operation:**    See "[Peaks per Range](#)" on page 155

#### 6.7.7.4 Adjustment of X-Axis to the range definitions

[SENSe:]LIST:XADJust.....568

**[SENSe:]LIST:XADJust**

Sets the x-axis range for the spurious emission measurement from the start frequency of the first sweep range to the stop frequency of the last sweep range.

**Example:** `SENS:LIST:XADJ`

**Usage:** Event

**6.7.7.5 Spurious emission measurements**

Commands to perform the measurement described elsewhere.

- `[SENSe:]SWEep:MODE`
- `INITiate<mt>[:IMMediate]`

**6.7.7.6 Result retrieval**

Commands to retrieve results described elsewhere.

- `CALCulate<n>:LIMit<li>:FAIL?`
- `TRACe<n>[:DATA]`
- `TRACe<n>[:DATA]:MEMory?`
- `TRACe<n>[:DATA]:X?`

**6.7.7.7 Programming example: spurious emissions measurement**

In the following example, the Spurious Emissions measurement is configured by defining ranges and parameters to create the following sweep list.

Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task.

```
//-----Preparing the measurement-----
*RST
//Resets the instrument

SWE:MODE LIST
//Activates spurious emissions measurement

INIT:CONT OFF
//Selects single sweep mode.

//Spurious measurement has to be in single sweep mode to be configured
//and no sweep operation may be running!

// If required, a sweep stop can be ensured by INIT:IMM;*WAI

//-----Configuring a Sweep List-----

LIST:RANG:COUNT?
```

```

//Returns the number of measurement ranges in the sweep list.
LIST:RANG4:DEL
//Deletes the fourth range.
LIST:RANG1:STAR 10000000
//Defines a start frequency of 10 MHz for range 1.
LIST:RANG1:STOP 100000000
//Defines a stop frequency of 100 MHz for range 1.
LIST:RANG1:BAND 500000
//Defines a resolution bandwidth of 500 kHz in range 1.
LIST:RANG1:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 1.
LIST:RANG1:INP:ATT:AUTO OFF
//Turns automatic selection of the input attenuation in range 1 off.

LIST:RANG1:INP:ATT 10
//Defines a input attenuation of 10 dBm for range 1.

LIST:RANG1:FILT:TYPE CFILter
//Selects an Channel filter for range 1.
LIST:RANG1:DET SAMP
//Selects a sample detector for range 1.
LIST:RANG1:POIN 601
//Defines 601 sweep points for range 1.
LIST:RANG1:RLEV -20
//Defines a reference level of -20 dBm for range 1.
LIST:RANG1:SWE:TIME 5
//Defines a manual sweep time of 5 second for range 1.

// Create a transducer that can be used.
// It has to cover the corresponding frequency range
//
SENSE1:CORRection:TRANsducer:SElect 'Test'
SENSE1:CORRection:TRANsducer:UNIT 'DB'
SENSE1:CORRection:TRANsducer:COMMeNT 'Test Transducer'
// Frequency Span 0 MHz to 20 Ghz
SENSE1:CORRection:TRANsducer:DATA 0e6,5, 20e9,3

SENS:LIST:RANG1:TRAN 'Test'
//Includes a transducer called 'Test' for range 1.

LIST:RANG1:LIM:STAR 10
LIST:RANG1:LIM:STOP 10
//Defines an absolute limit of 10 dBm at the start and stop frequencies of range 1.
LIST:RANG:LIM:STAT ON
//Turns the limit check for all ranges on.

//-----Configuring the List Evaluation-----
CALC:PSE:MARG 100
//Sets the threshold to 100 dB.

```

```

CALC:PSE:PSH ON
//Marks all peaks in the diagram with blue squares.
CALC:PSE:SUBR 10
//Sets 10 peaks per range to be stored in the list.

//-----Performing the Measurement-----

INIT:SPUR; *WAI
//Performs a spurious emission measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:LIM1:FAIL?
//Queries the result of the check for limit line 1.
TRAC? SPUR
//Queries the peak list of the spurious emission measurement.

```

## 6.7.8 Statistics

|   |     |
|---|-----|
| • <a href="#">Measurement selection</a> .....                     | 570 |
| • <a href="#">Measurement configuration</a> .....                 | 571 |
| • <a href="#">Gate ranges</a> .....                               | 572 |
| • <a href="#">Diagram scale</a> .....                             | 574 |
| • <a href="#">Measurement control</a> .....                       | 576 |
| • <a href="#">Result retrieval</a> .....                          | 577 |
| • <a href="#">Programming example: measuring statistics</a> ..... | 578 |

### 6.7.8.1 Measurement selection

|  |     |
|--|-----|
| <a href="#">CALCulate&lt;n&gt;:STATistics:APD[:STATe]</a> .....  | 570 |
| <a href="#">CALCulate&lt;n&gt;:STATistics:CCDF[:STATe]</a> ..... | 570 |

---

#### **CALCulate<n>:STATistics:APD[:STATe] <State>**

Turns the APD measurement on and off.

##### **Suffix:**

<n> [Window](#)

##### **Parameters:**

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

##### **Example:**

CALC:STAT:APD ON  
Switches on the APD measurement.

---

#### **CALCulate<n>:STATistics:CCDF[:STATe] <State>**

Turns the "CCDF" on and off.

**Suffix:**

&lt;n&gt; irrelevant

**Parameters:**

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

\*RST: 0

**Example:**

CALC:STAT:CCDF ON

Switches on the "CCDF" measurement.

**6.7.8.2 Measurement configuration**

Commands to configure statistical measurements described elsewhere.

- [SENSe:]BANDwidth[:RESolution][:VALue]

CALCulate<n>:MARKer<m>:Y:PERCent..... 571

CALCulate<n>:STATistics:NSAMples..... 571

**CALCulate<n>:MARKer<m>:Y:PERCent <Probability>**

Sets a marker to a particular probability value. You can query the corresponding level with CALCulate<n>:MARKer<m>:X.

Using the command turns delta markers into normal markers.

**Suffix:**

&lt;n&gt; Window

&lt;m&gt; Marker

**Parameters:**

&lt;Probability&gt; Range: 0 % to 100 %

Default unit: %

**Example:**

CALC1:MARK:Y:PERC 95PCT

Positions marker 1 to a probability of 95 %.

**Manual operation:** See "Percent Marker (CCDF only)" on page 163

**CALCulate<n>:STATistics:NSAMples <Samples>**

Defines the number of samples included in the analysis of statistical measurement functions.

**Suffix:**

&lt;n&gt; Window

**Parameters:**

&lt;Samples&gt; Range: Min: 100, Max: depends on the RBW filter

\*RST: 100000

**Example:**

CALC:STAT:NSAM 500

Sets the number of measurement points to be acquired to 500.

**Manual operation:** See "Number of Samples" on page 164

### 6.7.8.3 Gate ranges

|   |     |
|---|-----|
| [SENSe:]SWEep:EGATe:TRACe<t>:COMMeNt.....     | 572 |
| [SENSe:]SWEep:EGATe:TRACe<t>:PERiod.....      | 572 |
| [SENSe:]SWEep:EGATe:TRACe<t>:STARt<gr>.....   | 572 |
| [SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr>.....    | 573 |
| [SENSe:]SWEep:EGATe:TRACe<t>[:STATe<gr>]..... | 573 |

---

#### [SENSe:]SWEep:EGATe:TRACe<t>:COMMeNt <Comment>

Defines a comment for the gate of a particular trace.

##### Suffix:

<t> [Trace](#)

##### Parameters:

<Comment> String containing the comment.

**Example:** SWE:EGAT:TRAC1:COMM 'MyComment'  
Defines a comment for the gate in trace 1.

**Manual operation:** See "[Comment](#)" on page 165

---

#### [SENSe:]SWEep:EGATe:TRACe<t>:PERiod <Length>

Defines the length of the gate for all traces.

The gate length applies to all traces.

##### Suffix:

<t> irrelevant

##### Parameters:

<Length> Range: 100 ns to 1000 s  
\*RST: 2 ms  
Default unit: s

**Example:** SWE:EGAT:TRAC:PER 5ms  
Defines the period for gated triggering to 5 ms.

**Manual operation:** See "[Period](#)" on page 165

---

#### [SENSe:]SWEep:EGATe:TRACe<t>:STARt<gr> <Time>

Defines the start time for a gate range.

##### Suffix:

<t> [Trace](#)

<gr> 1..n  
gate range

##### Parameters:

<Time>



The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe<t>:PERiod`. The following rules apply:

- the start time may not be higher than the length of the gate
- the start time may not be lower than the stop time of the gate range of a lower order

The reset values depend on the gate range.

- for gate range 1, the start time is 0 ms
- for gate range 3, the start time is 2 ms
- for gate range 5, the start time is 4 ms

Default unit: s

**Example:**

`SWE:EGAT:TRAC1:STAR1 3ms`

Sets the Starting point for range 1 on trace 1 at 3 ms.

**Manual operation:** See "Range <x> Start/Stop" on page 166

**[SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr> <Time>**

Defines the stop time for a gate range.

**Suffix:**

|      |                    |
|------|--------------------|
| <t>  | Trace              |
| <gr> | 1..n<br>gate range |

**Parameters:**

<Time> The value range depends on the gate period you have set for the selected trace with `[SENSe:]SWEep:EGATe:TRACe<t>:PERiod`. The following rules apply:

- the stop time may not be higher than the length of the gate
- the stop time may not be lower than the start time

The reset values depend on the gate range.

- for gate range 1, the stop time is 1 ms
- for gate range 3, the stop time is 3 ms
- for gate range 5, the stop time is 5 ms

Default unit: s

**Example:**

`SWE:EGAT:TRAC1:STOP1 5ms`

Sets the stopping point for range 1 on trace 1 at 5 ms.

**Manual operation:** See "Range <x> Start/Stop" on page 166

**[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<gr>] <State>**

Includes or excludes a gate range for a particular trace.

**Suffix:**

|     |       |
|-----|-------|
| <t> | Trace |
|-----|-------|

<gr> gate range

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

**Example:** SWE:EGAT:TRAC1:STAT1 ON  
 Activates gate range 1 for trace 1.

**Manual operation:** See ["Range <x> Use"](#) on page 166

#### 6.7.8.4 Diagram scale

|  |     |
|--|-----|
| CALCulate<n>:STATistics:PRESet.....          | 574 |
| CALCulate<n>:STATistics:SCALE:AUTO ONCE..... | 574 |
| CALCulate<n>:STATistics:SCALE:X:RANGe.....   | 575 |
| CALCulate<n>:STATistics:SCALE:X:RLEVel.....  | 575 |
| CALCulate<n>:STATistics:SCALE:Y:LOWer.....   | 576 |
| CALCulate<n>:STATistics:SCALE:Y:UNIT.....    | 576 |
| CALCulate<n>:STATistics:SCALE:Y:UPPer.....   | 576 |

---

#### CALCulate<n>:STATistics:PRESet

Resets the scale of the diagram (x- and y-axis).

- Reference level (x-axis)  
0.0 dBm
- Display range (x-axis) for APD measurements  
100 dB
- Display range (x-axis) for CCDF measurements  
20 dB
- Upper limit of the y-axis  
1.0
- Lower limit of the y-axis  
1E-6

**Suffix:**

<n> [Window](#)

**Example:** CALC:STAT:PRESet  
 Resets the scaling for statistical functions

**Manual operation:** See ["Default Settings"](#) on page 168

---

#### CALCulate<n>:STATistics:SCALE:AUTO ONCE

Initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get valid results, you have to perform a complete sweep with synchronization to the end of the auto range process. This is only possible in single sweep mode.

**Suffix:**

<n> [Window](#)

**Manual operation:** See ["Adjust Settings"](#) on page 164

**CALCulate<n>:STATistics:SCALE:X:RANGe <Range>**

Defines the display range of the x-axis for statistical measurements.

The effects are identical to [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:Y\[:SCALE\]](#).

**Suffix:**

<n> [Window](#)

**Parameters:**

<Range>                      Range:        1 dB to 200 dB  
                                  \*RST:        100 dB  
                                  Default unit: dB

**Example:**                    CALC:STAT:SCAL:X:RANG 20dB

**Manual operation:** See ["Range"](#) on page 167

**CALCulate<n>:STATistics:SCALE:X:RLEVel <RefLevel>**

Sets the reference level for statistical measurements. The effects are identical to [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:Y\[:SCALE\]:RLEVel](#).

Note that in case of statistical measurements the reference level applies to the x-axis.

**Suffix:**

<n> [Window](#)

**Parameters:**

<RefLevel>                    The unit is variable.  
                                  If a reference level offset is included, the range is adjusted by that offset.  
                                  Range:        -130 dBm to 30 dBm  
                                  \*RST:        0 dBm  
                                  Default unit: dBm

**Example:**                    CALC:STAT:SCAL:X:RLEV -60dBm

**Manual operation:** See ["Ref Level"](#) on page 167

**CALCulate<n>:STATistics:SCALe:Y:LOWer <Magnitude>**

Defines the lower vertical limit of the diagram.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Magnitude> The number is a statistical value and therefore dimensionless.  
 Range: 1E-9 to 0.1  
 \*RST: 1E-6

**Example:** CALC:STAT:SCAL:Y:LOW 0.001

**Manual operation:** See ["Y-Max/ Y-Min"](#) on page 167

**CALCulate<n>:STATistics:SCALe:Y:UNIT <Unit>**

Selects the unit of the y-axis.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Unit> PCT | ABS  
 \*RST: ABS

**Example:** CALC:STAT:SCAL:Y:UNIT PCT  
 Sets the percentage scale.

**Manual operation:** See ["Y-Unit"](#) on page 167

**CALCulate<n>:STATistics:SCALe:Y:UPPer <Magnitude>**

Defines the upper vertical limit of the diagram.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Magnitude> The number is a statistical value and therefore dimensionless.  
 Range: 1E-5 to 1.0  
 \*RST: 1.0

**Example:** CALC:STAT:SCAL:Y:UPP 0.01

**Manual operation:** See ["Y-Max/ Y-Min"](#) on page 167

**6.7.8.5 Measurement control**

Commands to perform statistical measurements described elsewhere.

- [INITiate<mt>\[:IMMediate\]](#)

### 6.7.8.6 Result retrieval

Commands to retrieve results described elsewhere.

- `CALCulate<n>:MARKer<m>:X`

|   |     |
|---|-----|
| <code>CALCulate&lt;n&gt;:STATistics:CCDF:X&lt;t&gt;?</code> .....   | 577 |
| <code>CALCulate&lt;n&gt;:STATistics:RESult&lt;res&gt;?</code> ..... | 577 |
| <code>DISPlay[:WINDow&lt;n&gt;]:STATistics:CCDF:GAUSS</code> .....  | 578 |

---

#### **CALCulate<n>:STATistics:CCDF:X<t>? <Probability>**

Queries the results of the CCDF.

##### **Suffix:**

<n>                      Window

<t>                      Trace

##### **Query parameters:**

<Probability>        **P0\_01**  
                           Level value for 0.01 % probability

**P0\_1**  
                           Level value for 0.1 % probability

**P1**  
                           P1: Level value for 1 % probability

**P10**  
                           Level value for 10 % probability

##### **Return values:**

<CCDF Result>

##### **Example:**

`CALC:STAT:CCDF:X1? P10`

Returns the level values that are over 10 % above the mean value.

##### **Usage:**

Query only

---

#### **CALCulate<n>:STATistics:RESult<res>? <ResultType>**

Queries the results of a measurement for a specific trace.

##### **Suffix:**

<n>                      Window

<res>                   Trace

##### **Query parameters:**

<ResultType>        **MEAN**  
                           Average (=RMS) power in dBm measured during the measurement time.

**PEAK**  
                           Peak power in dBm measured during the measurement time.

**CFACTor**

Determined crest factor (= ratio of peak power to average power) in dB.

**ALL**

Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

**Example:**

CALC:STAT:RES2? ALL

Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

**Usage:**

Query only

**DISPlay[:WINDow<n>]:STATistics:CCDF:GAUSSs <State>**

Enables or disables the red trace in the CCDF display indicating the normal distribution.

**Suffix:**

<n> 1..n  
Window

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off  
**ON | 1**  
Switches the function on  
\*RST: 1

**Example:**

DISP:WIND:STAT:CCDF:GAUS OFF

**Manual operation:** See ["Normal Distribution"](#) on page 164

**6.7.8.7 Programming example: measuring statistics**

This example demonstrates how to determine statistical values for a measurement in a remote environment using the gated statistics example described in [Chapter 3.7.4, "APD and CCDF basics - gated triggering"](#), on page 161.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
TRIG:SOUR EXT
//Defines the use of an external trigger.
TRIG:HOLD 25us
//Defines a trigger offset of 25 µs.
CALC:STAT:APD ON
//Activates APD measurement.
CALC:STAT:NSAM 1000
```

```

//Sets the number of samples to be included in the statistical evaluation to 1000.

//-----Defining Gate ranges -----

SWE:EGAT:TRAC1:COMM 'GSM - useful part'
//Defines a comment for the gate
SWE:EGAT:TRAC1:PER 4.61536ms
//Sets the gate period to 4.61536ms.
SWE:EGAT:TRAC1:STAR1 15us
//Sets the start of range 1 to 15 µs.
SWE:EGAT:TRAC1:STOP1 557.8us
//Sets the end of range 1 to 15 µs (start time) + 542.77 µs (useful part) = 557.8 µs.
SWE:EGAT:TRAC1:STAT1 ON
//Activates the use of range 1.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:STAT:RES1? MEAN
//Returns the mean average power for the useful part of the GSM signal.

//----- Determining the CCDF values-----

CALC:STAT:CCDF ON
//Activates CCDF measurement.
CALC:MARK2:Y:PERC 95PCT
//Sets marker 2 to the 95% probability value.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
CALC:STAT:CCDF:X? P1
//Returns the level value for 10% probability for the CCDF.
CALC:MARK2:X?
//Returns the level for a probability of 95%.

//----- Scaling the diagram -----
CALC:STAT:SCAL:X:RLEV -70dBm
//Sets the reference level to -70 dBm (x-axis!)
CALC:STAT:SCAL:X:RANG 20dB
//Defines a power level range of 20 dB for the x-axis
CALC:STAT:SCAL:Y:LOW 0.0001
//Sets the minimum of the y-axis to 0.01% probability
CALC:STAT:SCAL:Y:UPP 1.0
//Sets the maximum of the y-axis to 100% probability

```

```
CALC:STAT:SCAL:Y:UNIT PCT
//Displays percentage values on y-axis scale
```

## 6.7.9 Time domain power

- [Measurement configuration](#).....580
- [Measurement control](#)..... 583
- [Result retrieval](#)..... 583
- [Programming example: time domain power](#).....588

### 6.7.9.1 Measurement configuration

Commands to configure time domain power measurements described elsewhere.

- [CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#)
- [CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#)
- [CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#)

|  |     |
|--|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:AOff</a> .....               | 580 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:AVERage</a> .....            | 580 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:MEAN[:STATe]</a> .....       | 581 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:PHOLd</a> .....              | 581 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:PPEak[:STATe]</a> .....      | 582 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:RMS[:STATe]</a> .....        | 582 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:SDEViation[:STATe]</a> ..... | 582 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY[:STATe]</a> .....            | 582 |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AOff**

Turns all time domain power evaluation modes off.

##### **Suffix:**

|     |                        |
|-----|------------------------|
| <n> | <a href="#">Window</a> |
| <m> | <a href="#">Marker</a> |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERage <State>**

Switches on or off averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with [\[SENSe:\]AVERage<n>:COUNT](#).

Averaging is reset by switching it off and on again.

Synchronization to the end of averaging is only possible in single sweep mode.



**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

\*RST: 0

**Example:**

INIT:CONT OFF

Switches to single sweep mode.

CALC:MARK:FUNC:SUMM:AVER ON

Switches on the calculation of average.

AVER:COUN 200

Sets the measurement counter to 200.

INIT;\*WAI

Starts a sweep and waits for the end.

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN[:STATE] <State>**

Turns the evaluation to determine the mean time domain power on and off.

The R&amp;S ESW performs the measurement on the trace marker 1 is positioned on.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

\*RST: 0

**Manual operation:** See ["Results"](#) on page 175**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLD <State>**

Switches on or off the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

\*RST: 0

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak[:STATe] <State>**

Turns the evaluation to determine the positive peak time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 1 | 0

\*RST: 0

**Manual operation:** See ["Results"](#) on page 175

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS[:STATe] <State>**

Turns the evaluation to determine the RMS time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 1 | 0

\*RST: 0

**Manual operation:** See ["Results"](#) on page 175

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEVIation[:STATe] <State>**

Turns the evaluation to determine the standard deviation of the time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 1 | 0

\*RST: 0

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY[:STATe] <State>**

Turns time domain power measurements on and off. This measurement is only available in zero span.

When you turn the measurement on, the R&S ESW activates a marker and positions it on the peak power level in the marker search range.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 1 | 0

\*RST: 0

**6.7.9.2 Measurement control**

Commands to perform time domain power measurements described elsewhere.

- [INITiate<mt>\[:IMMediate\]](#)

**6.7.9.3 Result retrieval**

- [Mean power](#)..... 583
- [Peak power](#)..... 584
- [RMS power](#)..... 585
- [Standard deviation](#)..... 587

**Mean power**

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:AVERage:RESult?](#)..... 583

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:PHOLd:RESult?](#)..... 584

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:RESult?](#)..... 584

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:AVERage:RESult?**

Queries the average mean time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:AVERage](#) on page 580.

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.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<MeanPower> Mean power of the signal during the measurement time.

**Usage:** Query only

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:PHOLD:RESult?**

Queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLD](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<MeanPower> Mean power of the signal during the measurement time.

**Usage:** Query only

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:RESult?**

Queries the mean time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<MeanPower> Mean power of the signal during the measurement time.

**Usage:** Query only

**Manual operation:** See ["Results"](#) on page 175

**Peak power**

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:AVERage:RESult?](#)..... 584

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:PHOLD:RESult?](#)..... 585

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:RESult?](#)..... 585

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:AVERage:RESult?**

Queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERage](#) on page 580.

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.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Return values:**

&lt;PeakPower&gt; Peak power of the signal during the measurement time.

**Usage:** Query only**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:PHOLd:RESult?**

Queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Return values:**

&lt;PeakPower&gt; Peak power of the signal during the measurement time.

**Usage:** Query only**CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:RESult?**

Queries the positive peak time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Return values:**

&lt;PeakPower&gt; Peak power of the signal during the measurement time.

**Usage:** Query only**Manual operation:** See ["Results"](#) on page 175**RMS power**

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:RMS:AVERage:RESult?</a> ..... | 586 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:RMS:PHOLd:RESult?</a> .....   | 586 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:SUMMARY:RMS:RESult?</a> .....         | 586 |

---

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:RMS:AVERage:RESult?**

Queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:AVERage](#) on page 580.

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.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<RMSPower> RMS power of the signal during the measurement time.

**Usage:** Query only

---

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:RMS:PHOLd:RESult?**

Queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<RMSPower> RMS power of the signal during the measurement time.

**Usage:** Query only

---

**CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:RMS:RESult?**

Queries the RMS of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<RMSPower> RMS power of the signal during the measurement time.

**Usage:** Query only  
**Manual operation:** See "Results" on page 175

### Standard deviation

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation:AVERage:RESult?](#).....587  
[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation:PHOLd:RESult?](#).....587  
[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation:RESult?](#).....587

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation:AVERage:RESult?**

Queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERage](#) on page 580.

[MARKer<m>:FUNCTION:SUMMARY:AVERage](#) on page 580.

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.

#### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

#### **Return values:**

<StandardDeviation> Standard deviation of the signal during the measurement time.

**Usage:** Query only

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation:PHOLd:RESult?**

Queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLd](#).

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

#### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

#### **Return values:**

<StandardDeviation> Standard deviation of the signal during the measurement time.

**Usage:** Query only

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation:RESult?**

Queries the standard deviation of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<StandardDeviation> Standard deviation of the signal during the measurement time.

**Usage:** Query only

#### 6.7.9.4 Programming example: time domain power

This programming example demonstrates the measurement example described in [Chapter 3.8.6, "Measurement example"](#), on page 177 in a remote environment.

```
//-----Configuring the Measurement-----
*RST
//Resets the instrument

INIT:CONT OFF
//Turns on single sweep mode.

FREQ:CEN 1.8GHz
//Sets the center frequency to 1.8 GHz.

BAND:RES 100kHz
//Sets the bandwidth to 100 kHz.

SWE:TIME 10ms
//Sets the sweep time to 640 µs.

FREQ:SPAN 0
//Sets the instrument to zero span.

CALC:MARK:FUNC:SUMM:STAT ON
//Turns on time domain power measurements.

CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:RMS ON
//Turns the evaluation of the mean, peak and RMS time domain power.

CALC:MARK:X:SLIM ON
//Activates limit lines for evaluation.

CALC:MARK:X:SLIM:LEFT 1ms
//Sets the left limit line to 326 µs.
```



```

CALC:MARK:X:SLIM:RIGH 6ms
//Sets the right limit line to 538  $\mu$ s.

//-----Performing the Measurement-----

INIT;*WAI
//Initiates the measurement and waits until the measurement is finished.

//-----Retrieving the Results-----
CALC:MARK:FUNC:SUMM:MEAN:RES?
CALC:MARK:FUNC:SUMM:PPE:RES?
CALC:MARK:FUNC:SUMM:RMS:RES?
//Queries the mean, peak and RMS time domain power.

```

6.7.10 Harmonic distortion

|  |     |
|--|-----|
| • <a href="#">Measurement selection</a> .....                      | 589 |
| • <a href="#">Measurement configuration</a> .....                  | 590 |
| • <a href="#">Measurement control</a> .....                        | 591 |
| • <a href="#">Result retrieval</a> .....                           | 591 |
| • <a href="#">Example: measuring the harmonic distortion</a> ..... | 592 |

6.7.10.1 Measurement selection

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:HARMonics[:STATe]</a> ..... | 589 |
|---|-----|

CALCulate<n>:MARKer<m>:FUNCTION:HARMonics[:STATe] <State>

Turns the harmonic distortion measurement on and off.

Note the following:

- If you perform the measurement in the frequency domain, the search range for the frequency of the first harmonic, whose power is determined, is defined by the last span.
- If you perform the measurement in the time domain, the current center frequency is used as the frequency of the first harmonic. Thus, the frequency search is bypassed. The first harmonic frequency is set by a specific center frequency in zero span before the harmonic measurement is started.

Suffix:

|     |                        |
|-----|------------------------|
| <n> | <a href="#">Window</a> |
| <m> | <a href="#">Marker</a> |

Parameters:

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

**Example:** `CALC:MARK:FUNC:HARM ON`  
Activates the harmonic distortion measurement.

### 6.7.10.2 Measurement configuration

Commands to configure the measurement described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNCTION:CENTer`
- `[SENSe:]SWEep:TIME:AUTO`

`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:BANDwidth:AUTO`.....590  
`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:NHARmonics`.....590  
`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:PRESet`.....590

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:BANDwidth:AUTO <State>**

Selects the resolution bandwidth of the harmonic in respect to the bandwidth of the first harmonic.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

identical

**ON | 1**

a multiple

\*RST: 1

**Manual operation:** See ["Harmonic RBW Auto"](#) on page 183

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:NHARmonics <NoHarmonics>**

Selects the number of harmonics that the R&S ESW looks for.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<NoHarmonics> Range: 1 to 26

\*RST: 10

**Manual operation:** See ["Number of Harmonics"](#) on page 183

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:PRESet**

Initiates a measurement to determine the ideal configuration for the harmonic distortion measurement.

The method depends on the span.

- Frequency domain (span > 0)  
Frequency and level of the first harmonic are determined and used for the measurement list.
- Time domain (span = 0)  
The level of the first harmonic is determined. The frequency remains unchanged.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Adjust Settings"](#) on page 183

### 6.7.10.3 Measurement control

Commands to perform the measurement described elsewhere.

- [INITiate<mt>\[:IMMediate\]](#)

### 6.7.10.4 Result retrieval

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:HARMonics:DISTortion?</a> ..... | 591 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:HARMonics:LIST</a> .....        | 591 |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:DISTortion?**

Queries the total harmonic distortion of the signal.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Query parameters:**

<Result> [TOTal](#)

**Return values:**

<DistortionPct>

<DistortionDb>

**Usage:** [Query only](#)

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:LIST**

Queries the position of the harmonics.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<Harmonics> Returns one value for every harmonic.  
The first value is the absolute power of the first harmonic. The unit is variable.  
The other values are power levels relative to the first harmonic. The unit for these is dB.

#### 6.7.10.5 Example: measuring the harmonic distortion

```
//-----Configuring the Measurement-----
*RST
//Resets the instrument.

INIT:CONT OFF
//Turns on single sweep mode.

CALC:MARK:FUNC:HARM ON
//Turns on the harmonic distortion measurement.
CALC:MARK:FUNC:HARM:NHAR 3
//Defines three harmonics to be found.

CALC:MARK:FUNC:HARM:BAND:AUTO OFF
//Turns off automatic bandwidth selection.
CALC:MARK:FUNC:HARM:PRES
//Determines the ideal configuration.

//-----Performing the Measurement-----

INIT;*WAI
//Initiates the measurement and finishes the sweep.

//-----Retrieving the Results-----
CALC:MARK:FUNC:HARM:LIST?
//Queries the position of the harmonics.
CALC:MARK:FUNC:HARM:DIST? TOT
//Queries the total harmonic distortion.
```

#### 6.7.11 Third order intercept point (TOI)

- [Measurement configuration](#).....593
- [Programming example: measuring the TOI](#)..... 595

### 6.7.11.1 Measurement configuration

Commands to configure TOI measurements described elsewhere.

- `CALCulate<n>:DELTamarker<m>:X`
- `CALCulate<n>:DELTamarker<m>:X:RELative?`
- `CALCulate<n>:DELTamarker<m>:Y?`
- `CALCulate<n>:MARKer<m>:X`
- `CALCulate<n>:MARKer<m>:Y?`

|  |     |
|--|-----|
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:TOI:RESult?</code>           | 593 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:TOI:RESult:MINimum?</code>   | 593 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:TOI:RESult:MAXimum?</code>   | 594 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:TOI:SEARChsignal ONCE</code> | 594 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:TOI[:STATE]</code>           | 595 |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?**

Queries the results for the third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

##### **Suffix:**

<n>                      [Window](#)

<m>                      [Marker](#)

##### **Return values:**

<TOI>                      Third order intercept point.

##### **Example:**

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:TOI ON
Switches the intercept measurement.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:TOI:RES?
Outputs the measured value.
```

**Usage:**                      Query only

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MINimum?**

Queries the results for the minimum third order intercept point measurement (see [Chapter 3.10.3, "TOI results"](#), on page 189).

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.

**Suffix:**

&lt;n&gt; Window

&lt;m&gt; Marker

**Return values:**

&lt;TOI&gt; Minimum third order intercept point.

**Example:**

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:TOI ON
Switches the intercept measurement.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:TOI:RES:MIN?
Returns the minimum TOI.
```

**Usage:** Query only**CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MAXimum?**

Queries the results for the maximum third order intercept point measurement (see [Chapter 3.10.3, "TOI results"](#), on page 189).

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.

**Suffix:**

&lt;n&gt; Window

&lt;m&gt; Marker

**Return values:**

&lt;TOI&gt; Maximum third order intercept point.

**Example:**

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:TOI ON
Switches the intercept measurement.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:TOI:RES:MAX?
Returns the maximum TOI.
```

**Usage:** Query only**CALCulate<n>:MARKer<m>:FUNCtion:TOI:SEARchsignal ONCE**

This command initiates a search for signals in the current trace to determine the third intercept point.

**Suffix:**

&lt;n&gt; irrelevant

<m> irrelevant

**Manual operation:** See "Search Signals" on page 191

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:TOI[:STATe] <State>**

Initiates a measurement to determine the third intercept point.

A two-tone signal with equal carrier levels is expected at the RF input of the instrument. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can be modified separately afterwards with the [CALCulate<n>:DELTamarker<m>:X](#) command.

The third-order intercept is calculated from the level spacing between the normal markers and the delta markers.

#### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

#### **Parameters:**

<State> ON | OFF | 1 | 0

\*RST: 0

#### **Example:**

CALC:MARK:FUNC:TOI ON

Switches on the measurement of the third-order intercept.

### **6.7.11.2 Programming example: measuring the TOI**

This example demonstrates how to determine the TOI in a remote environment.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
CALC:MARK:FUNC:TOI ON
//Activate TOI measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:TOI:SEAR ONCE
//Initiates a search for signals in the current trace.

//-----Retrieving Results-----
CALC:MARK:FUNC:TOI:RES?
//Returns the TOI.
```

### 6.7.12 AM modulation depth

- [Measurement configuration](#).....596
- [Example: measuring the AM modulation depth](#)..... 597

#### 6.7.12.1 Measurement configuration

Commands to configure the measurement described elsewhere.

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

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:MDEPth:RESult&lt;t&gt;?</a> ..... | 596 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:MDEPth:SEARchsignal ONCE.....</a> | 596 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:MDEPth[:STATE].....</a>           | 597 |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult<t>?**

Queries the results of the AM modulation depth measurement..

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

##### **Suffix:**

|     |                        |
|-----|------------------------|
| <n> | <a href="#">Window</a> |
| <m> | <a href="#">Marker</a> |
| <t> | <a href="#">Trace</a>  |

##### **Return values:**

<ModulationDepth> Modulation depth in %.

**Usage:** Query only

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:SEARchsignal ONCE**

This command initiates a search for the signals required for the AM depth measurement.

Note that the command does not perform a new measurement, but looks for the signals on the current trace.

##### **Suffix:**

|     |                        |
|-----|------------------------|
| <n> | <a href="#">Window</a> |
| <m> | <a href="#">Marker</a> |

##### **Example:**

`CALC:MARK:FUNC:MDEP:SEAR ONCE`

Executes the search of an AM modulated signal at the currently available trace.

**Manual operation:** See "[Search Signals](#)" on page 196



**CALCulate<n>:MARKer<m>:FUNCTION:MDEPth[:STATe] <State>**

Turns the AM Modulation Depth measurement on and off.

To work correctly, the measurement requires an AM modulated signal.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 1 | 0

\*RST: 0

**6.7.12.2 Example: measuring the AM modulation depth**

This example demonstrates how to determine the AM modulation depth in a remote environment. Note that without a real input signal this measurement will not return useful results.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
FREQ:CENt 100MHz
//Set center frequency
FREQ:SPAN 10KHz
// Set span
CALC:MARK:FUNC:MDEP ON
//Activate AM modulation depth measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT:IMM
// Perform a single measurement
CALC:MARK:FUNC:MDEP:SEAR ONCE
//Initiates a search for signals in the current trace.

//-----Retrieving Results-----
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results.

//If the results are not accurate, change the position of the
//the temporary markers manually.

//----Changing the position of the temp markers----
CALC:MARK:X 100MHz
//Positions the reference marker on 100 MHz.
CALC:DELT2:X 5KHz
//Positions delta marker 2 and 3 at a distance of 5 kHz to the reference marker.
CALC:DELT3:X 1KHz
```

```
//Corrects the position of delta marker 3 by 1 kHz.

CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results for the repositioned markers.
```

### 6.7.13 List evaluations

A list evaluation is a multiple power measurement that measures the power at up to 200 frequencies. The measurement itself is a time domain measurement. Note that if you set a span greater than 0, the R&S ESW aborts the list evaluation.

List evaluations allow for a different instrument setup for each frequency you want to measure. You can define most of the settings with the commands described here. Settings not covered by the commands listed below can be controlled with the common configuration commands (see [Chapter 6.8, "Configuration"](#), on page 620). Note that these commands have to be sent prior to the commands that control the list evaluation.

In case of a triggered measurement, a separate trigger event is required for each frequency to initiate that measurement. Note that you have to make changes to the trigger level in the time domain in order for it to take effect for the List Evaluation commands.



The list evaluation is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S ESW aborts the list evaluation.

The R&S ESW also aborts the list evaluation if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. This method causes the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

#### 6.7.13.1 Performing list evaluations

All remote control commands specific to list evaluations (which are available via remote control only) are described here.

##### Remote commands exclusive to list evaluation

|                               |     |
|-------------------------------|-----|
| [SENSe:]LIST:POWer:RESult?    | 599 |
| [SENSe:]LIST:POWer[:SEquence] | 599 |
| [SENSe:]LIST:POWer:SET        | 600 |
| [SENSe:]LIST:POWer:STATe      | 601 |

**[SENSe:]LIST:POWer:RESult?**

Queries the results of the list evaluation.

May be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

**Return values:**

<PowerLevel>      Power level for each frequency included in the measurement. The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with [\[SENSe:\]LIST:POWer:SET](#). The result is a list of floating point values separated by commas. The unit depends on [CALCulate<n>:UNIT:POWer](#).

**Usage:**              Query only

**[SENSe:]LIST:POWer[:SEQUence]**

Configures and initiates the List Evaluation measurement.

The list can contain up to 200 entries (frequencies). You can define a different instrument setup for each frequency that is in the list.

If you synchronize the measurement with \*OPC, the R&S ESW produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see [\[SENSe:\]LIST:POWer:RESult?](#).

**Parameters:**

|                 |  |
|-----------------|--|
| <Frequency>     | Defines the frequency. Each frequency corresponds to one list entry.<br><br>Range:      0 to Fmax<br>Default unit: Hz    |
| <RefLevel>      | Defines the reference level for a list entry.<br><br>Range:      -130 to 30<br>Increment: 0.01<br>Default unit: dBm      |
| <RFAttenuation> | Defines the RF attenuation for a list entry.<br><br>Range:      0 to 70<br>Increment: 1<br>Default unit: dB              |
| <FilterType>    | Selects the filter type for a list entry. For more information see <a href="#">[SENSe:]BANDwidth[:RESolution]:TYPE</a> . |
| <RBW>           | Defines the resolution bandwidth for a list entry.   |

|                |  |
|----------------|--|
| <VBW>          | Defines the measurement time for a list entry.   |
| <MeasTime>     | Defines the measurement time for a list entry.<br>Range: 1 $\mu$ s to 16000 s<br>Default unit: s |
| <TriggerLevel> | Reserved for future use; currently: must be 0.   |
| <PowerLevel>   | Default unit: PCT  |
| <b>Usage:</b>  | Asynchronous command   |

---

**[SENSe:]LIST:Power:SET** <State>, <State>, <State>, <TriggerSource>, <TriggerSlope>, <TriggerOffset>, <GateLength>

Defines global List Evaluation parameters.

These parameters are valid for every frequency you want to measure.

The state of the first three parameters (<PeakPower>, <RMSPower> and <AVG-Power>) define the number of results for each frequency in the list.

Note that you have to set the trigger level *after* sending this command.

**Parameters:**

|                 |   |
|-----------------|---|
| <State>         | ON   OFF   0   1<br>Turns peak power evaluation on and off.<br>*RST: 1  |
| <State>         | ON   OFF   0   1<br>Turns RMS power evaluation on and off.<br>*RST: 0   |
| <State>         | ON   OFF   0   1<br>Turns average power evaluation on and off.<br>*RST: 0                                       |
| <TriggerSource> | IMMediate   LINE   EXTernal   VIDEo   IFPower   RFPower   EXT2   EXT3   EXT4   LXI<br>Selects a trigger source. |
| <TriggerSlope>  | POSitive   NEGative<br>Selects the trigger slop.  |
| <TriggerOffset> | Defines the trigger delay.<br>Range: negative measurement time to 30 s<br>*RST: 0<br>Default unit: s            |

<GateLength> Defines the gate length for gated measurements.  
 Setting 0 seconds turns gated measurements off.  
 To perform gated measurements, the trigger source must be different from IMMEDIATE.  
 Range: 31.25 ns to 30 s  
 \*RST: 0 s  
 Default unit: s

---

#### [SENSe:]LIST:POWer:STATe <State>

Turns the List Evaluation off.

#### Parameters:

<State> OFF | 0  
 \*RST: 0

### 6.7.13.2 Example: performing list evaluation

The following example shows a list evaluation with the following configuration.

| No | Freq [MHz] | Ref Level [dBm] | RF Attenuation [dB] | EI Attenuation [dB] | Filter  | RBW    | VBW     | Meas Time | Trigger Level |
|----|------------|-----------------|---------------------|---------------------|---------|--------|---------|-----------|---------------|
| 1  | 935.2      | 0               | 10                  | ---                 | Normal  | 1 MHz  | 3 MHz   | 440 µs    | 0             |
| 2  | 935.4      | 0               | 10                  | 10                  | Channel | 30 kHz | 100 kHz | 440 µs    | 0             |
| 3  | 935.6      | 0               | 10                  | 20                  | Channel | 30 kHz | 100 kHz | 440 µs    | 0             |

-----Measurement with synchronization via service request-----

\*ESE 1

\*SRE 32

// Configures the status reporting system to produce a service request.

LIST:POW:SET ON,ON,OFF,EXT,POS,10us,434us

//Turns on the list evaluation, configures the global list evaluation settings and

//evaluates the peak and RMS power.

LIST:POW

935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,

935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,

935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0;

\*OPC

//Defines a list with 3 entries and initiates the measurement with synchronization to the end

//Analyzer produces a service request

//On service request:

SENS:LIST:POW:RES?

//Returns the results of the measurements, two for each frequency (peak and RMS power).

-----Initiliazing the measurement and querying results simultaneously-----

```

LIST:POW?
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0
//Defines a list with 3 entries, initiates the measurement and queries the results.
//Result example:
-28.3,-30.6,-38.1

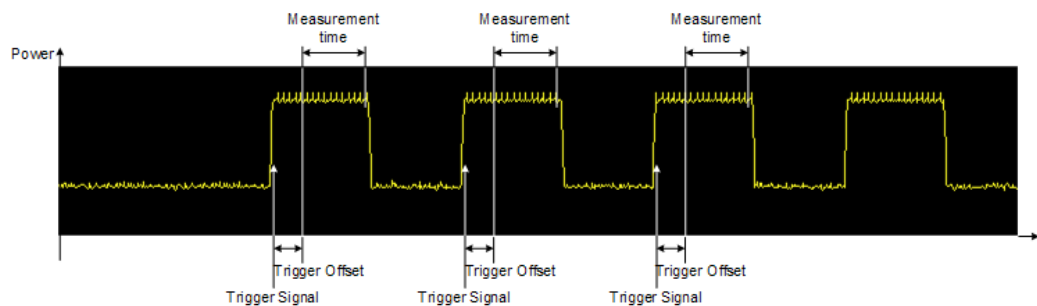
```

### 6.7.14 Measuring the pulse power

All remote control commands specific to measuring the mean or peak pulse power (e.g. bursts in various telecommunications standards) are described here. This measurement is available via remote control only.

The Pulse Power measurement is a gated measurement that determines the power over a particular number of pulses. The measurement is controlled by an external trigger or the video signal. A separate trigger event is required for each burst included in the measurement. In case of an external trigger source, the trigger level corresponds to the TTL level. In case of a video signal, you can define any threshold.

The figure below shows the relations between the available trigger settings.



The measurement is always on trace 1, either with the peak detector to determine the peak power or the RMS detector to determine the RMS power. Overall, you can configure the measurement independent of the instrument setup with the commands listed below only, which results in faster measurements.



The Pulse Power measurement is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S ESW aborts the Pulse Power measurement.

The R&S ESW also aborts the Pulse Power measurement if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. With this method, there is the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.

- Instrument setup and querying of the result list at the end of the measurement:  
With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

#### 6.7.14.1 Performing pulse power measurements

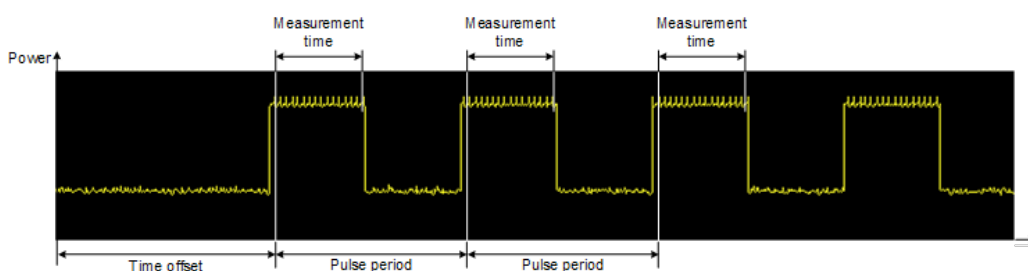
The following commands control pulse power measurements.

|  |     |
|--|-----|
| CALCulate<n>:MARKer<m>:FUNCTION:MSUMmary | 603 |
| [SENSe:]MPOWer:FTYPE                     | 604 |
| [SENSe:]MPOWer:RESult[:LIST]?            | 604 |
| [SENSe:]MPOWer[:SEQuence]                | 605 |
| [SENSe:]MPOWer:RESult:MIN?               | 606 |

**CALCulate<n>:MARKer<m>:FUNCTION:MSUMmary** <TimeOffset>, <MeasTime>, <PulsePeriod>, <OfPulses>

Configures power measurements on pulses in the time domain.

To evaluate the pulse power, the R&S ESW uses the data captured during a previous measurement. The data recorded during the set measurement time is combined to a measured value for each pulse according to the detector specified and the indicated number of results is output as a list.



To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

#### Suffix:

<n> [Window](#)

<m> [Marker](#)

#### Parameters:

<TimeOffset> Defines a time offset to start the measurement at the first pulse of a trace.

\*RST: 0

Default unit: s

<MeasTime> Defines the measurement time.

Default unit: s

|                 |   |
|-----------------|---|
| <PulsePeriod>   | Defines the pulse period.<br>Default unit: s  |
| <OfPulses>      | Defines the number of pulses to measure.  |
| <b>Example:</b> | <code>CALC:MARK:FUNC:MSUM 50US,450US,576.9US,8</code><br>Evaluates data that contains 8 pulses during a measurement time of 450 µs and a pulse period of 576.9 µs. The evaluation starts with an offset of 50 µs. |

---

#### [SENSe:]MPOWer:FTYPE <FilterType>

This command selects the filter type for pulse power measurements.

##### Parameters:

|              |  |
|--------------|--|
| <FilterType> | <b>CFILter</b><br>Channel filters<br>Available in the Spectrum application.<br><b>NORMal</b><br>3 dB Gaussian filters<br>Available in the Spectrum application.<br><b>P5</b><br>5-pole filters<br>Available for FFT sweeps in the Spectrum application.<br><b>RRC</b><br>RRC filters<br><b>CISPr   PULSe</b><br>6 dB CISPR filter<br>Return value for query is always <code>PULS</code> .<br><b>MIL</b><br>6 dB MIL standard filter<br><b>*RST:</b> Depends on application |
|--------------|--|

---

#### [SENSe:]MPOWer:RESult[:LIST]?

Queries the results of the pulse power measurement.

May be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

##### Return values:

|              |  |
|--------------|--|
| <PulsePower> | List of pulse powers.<br>The number of values depends on the number of pulses you have been measuring.<br>The unit is dBm. |
|--------------|--|

**Usage:** Query only



---

**[SENSe:]MPOWer[:SEQuence]** <Frequency>, <RBW>, <MeasTime>,  
<TriggerSource>, <TriggerLevel>, <TriggerOffset>, <Detector>, <NoPulses>

Configures and initiates the pulse power measurement.

The R&S ESW caches all measurement parameters that you can set with this command. If you use the command repeatedly, the R&S ESW only changes those settings that you have actually changed before initiating the measurement. Thus, measurement times are kept as low as possible.

If you synchronize the measurement with \*OPC, the R&S ESW produces a service request when all frequencies have been measured and the number of individual measurements has been performed.

Note that using the command as a query initiates the measurement and returns the results if all frequencies have been measured. For more information on querying the results see [\[SENSe:\]LIST:POWer:RESult?](#).

**Parameters:**

|                 |  |
|-----------------|--|
| <Frequency>     | Defines the pulse frequency.<br>Range: 0 to Fmax<br>Default unit: Hz   |
| <RBW>           | Defines the resolution bandwidth.<br>Default unit: HZ  |
| <MeasTime>      | Defines the measurement time.<br>Range: 1 µs to 30 s<br>Default unit: S  |
| <TriggerSource> | Selects a trigger source.  |
| <TriggerLevel>  | Defines a trigger level.<br>The trigger level is available for the video trigger or IF power trigger.<br>For a video trigger, the level is a percentage (0 to 100) of the diagram height.<br>For an IF power trigger, the level is a dBm value. See the specifications document for available trigger levels and trigger bandwidths.<br>For an external trigger, the R&S ESW uses a fixed TTL level. |
| <TriggerOffset> | Defines the trigger delay.<br>Range: 0 s to 30 s<br>*RST: 0 s<br>Default unit: s   |
| <Detector>      | Selects the detector and therefore the way the measurement is evaluated.<br><b>MEAN</b><br>Calculates the RMS pulse power.<br><b>PEAK</b><br>Calculates the peak pulse power.  |

|                       |  |
|-----------------------|--|
| <OfPulses>            | Defines the number of pulses included in the measurement.<br>Range: 1 to 32001                               |
| <b>Return values:</b> |  |
| <PowerLevel>          | Pulse power level.<br>The result is a list of floating point values separated by commas.<br>The unit is dBm. |
| <b>Usage:</b>         | Asynchronous command   |

**[SENSe:]MPOWer:RESult:MIN?**

Queries the lowest pulse power that has been measured during a pulse power measurement.

If there are no results, the command returns an error.

**Return values:**

|              |  |
|--------------|--|
| <PulsePower> | Lowest power level of the pulse power measurement.<br>The unit is dBm. |
|--------------|--|

|               |            |
|---------------|------------|
| <b>Usage:</b> | Query only |
|---------------|------------|

**6.7.14.2 Example: performing a pulse power measurement**

The following example shows a pulse power measurement.

```

-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
MPOW:FTYP NORM
//Selects a Gaussian filter for the measurement.
MPOW 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20;
*OPC
//Configures and initiates a measurement on 20 pulses with synchronization to the end.
//Analyzer produces a service request
//On service request:
MPOW:RES?
//Returns the results of the measurements (20 power levels).
MPOW:RES:MIN?
//Returns the lowest of the 20 power level that have been measured.

-----Initiliazing the measurement and querying results simultaneously-----
MPOW? 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20
//Configures, initiates and queries the results of the measurement.
//Result example:
-105.225059509,-105.656074524,-105.423065186,-104.374649048,-103.059822083,-101.29511261,
-99.96534729,-99.7452468872,-99.6610794067,-100.327224731,-100.96686554,-101.450386047,
-102.150642395,-103.240142822,-105.95476532,-110.583129883,-115.7760849,-126.279388428,
-124.620399475,-116.97366333

```

### 6.7.15 EMI measurements

|  |     |
|--|-----|
| • <a href="#">Measurement selection</a> .....    | 607 |
| • <a href="#">EMI marker configuration</a> ..... | 607 |
| • <a href="#">Final test configuration</a> ..... | 609 |
| • <a href="#">Limit line configuration</a> ..... | 609 |
| • <a href="#">LISN control</a> .....             | 609 |
| • <a href="#">Result retrieval</a> .....         | 611 |
| • <a href="#">Evaluating the results</a> .....   | 614 |

#### 6.7.15.1 Measurement selection

|  |     |
|--|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement[:STATe]</a> ..... | 607 |
|--|-----|

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement[:STATe] <State>**

This command turns the EMI measurement marker functionality on and off.

**Suffix:**

<n>, <m>                      irrelevant

**Parameters:**

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

#### 6.7.15.2 EMI marker configuration

Commands to configure EMI markers described elsewhere.

- [CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 719  
[CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 717
- [CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 719  
[CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 717
- [CALCulate<n>:DELTamarker<m>:MREference](#) on page 716
- [CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>](#) on page 718  
[CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>](#) on page 715  
[CALCulate<n>:DELTamarker<m>:LINK](#) on page 714
- [CALCulate<n>:MARKer<m>:TRACE](#) on page 719

|  |     |
|--|-----|
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:FMEasurement:DETECTOR</a> ..... | 607 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:DETECTOR</a> .....      | 608 |

---

#### **CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:DETECTOR <Detector>**

Selects the detector for a specific deltamarker during the final evaluation.

If the deltamarker is not yet active, the command also turns the deltamarker on.

**Suffix:**

<n>                              irrelevant

<m> [Marker](#)

**Parameters:**

<Detector> **OFF**  
no final measurement is performed

**AVER**  
average detector

**CAV**  
CISPR Average detector

**CRMS**  
RMS Average detector

**POS**  
maximum peak detector

**QPE**  
quasipeak detector

\*RST: OFF

**Manual operation:** See ["Final Test Detector"](#) on page 208

**CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DETector** <Detector>

Selects the detector for a specific marker during the final measurement.

If the marker is not yet active, the command also turns the marker on.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Detector> **OFF**  
no final measurement is performed

**AVER**  
average detector

**CAV**  
CISPR Average detector

**CRMS**  
RMS Average detector

**POS**  
maximum peak detector

**QPE**  
quasipeak detector

\*RST: OFF

**Manual operation:** See ["Final Test Detector"](#) on page 208

### 6.7.15.3 Final test configuration

Commands to configure final tests described elsewhere.

- [\[SENSe:\]BANDwidth\[:RESolution\]:TYPE](#) on page 665
- [\[SENSe:\]BANDwidth\[:RESolution\]](#) on page 665
- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:X:SPACing](#) on page 696

|  |     |
|--|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:PEAKsearch:AUTO</a> ..... | 609 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:PSEarch:AUTO</a> .....    | 609 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:DWELI</a> .....           | 609 |

---

**CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:PEAKsearch:AUTO**  
 <State>

**CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:PSEarch:AUTO** <State>

**Suffix:**

<n> 1..n

<m> 1..n

**Parameters:**

<State>

---

**CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DWELI** <Time>

Defines the dwell time during the final measurement.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<Time> Range: 100 us to 100 s  
 \*RST: 1 s  
 Default unit: s

**Manual operation:** See ["Dwell Time"](#) on page 211

### 6.7.15.4 Limit line configuration

The remote commands required to configure limit lines for EMI measurements are described in [Chapter 6.9.4, "Lines"](#), on page 770.

### 6.7.15.5 LISN control

|   |     |
|---|-----|
| <a href="#">INPut:LISN:FILTer:HPASs[:STATe]</a> ..... | 610 |
| <a href="#">INPut:LISN:PHASe</a> .....                | 610 |
| <a href="#">INPut:LISN[:TYPE]</a> .....               | 611 |

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

Turns the 150 kHz highpass filter for the ENV216 network on and off.

Prerequisites for this command

- Select ENV216 network ([INPut:LISN\[:TYPE\]](#)).

**Parameters:**

<State>                    ON | OFF | 0 | 1  
                              **OFF | 0**  
                              Switches the function off  
                              **ON | 1**  
                              Switches the function on  
                              \*RST:        0

**Example:**                //Turn on high pass filter  
                              INP:LISN:TYPE ENV216  
                              INP:LISN:FILT:HPAS ON

**Manual operation:**    See "[150 kHz Highpass](#)" on page 214

**INPut:LISN:PHASe <Phase>**

Selects one LISN phase to be measured.

The command is available in all applications (spectrum, receiver, I/Q analyzer and analog demodulator).

**Parameters:**

<Phase>                    **L1**  
                              **L2**  
                              Available for networks with four phases (R&S ESH2Z5,  
                              R&S ENV4200 and R&S ENV432)  
                              **L3**  
                              Available for networks with four phases (R&S ESH2Z5,  
                              R&S ENV4200 and R&S ENV432)  
                              **N**  
                              \*RST:        L1

**Example:**                //Select phase L1  
                              INP:LISN:PHAS L1

**Manual operation:**    See "[Phase](#)" on page 214

**INPut:LISN[:TYPE] <Type>**

Turns automatic control of a LISN on and off. It also selects the type of network.

**Parameters:**

<Type>

**ENV216**

R&S ENV 216 / AMN6500: two phases and highpass are controllable.

**ENV432**

R&S ENV 432: four phases are controllable.

**ENV4200**

R&S ENV 4200: four phases are controllable.

**ESH2Z5**

R&S ESH2-Z5: four phases (incl. protective earth) are controllable.

**ESH3Z5**

R&S ESH3-Z5: two phases (incl. protective earth) are controllable.

**FOURphase**

R&S ESH2-Z5: four phases (incl. protective earth) are controllable.

**OFF**

Turns off remote control of the LISN.

**TWOPhase**

R&S ESH3-Z5: two phases (incl. protective earth) are controllable.

\*RST: OFF

**Example:**

```
//Select LISN
INP:LISN:TYPE TWOP
```

**Manual operation:** See "LISN Type" on page 214

**6.7.15.6 Result retrieval**

Commands to retrieve results described elsewhere.

- `CALCulate<n>:MARKer<m>:X` on page 720  
`CALCulate<n>:DELTamarker<m>:X` on page 718
- `CALCulate<n>:MARKer<m>:Y?` on page 735  
`CALCulate<n>:DELTamarker<m>:Y?` on page 734

|   |     |
|---|-----|
| <code>CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:FMEasurement:RESult?</code> .....                    | 612 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:RESult?</code> .....                         | 612 |
| <code>CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:FMEasurement:LIMit&lt;li&gt;:CONDition?</code> ..... | 612 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:LIMit&lt;li&gt;:CONDition?</code> .....      | 613 |
| <code>CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:FMEasurement:LIMit&lt;li&gt;:DELTA?</code> .....     | 613 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:LIMit&lt;li&gt;:DELTA?</code> .....          | 614 |

**CALCulate<n>:DELTaMarker<m>:FUNCTION:FMEasurement:RESult? <Result>**

Queries the result of the EMI measurement at the deltamarker position.

**Suffix:**

<n> irrelevant

<m> [Marker](#)

**Return values:**

<Result> Absolute power level measured during final EMI measurement.

**Example:**

CALC:DELT3:FUNC:FME:RES?

Queries the result of delta marker 3.

**Usage:**

Query only

**CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:RESult? <Result>**

Queries the result of the EMI measurement at the marker position.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<Result> Power level. The unit depends on the one you have currently set.

**Example:**

CALC:MARK1:FUNC:FME:RES?

Queries the result of marker 1.

**Usage:**

Query only

**CALCulate<n>:DELTaMarker<m>:FUNCTION:FMEasurement:LIMit<li>:CONDition? <Condition>**

Queries the condition of a deltamarker position in relation to all active limit lines. The results are provided as a comma-separated list, with one value per marker for each active limit line.

**Suffix:**

<n> irrelevant

<m> [Marker](#)

<li> irrelevant

**Return values:**

<Condition>

**0**

The deltamarker has passed the limit check.

**1**

The deltamarker is inside the margins of a limit line.



**2**

The deltamarker has failed the limit check.

**Example:**`CALC:DELT2:FUNC:FME:LIM:COND?`

Queries the condition of deltamarker 2 in relation to all active limit lines.

**Usage:**

Query only

**CALCulate<n>:MARKer<m>:FUNCtion:FMEasurement:LIMit<li>:CONDition?**  
 <Condition>

Queries the condition of a marker position in relation to all active limit lines. The results are provided as a comma-separated list, with one value per marker for each active limit line.

**Suffix:**<n> [Window](#)<m> [Marker](#)

&lt;li&gt; irrelevant

**Return values:**

<Condition> **0**  
 The marker has passed the limit check.

**1**  
 The marker is inside the margins of a limit line.

**2**  
 The marker has failed the limit check.

**Example:**`CALC:MARK1:FUNC:FME:LIM:COND?`

Queries the condition of marker 1 in relation to all active limit lines.

**Usage:**

Query only

**CALCulate<n>:DELTamarker<m>:FUNCtion:FMEasurement:LIMit<li>:DELTA?**

Queries the vertical distance from the deltamarker position to all active limit lines. The unit is dB.

The results are provided as a comma-separated list, with one value per marker for each active limit line.

If the deltamarker has been assigned to a different trace than the limit lines, or if no limit line is defined for the marker position, the command returns -200.

**Suffix:**

&lt;n&gt; irrelevant

<m> [Marker](#)

&lt;li&gt; irrelevant

**Return values:**

<Amplitude> Vertical distance to the limit line in dB.

**Example:**

CALC:DELT3:FUNC:FME:LIM:DELT?

Queries the distance of deltamarker 3 to all active limit lines.

**Usage:**

Query only

**CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:LIMit<li>:DELTA?**

<Amplitude>

Queries the vertical distance from the marker position to the limit line. The unit is dB.

The results are provided as a comma-separated list, with one value per marker for each active limit line.

If the marker has been assigned to a different trace than the limit lines, or if no limit line is defined for the marker position, the command returns -200.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

<li> irrelevant

**Return values:**

<Amplitude> Vertical distance to the limit line in dB.

**Example:**

CALC:MARK3:FUNC:FME:LIM:DELT?

Queries the distance of marker 3 to all active limit lines.

**Usage:**

Query only

**6.7.15.7 Evaluating the results**

The commands required to control the demodulation of signals at the marker position are described in "[Marker demodulation](#)" on page 754.

**6.7.16 Programming example: EMI measurement**

This example demonstrates how to detect electromagnetic interferences (EMI) in a remote environment.

```
//----- Preparing the measurement -----
//Reset the instrument
*RST
//Define the span to be analyzed
FREQ:STAR 150kHz
FREQ:STOP 1GHz
//Configure two traces, one with peak detector, one with average detector
DISP:TRAC1 ON
DISP:TRAC2 ON
```

```
DET1 POS
DET2 AVER

//----- Configuring the measurement -----
//Select EMI measurement
CALC:MARK:FUNC:FME:STAT ON
//Configure CISPR filter and RBW
BAND:TYPE CISP
BAND:RES 1MHz
//Define the dwell time
CALC:MARK:FUNC:FME:DWEL 1ms
//Configure an auto peak search
CALC:MARK:FUNC:FME:PEAK:AUTO ON
//Configure a logarithmic frequency scaling
DISP:TRAC:X:SPAC LOG
//Configure marker demodulation for marker 1
CALC:MARK:FUNC:DEM ON
//Increase the number of sweep points
SWE:POIN 200000
//Set the unit to V
CALC:UNIT:POW V

//----- Configuring EMI markers -----
//Activate 6 normal EMI markers
CALC:MARK1 ON
CALC:MARK2 ON
CALC:MARK3 ON
CALC:MARK4 ON
CALC:MARK5 ON
CALC:MARK6 ON
//Set markers 1 to 3 on trace 1. Set markers 4 to 6 on trace 2.
CALC:MARK1:TRAC 1
CALC:MARK2:TRAC 1
CALC:MARK3:TRAC 1
CALC:MARK4:TRAC 2
CALC:MARK5:TRAC 2
CALC:MARK6:TRAC 2
//Use CISPR average detector for all markers during final test
CALC:MARK1:FUNC:FME:DET CAV
CALC:MARK2:FUNC:FME:DET CAV
CALC:MARK3:FUNC:FME:DET CAV
CALC:MARK4:FUNC:FME:DET CAV
CALC:MARK5:FUNC:FME:DET CAV
CALC:MARK6:FUNC:FME:DET CAV

//----- Configuring a limit check -----
//Select EN55011A.LIN as limit line 1
CALC:LIM1:NAME "EN55011A.LIN"
//Configure trace 1 to be checked against limit line 1
```

```

CALC:LIM1:TRAC1:CHEC ON
//Clear the results of all previous limit checks
CALC:LIM:CLE

//----- Performing the Measurement -----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//----- Retrieving Results -----
//Query the results for the EMI measurement
//First marker frequency, then final test level
CALC:MARK1:X?
CALC:MARK1:FUNC:FME:RES?
CALC:MARK2:X?
CALC:MARK2:FUNC:FME:RES?
CALC:MARK3:X?
CALC:MARK3:FUNC:FME:RES?
CALC:MARK4:X?
CALC:MARK4:FUNC:FME:RES?
CALC:MARK5:X?
CALC:MARK5:FUNC:FME:RES?
CALC:MARK6:X?
CALC:MARK6:FUNC:FME:RES?

//Query the result of the limit check for trace 1
CALC:LIM1:FAIL?
//Query the result of the limit check and the distance from the limit lines
//for each marker
CALC:MARK1:FUNC:FME:LIM:COND?
CALC:MARK1:FUNC:FME:LIM:DELT?
CALC:MARK2:FUNC:FME:LIM:COND?
CALC:MARK2:FUNC:FME:LIM:DELT?
CALC:MARK3:FUNC:FME:LIM:COND?
CALC:MARK3:FUNC:FME:LIM:DELT?
CALC:MARK4:FUNC:FME:LIM:COND?
CALC:MARK4:FUNC:FME:LIM:DELT?
CALC:MARK5:FUNC:FME:LIM:COND?
CALC:MARK5:FUNC:FME:LIM:DELT?
CALC:MARK6:FUNC:FME:LIM:COND?
CALC:MARK6:FUNC:FME:LIM:DELT?

```

### 6.7.17 Programming example: carrier-to-noise ratio

This programming example demonstrates how to perform a Carrier-to-noise measurement in a remote environment.

```
//-----Preparing the measurement-----
*RST
//Reset the instrument
FREQ:CEN 800MHz
//Sets the center frequency to the carrier frequency of 800 MHz.
CALC:MARK:FUNC:POW:SEL CN
//Activates carrier-to-noise ratio measurement.
POW:ACH:PRES CN
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PRES:RLEV
//Determines the ideal reference level for the measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

// Now turn off the carrier signal and repeat the measurement:
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:MARK:FUNC:POW:RES? CN
//Returns the carrier-to-noise ratio.
```

### 6.7.18 Programming example: performing a basic frequency sweep

This example demonstrates how to configure and perform a basic frequency sweep measurement in a remote environment.

This example assumes a signal is measured at 100 MHz, with a maximum power level of -3 dBm.



Some commands in the following examples may not be necessary as they reflect the default settings; however, they are included to demonstrate the command usage.

```
//-----Preparing the measurement -----
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//-----Configuring the Frequency and Span-----
FREQ:CEN 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.
```

```

//Activate signal tracking to keep the center frequency on the signal peak:
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
//After each sweep the maximum on trace 1 is searched within a range of 20 MHz
//around the center frequency. It must have a minimum power of -90dBm.

//-----Configuring the Bandwidth-----
BAND:AUTO OFF
BAND 1MHz
BAND:TYPE RRC
//Defines the RBW as 1 MHz using an RRC filter

BAND:VID:AUTO OFF
BAND:VID 500kHz
//Decouples the VBW from the RBW and decreases it to smooth the trace.

//-----Configuring the Sweep-----
SENS:SWE:COUN 10
//Defines 10 sweeps to be performed in each measurement.
SENS:SWE:POIN 500
//During each sweep, 500 trace points will be measured.
SENS:SWE:TIME:AUTO OFF
SENS:SWE:TIME 50ms
//Decouples the sweep time from the RBW,VBW and span and increases it to
//make the measurement more precise.

//-----Configuring Attenuation-----
INP:ATT 10dB
//Sets the mechanical attenuation to 10 dB and couples the reference level
//to the attenuation instead of vice versa.

//-----Configuring the Amplitude and Scaling-----
DISP:TRAC1:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
DISP:TRAC1:Y:RLEV:OFFS 10dB
//Shifts the trace display in the diagram up by 10dB.
CALC:UNIT:POW V
//Sets the unit of the y-axis to Volt. The reference level is now 70.711 mV.
DISP:TRAC1:Y:SPAC LOG
//Uses logarithmic scaling with absolute values (V).
DISP:TRAC1:Y 110dB
//Increases the displayed range of the y-axis to 110 dB.
DISP:TRAC1:Y:RPOS 80PCT
//Shifts the display of the reference level down, it is no longer the top line
//in the diagram. The reference level is displayed as a red line.

//-----Triggering-----
TRIG:SOUR IFP

```

```

TRIG:LEV:IFP -10dBm
TRIG:SLOP POS
TRIG:DTIM 50ms
TRIG:IFP:HYST 5dB
TRIG:HOLD 10ms
//Defines triggering when the second intermediate frequency rises to a level
//of -10 dBm, with a dropout time of 50 ms, a hysteresis of 5 dB and a delay
//of 10 ms.

SWE:EGAT ON
SWE:EGAT:TYPE EDGE
SWE:EGAT:LENG 5ms
//Defines gating. Values are measured for 5 ms after triggering.

OUTP:TRIG2:DIR OUTP
OUTP:TRIG2:OTYP UDEF
OUTP:TRIG2:LEV HIGH
OUTP:TRIG2:PULS:LENG 100us
OUTP:TRIG2:PULS:IMM
//Configures a high trigger signal with a pulse length of 100 us to be output at
//the front TRIGGER INPUT/OUTPUT connector once.

//-----Configuring the Trace-----
DISP:TRAC2 ON
DISP:TRAC2:MODE AVER
DISP:TRAC3 ON
DISP:TRAC3:MODE MAXH
//Configures 3 traces: 1 (default): clear/write; 2: average; 3: max hold

SENS:DET1 POS
SENS:DET2 RMS
SENS:DET3 POS
//Configures traces 1 and 3 to use the positive peak detector; trace 2 uses
//the RMS detector.

TRAC:COPY TRACE4,TRACE1
//Copies trace 1 to a new trace 4 which will then be averaged.

SENS:AVER:STAT4 ON
SENS:AVER:COUN 10
SENS:AVER:TYPE LIN
//Configures trace 4 to be averaged linearly over 10 sweeps.

CALC:MATH:STAT ON
CALC:MATH:MODE LIN
CALC:MATH (TRACE1-TRACE2)
CALC:MATH:POS 100
//Calculates the linear difference between the measured and average values.
//The resulting trace is displayed at the top of the diagram.

```

```
//-----Performing the Measurement-----
INIT;*WAI
//Initiates a new measurement and waits until the last sweep has finished.

//-----Retrieving Results-----
TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
TRAC:DATA? TRACE4
//Returns one power and one frequency value per sweep point for each trace.
```

## 6.8 Configuration

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### 6.8.1 Inputs and output configuration

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#### 6.8.1.1 Input source selection

|                   |     |
|-------------------|-----|
| INPut:SElect..... | 620 |
|-------------------|-----|

---

##### INPut:SElect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S ESW.

##### Parameters:

|          |  |
|----------|--|
| <Source> | <b>RF</b>                              |
|          | Radio Frequency ("RF INPUT" connector) |
| *RST:    | RF                                     |



**Manual operation:** See ["Radio Frequency State"](#) on page 228

### 6.8.1.2 RF input configuration

|  |     |
|--|-----|
| <a href="#">INPut:ATTenuation:LIMiter[:STATe]</a> .....  | 621 |
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| <a href="#">INPut:UPOrT:STATe</a> .....                  | 622 |
| <a href="#">INPut:UPOrT[:VALue]</a> .....                | 623 |

---

#### **INPut:ATTenuation:LIMiter[:STATe] <State>**

This command turns the pulse limiter on and off.

The pulse limiter is an additional protection mechanism for the second RF input that attenuates high level pulses.

##### **Parameters:**

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

**Example:**                //Turn on pulse limiter  
                              INP:ATT:LIM ON

**Manual operation:** See ["Pulse Limiter"](#) on page 229

---

#### **INPut:ATTenuation:PROTection:RESet**

Resets the attenuator and reconnects the RF input with the input mixer for the R&S ESW 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.

(See the description of the `STATus:QUESTionable:POWer` status register in the R&S ESW manual.

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

For more information, see [Chapter 4.3.1.1, "Increasing measurement sensitivity \(or avoiding an input mixer overload\)"](#), on page 223.

**Example:**                INP:ATT:PROT:RES

---

#### **INPut:COUPling <CouplingType>**

Selects the coupling type of the RF input.

##### **Parameters:**

<CouplingType>        AC | DC

**AC**

AC coupling

**DC**

DC coupling

\*RST: AC

**Example:** INP:COUP DC**Manual operation:** See ["Input Coupling"](#) on page 228**INPut:IMPedance** <Impedance>

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

**Parameters:**

&lt;Impedance&gt;

50 | 75

**numeric value**

User-defined impedance from 50 Ohm to 100000000 Ohm (=100 MOhm)

User-defined values are only available for the Spectrum application, the I/Q Analyzer, and some optional applications.

\*RST: 50  $\Omega$ 

Default unit: OHM

**Example:** INP:IMP 75**Manual operation:** See ["Impedance"](#) on page 229See ["Unit"](#) on page 293**INPut:TYPE** <Input>

The command selects the signal source.

**Parameters:**

&lt;Input&gt;

**INPUT1**

Selects RF input 1.

**INPUT2**

Selects RF input 2.

\*RST: INPUT1

**Example:** //Select input path  
INP:TYPE INPUT1

**INPut:UPORt:STATe** <State>

Toggles the control lines of the user ports for the **AUX PORT** connector. This SUB-D male connector is located on the rear panel of the R&S ESW.

See the R&S ESW Getting Started manual for details.

**Parameters:**

<State>                    **ON | 1**  
                               User port is switched to INPut  
                               **OFF | 0**  
                               User port is switched to OUTPut  
 \***RST:**                    1

---

**INPut:UPORt[:VALue]**

Queries the control lines of the user ports.

For details see [OUTPut:UPORt\[:VALue\]](#) on page 647.

**Return values:**

<Level>                    bit values in hexadecimal format  
                               TTL type voltage levels (max. 5V)  
 Range:                    #B00000000 to #B00111111

**Example:**

```
INP:UPOR?
//Result: #B00100100
Pins 5 and 7 are active.
```

### 6.8.1.3 External generator configuration (Optional)

|   |     |
|---|-----|
| <a href="#">[SENSe]:CORRection:COLLect[:ACQuire]</a> .....                                | 624 |
| <a href="#">[SENSe]:CORRection:METHod</a> .....   | 624 |
| <a href="#">[SENSe]:CORRection:RECall</a> .....   | 625 |
| <a href="#">[SENSe]:CORRection[:STATe]</a> .....  | 625 |
| <a href="#">[SENSe]:CORRection:TRANsducer:GENerate</a> .....                              | 625 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:FREQuency</a> .....                      | 626 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:FREQuency:COUPling[:STATe]</a> .....     | 626 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:FREQuency[:FACTor]:DENominator</a> ..... | 626 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:FREQuency[:FACTor]:NUMerator</a> .....   | 627 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:FREQuency:OFFSet</a> .....               | 628 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:FREQuency:SWEep[:STATe]</a> .....        | 628 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:POWER[:LEVel]</a> .....                  | 628 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;[:STATe]</a> .....                        | 629 |
| <a href="#">SOURce&lt;si&gt;:POWER[:LEVel][:IMMediate]:OFFSet</a> .....                   | 629 |
| <a href="#">SOURce&lt;si&gt;:EXTernal&lt;gen&gt;:ROSCillator[:SOURce]</a> .....           | 629 |
| <a href="#">SYSTem:COMMunicate:GPIB:RDEVice:GENerator&lt;gen&gt;:ADDRess</a> .....        | 630 |
| <a href="#">SYSTem:COMMunicate:RDEVice:GENerator&lt;gen&gt;:INTerface</a> .....           | 630 |
| <a href="#">SYSTem:COMMunicate:RDEVice:GENerator&lt;gen&gt;:LINK</a> .....                | 630 |
| <a href="#">SYSTem:COMMunicate:RDEVice:GENerator&lt;gen&gt;:TYPE</a> .....                | 631 |
| <a href="#">SYSTem:COMMunicate:TCPIp:RDEVice:GENerator&lt;gen&gt;:ADDRess</a> .....       | 631 |

**[SENSe:]CORRection:COLLect[:ACQuire] <MeasType>**

Initiates a reference measurement (calibration). The reference measurement is the basis for the measurement normalization. The result depends on whether a reflection measurement or transmission measurement is performed (see [\[SENSe:\]CORRection:METHod](#) on page 624).

To obtain a correct reference measurement, a complete sweep with synchronization to the end of the sweep must have been carried out. This is only possible in the single sweep mode.

Is only available if external generator control is active (see [SOURCE<si>:EXTernal<gen>\[:STATe\]](#) on page 629).

**Setting parameters:**

<MeasType>      THROugh | OPEN

**THROugh**

"TRANsmission" mode: calibration with direct connection between generator and device input

"REFLection" mode: calibration with short circuit at the input

**OPEN**

only allowed in "REFLection" mode: calibration with open input

**Example:**

```
INIT:CONT OFF
```

Selects single sweep operation

```
CORR:METH TRAN
```

Selects a transmission measurement.

```
CORR:COLL THR;*WAI
```

Starts the measurement of reference data using direct connection between generator and device input and waits for the sweep end.

**Usage:**

Setting only

**Manual operation:**

See ["Calibrate Reflection Short"](#) on page 245

See ["Calibrate Reflection Open"](#) on page 245

**[SENSe:]CORRection:METHod <Type>**

Selects the type of measurement to be performed with the generator.

Is only available if external generator control is active (see [SOURCE<si>:EXTernal<gen>\[:STATe\]](#) on page 629).

**Parameters:**

<Type>

**REFLection**

Selects reflection measurements.

**TRANsmission**

Selects transmission measurements.

```
*RST:      TRANsmission
```

**Example:**

```
CORR:METH TRAN
```

Sets the type of measurement to "transmission".

**Manual operation:** See ["Calibrate Transmission"](#) on page 244  
 See ["Calibrate Reflection Short"](#) on page 245  
 See ["Calibrate Reflection Open"](#) on page 245

---

### **[SENSe:]CORRection:RECall**

Restores the measurement configuration used for calibration.

Is only available if external generator control is active (see [SOURCE<si>:EXTernal<gen>\[:STATe\]](#) on page 629).

**Example:** CORR:REC

**Manual operation:** See ["Recall Cal. Settings"](#) on page 245

---

### **[SENSe:]CORRection[:STATe] <State>**

Turns correction of measurement results (normalization) on and off.

The command is available after you have created a reference trace for the selected measurement type with [\[SENSe:\]CORRection:COLLect\[:ACQuire\]](#) on page 624.

Is only available if external generator control is active (see [SOURCE<si>:EXTernal<gen>\[:STATe\]](#) on page 629).

#### **Parameters:**

<State>                    ON | OFF | 0 | 1  
                              **OFF | 0**  
                              Switches the function off  
                              **ON | 1**  
                              Switches the function on  
                              \*RST:        1

**Example:** CORR ON  
 Activates normalization.

**Manual operation:** See ["Normalization state"](#) on page 245

---

### **[SENSe:]CORRection:TRANsducer:GENerate <Name>**

Uses the normalized measurement data to generate a transducer factor with up to 1001 points. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix .trd under

C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\trd. The frequency points are allocated in equidistant steps between start and stop frequency.

#### **Parameters:**

<Name>                    '<name>'

**Example:** CORR:TRAN:GEN 'MyGenerator'  
 Creates the transducer file  
 C:\r\_s\instr\trd\MyGenerator.trd.

**Manual operation:** See ["Save as Trd Factor"](#) on page 245

---

### **SOURce<si>:EXTernal<gen>:FREQuency <Frequency>**

Defines a fixed source frequency for the external generator.

**Suffix:**

<si> irrelevant

<gen>

**Parameters:**

<Frequency> Source frequency of the external generator.

\*RST: 1100050000

Default unit: HZ

**Example:** //Define frequency of the generator

SOUR:EXT:FREQ 10MHz

**Manual operation:** See ["\(Manual\) Source Frequency"](#) on page 243

---

### **SOURce<si>:EXTernal<gen>:FREQuency:COUPling[:STATe] <State>**

Couples the frequency of the external generator output to the R&S ESW.

**Suffix:**

<si> irrelevant

<gen>

**Parameters:**

<State> ON | OFF | 0 | 1

**ON | 1**

Default setting: a series of frequencies is defined (one for each sweep point), based on the current frequency at the RF input of the R&S ESW. The RF frequency range covers the currently defined span of the R&S ESW (unless limited by the range of the signal generator).

**OFF | 0**

The generator uses a single fixed frequency, defined by

[SOURce<si>:EXTernal<gen>:FREQuency](#).

\*RST: 1

**Example:** SOUR:EXT:FREQ:COUP ON

**Manual operation:** See ["Source Frequency Coupling"](#) on page 243

---

### **SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:DENominator <Value>**

Defines the denominator of the factor with which the analyzer frequency is multiplied to obtain the transmit frequency of the selected generator.

Select the multiplication factor such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

**Suffix:**

<si> irrelevant

<gen>

**Parameters:**

<Value> <numeric value>

\*RST: 1

**Example:**

//Define multiplication factor of 4/3; the transmit frequency of the generator is 4/3 times the analyzer frequency

SOUR:EXT:FREQ:NUM 4

SOUR:EXT:FREQ:DEN 3

**Manual operation:**

See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 243

**SOURce<si>:EXTernal<gen>:FREQuency[:FACTor]:NUMerator <Value>**

Defines the numerator of the factor with which the analyzer frequency is multiplied to obtain the transmit frequency of the selected generator.

Select the multiplication factor such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

**Suffix:**

<si> irrelevant

<gen>

**Parameters:**

<Value> <numeric value>

\*RST: 1

**Example:**

//Define multiplication factor of 4/3; the transmit frequency of the generator is 4/3 times the analyzer frequency

SOUR:EXT:FREQ:NUM 4

SOUR:EXT:FREQ:DEN 3

**Manual operation:**

See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 243

**SOURce<si>:EXTernal<gen>:FREQuency:OFFSet <Offset>**

Defines the frequency offset of the generator with reference to the analyzer frequency.

Select the offset such that the frequency range of the generator is not exceeded if the following formula is applied to the start and stop frequency of the analyzer:

$$F_{Generator} = \left| F_{Analyzer} * \frac{Numerator}{Denominator} + F_{Offset} \right|$$

**Suffix:**

<si> irrelevant

<gen>

**Parameters:**

<Offset> <numeric value>, specified in Hz, kHz, MHz or GHz, rounded to the nearest Hz

\*RST: 0 Hz

Default unit: HZ

**Example:**

//Define an offset between generator output frequency and analyzer frequency

SOUR:EXT:FREQ:OFFS 10HZ

**Manual operation:** See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 243

**SOURce<si>:EXTernal<gen>:FREQuency:SWEep[:STATe] <State>**

Note that this command is maintained for compatibility reasons only. It is not required in new remote control programs.

Activates or deactivates the frequency sweep for the selected generator.

**Suffix:**

<si> irrelevant

<gen>

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

SOUR:EXT:FREQ:SWE ON

Activates the frequency sweep for the external generator.

**SOURce<si>:EXTernal<gen>:POWer[:LEVel] <Level>**

Sets the output power of the selected generator.



**Suffix:**

&lt;si&gt; irrelevant

&lt;gen&gt;

**Parameters:**

&lt;Level&gt; &lt;numeric value&gt;

\*RST: -20 dBm

Default unit: DBM

**Example:**

//Define generator output level

SOUR:EXT:POW -30dBm

**Manual operation:** See ["Source Power"](#) on page 242**SOURce<si>:EXTeRnal<gen>[:STATe] <State>**

Activates or deactivates the connected external generator.

**Suffix:**

&lt;si&gt; irrelevant

&lt;gen&gt;

**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Manual operation:** See ["Source State"](#) on page 242**SOURce<si>:POWeR[:LEVeL][:IMMeDiate]:OFFSet <Offset>****Suffix:**

&lt;si&gt; irrelevant

**Parameters:**

&lt;Offset&gt; Range: -200 dB to +200 dB

\*RST: 0dB

Default unit: DB

**Example:**

SOUR:POW:OFFS -10dB

**Manual operation:** See ["Source Offset"](#) on page 242**SOURce<si>:EXTeRnal<gen>:ROSCillator[:SOURce] <Source>**

Controls selection of the reference oscillator for the external generator.

If the external reference oscillator is selected, the reference signal must be connected to the rear panel of the instrument.

**Suffix:**

&lt;si&gt; irrelevant

&lt;gen&gt; irrelevant

**Parameters:**

&lt;Source&gt;

**INTernal**

Uses the internal reference.

**EXTernal**

Uses the external reference; if none is available, an error flag is displayed in the status bar.

\*RST: INT

**Example:**

//Select an external reference oscillator

SOUR:EXT:ROSC EXT

**Manual operation:** See ["Reference"](#) on page 241**SYSTem:COMMunicate:GPIB:RDEvice:GENerator<gen>:ADDRess <Number>**

Changes the IEC/IEEE-bus address of the external generator.

**Suffix:**

&lt;gen&gt; 1..n

**Parameters:**

&lt;Number&gt;

Range: 0 to 30

\*RST: 28

**Example:**

SYST:COMM:GPIB:RDEV:GEN:ADDR 15

**Manual operation:** See ["GPIB Address/TCPIP Address / Computer Name"](#) on page 241**SYSTem:COMMunicate:RDEvice:GENerator<gen>:INTERface <Type>**

Defines the interface used for the connection to the external generator.

**Suffix:**

&lt;gen&gt;

**Parameters:**

&lt;Type&gt;

**GPIB****TCPIp****Example:**

SYST:COMM:RDEV:GEN:INT TCP

**Manual operation:** See ["Interface"](#) on page 240**SYSTem:COMMunicate:RDEvice:GENerator<gen>:LINK <Type>**

Selects the link type of the external generator if the GPIB interface is used.

The difference between the two GPIB operating modes is the execution speed. During GPIB operation, each frequency to be set is transmitted to the generator separately. If the TTL interface is also used, a whole frequency list can be programmed in one go. Frequencies can then be switched per TTL handshake, which speeds up the process considerably.

Is only available if external generator control is active (see [SOURce<si>:EXTernal<gen>\[:STATe\]](#) on page 629).

**Suffix:**

<gen>

**Parameters:**

<Type>

GPIB | TTL

**GPIB**

GPIB connection without TTL synchronization (for all generators of other manufacturers and some Rohde & Schwarz devices)

**TTL**

GPIB connection with TTL synchronization (if available; for most Rohde&Schwarz devices)

\*RST: GPIB

**Example:**

SYST:COMM:RDEV:GEN:LINK TTL

Selects GPIB + TTL interface for generator operation.

**Manual operation:** See ["TTL Handshake"](#) on page 240

**SYSTem:COMMunicate:RDEvice:GENerator<gen>:TYPE <Type>**

Selects the type of external generator.

For a list of the available generator types, see the specifications document.

**Suffix:**

<gen>

**Parameters:**

<Name>

<Generator name as string value>

\*RST: SMU02

**Example:**

//Select an external generator

SYST:COMM:RDEV:GEN:TYPE 'SMW06'

**Manual operation:** See ["Generator Type"](#) on page 240

**SYSTem:COMMunicate:TCPIp:RDEvice:GENerator<gen>:ADDRess <Address>**

Configures the TCP/IP address for the external generator.

**Suffix:**

<gen>

**Parameters:**

<Address> TCP/IP address between 0.0.0.0 and 0.255.255.255  
 \*RST: 0.0.0.0

**Example:**

SYST:COMM:TCP:RDEV:GEN:ADDR 130.094.122.195

**Manual operation:**

See ["GPIB Address/TCPIP Address / Computer Name"](#) on page 241

**6.8.1.4 External mixer configuration (Optional)**

|   |     |
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**[SENSe:]CORRection:CVL:BAND <Band>**

Defines the waveguide band for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<Band> K | KA | Q | U | V | E | W | F | D | G | Y | J | USER  
Standard waveguide band or user-defined band.  
For a definition of the frequency range for the pre-defined bands, see [Table 6-4](#).  
\*RST: F (90 GHz - 140 GHz)

**Example:**

```
CORR:CVL:SEL 'LOSS_TAB_4'
Selects the conversion loss table.
CORR:CVL:BAND KA
Sets the band to KA (26.5 GHz - 40 GHz).
```

**Manual operation:** See ["Band"](#) on page 272

**[SENSe:]CORRection:CVL:BIAS <BiasSetting>**

Defines the bias setting to be used with the conversion loss table.

Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<BiasSetting> \*RST: 0.0 A  
Default unit: A

**Example:**

```
CORR:CVL:SEL 'LOSS_TAB_4'
Selects the conversion loss table.
CORR:CVL:BIAS 3A
```

**Manual operation:** See ["Write to CVL table"](#) on page 270  
See ["Bias"](#) on page 272

**[SENSe:]CORRection:CVL:CATalog?**

Queries all available conversion loss tables saved in the C:\R\_S\Instr\User\cvl\ directory on the instrument.

Is only available with option B21 (External Mixer) installed.

**Return values:**

<Files> 'string'  
Comma-separated list of strings containing the file names.

**Example:** CORR:CVL:CAT?

**Usage:** Query only

**[SENSe:]CORRection:CVL:CLEar**

Deletes the selected conversion loss table. Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Example:**           CORR:CVL:SEL 'LOSS\_TAB\_4'  
                  Selects the conversion loss table.  
                  CORR:CVL:CLE

**Manual operation:** See ["Delete Table"](#) on page 271

**[SENSe:]CORRection:CVL:COMMeNT <Text>**

Defines a comment for the conversion loss table. Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<Text>

**Example:**           CORR:CVL:SEL 'LOSS\_TAB\_4'  
                  Selects the conversion loss table.  
                  CORR:CVL:COMM 'Conversion loss table for  
                  FS\_Z60'

**Manual operation:** See ["Comment"](#) on page 272

**[SENSe:]CORRection:CVL:DATA {<Freq>, <Level>}...**

Defines the reference values of the selected conversion loss tables. The values are entered as a set of frequency/level pairs. You can define a maximum of 500 frequency/level pairs. Before this command can be performed, you must select the conversion loss table (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<Freq>           The frequencies have to be sent in ascending order.  
                  Default unit: HZ

<Level>          Default unit: DB

**Example:**           CORR:CVL:SEL 'LOSS\_TAB\_4'  
                  Selects the conversion loss table.  
                  CORR:CVL:DATA 1MHZ,-30DB,2MHZ,-40DB

**Manual operation:** See ["Position/Value"](#) on page 273

**[SENSe:]CORRection:CVL:HARMonic <HarmOrder>**

Defines the harmonic order for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<HarmOrder>                      Range:        2 to 65

**Example:**

```
CORR:CVL:SEL 'LOSS_TAB_4'
Selects the conversion loss table.
CORR:CVL:HARM 3
```

**Manual operation:**    See ["Harmonic Order"](#) on page 272

**[SENSe:]CORRection:CVL:MIXer <Type>**

Defines the mixer name in the conversion loss table. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<Type>                              string  
Name of mixer with a maximum of 16 characters

**Example:**

```
CORR:CVL:SEL 'LOSS_TAB_4'
Selects the conversion loss table.
CORR:CVL:MIX 'FS_Z60'
```

**Manual operation:**    See ["Mixer Name"](#) on page 273

**[SENSe:]CORRection:CVL:PORTs <PortType>**

Defines the mixer type in the conversion loss table. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

**Parameters:**

<PortType>                        2 | 3  
\*RST:                              2

**Example:**            `CORR:CVL:SEL 'LOSS_TAB_4'`  
                       Selects the conversion loss table.  
                       `CORR:CVL:PORT 3`

**Manual operation:** See ["Mixer Type"](#) on page 273

#### **[SENSe:]CORRection:CVL:SElect <FileName>**

Selects the conversion loss table with the specified file name. If <file\_name> is not available, a new conversion loss table is created.

Is only available with option B21 (External Mixer) installed.

##### **Parameters:**

<FileName>            String containing the path and name of the file.

**Example:**            `CORR:CVL:SEL 'LOSS_TAB_4'`

**Manual operation:** See ["New Table"](#) on page 271  
                           See ["Edit Table"](#) on page 271  
                           See ["File Name"](#) on page 272

#### **[SENSe:]CORRection:CVL:SNUMber <SerialNo>**

Defines the serial number of the mixer for which the conversion loss table is to be used. This setting is checked against the current mixer setting before the table can be assigned to the range.

Before this command can be performed, the conversion loss table must be selected (see [\[SENSe:\]CORRection:CVL:SElect](#) on page 636).

Is only available with option B21 (External Mixer) installed.

##### **Parameters:**

<SerialNo>            Serial number with a maximum of 16 characters

**Example:**            `CORR:CVL:SEL 'LOSS_TAB_4'`  
                           Selects the conversion loss table.  
                           `CORR:CVL:MIX '123.4567'`

**Manual operation:** See ["Mixer S/N"](#) on page 273

#### **[SENSe:]MIXer<x>:BIAS:HIGH <BiasSetting>**

Defines the bias current for the high (last) range.

Is only available if the external mixer is active (see [\[SENSe:\]MIXer<x>\[:STATe\]](#) on page 643).

##### **Suffix:**

<x>                    1..n  
                           irrelevant



**Parameters:**

<BiasSetting>      \*RST:      0.0 A  
                               Default unit: A

**Manual operation:**    See "[Bias Value](#)" on page 269

**[SENSe:]MIXer<x>:BIAS[:LOW] <BiasSetting>**

Defines the bias current for the low (first) range.

Is only available if the external mixer is active (see [\[SENSe:\]MIXer<x>\[:STATe\]](#) on page 643).

**Suffix:**

<x>                      1..n  
                               irrelevant

**Parameters:**

<BiasSetting>      \*RST:      0.0 A  
                               Default unit: A

**Manual operation:**    See "[Bias Value](#)" on page 269

**[SENSe:]MIXer<x>:FREQuency:HANDover <Frequency>**

Defines the frequency at which the mixer switches from one range to the next (if two different ranges are selected). The handover frequency for each band can be selected freely within the overlapping frequency range.

Is only available if the external mixer is active (see [\[SENSe:\]MIXer<x>\[:STATe\]](#) on page 643).

**Suffix:**

<x>                      1..n  
                               irrelevant

**Parameters:**

<Frequency>            Default unit: HZ

**Example:**

MIX ON  
 Activates the external mixer.  
 MIX:FREQ:HAND 78.0299GHz  
 Sets the handover frequency to 78.0299 GHz.

**Manual operation:**    See "[Handover Freq](#)" on page 266

**[SENSe:]MIXer<x>:FREQuency:START**

Sets or queries the frequency at which the external mixer band starts.

**Suffix:**

<x>                      1..n  
                               irrelevant

**Example:** `MIX:FREQ:STAR?`  
Queries the start frequency of the band.

**Manual operation:** See ["RF Start / RF Stop"](#) on page 265

#### **[SENSe:]MIXer<x>:FREQuency:STOP**

Sets or queries the frequency at which the external mixer band stops.

**Suffix:**  
<x> 1..n  
irrelevant

**Example:** `MIX:FREQ:STOP?`  
Queries the stop frequency of the band.

**Manual operation:** See ["RF Start / RF Stop"](#) on page 265

#### **[SENSe:]MIXer<x>:HARMonic:BAND:PRESet**

Restores the preset frequency ranges for the selected standard waveguide band.

**Note:** Changes to the band and mixer settings are maintained even after using the [PRESET] function. Use this command to restore the predefined band ranges.

**Suffix:**  
<x> 1..n  
irrelevant

**Example:** `MIX:HARM:BAND:PRESet`  
Presets the selected waveguide band.

**Manual operation:** See ["Preset Band"](#) on page 266

#### **[SENSe:]MIXer<x>:HARMonic:BAND <Band>**

Selects the external mixer band. The query returns the currently selected band.

Is only available if the external mixer is active (see [\[SENSe:\]MIXer<x>\[:STATe\]](#) on page 643).

**Suffix:**  
<x> 1..n  
irrelevant

**Parameters:**  
<Band> KA|Q|U|V|E|W|F|D|G|Y|J|USER  
Standard waveguide band or user-defined band.

**Manual operation:** See ["Band"](#) on page 266

Table 6-4: Frequency ranges for pre-defined bands

| Band   | Frequency start [GHz] | Frequency stop [GHz] |
|--|-----------------------|----------------------|
| KA (A) *)  | 26.5                  | 40.0                 |
| Q  | 33.0                  | 50.0                 |
| U  | 40.0                  | 60.0                 |
| V  | 50.0                  | 75.0                 |
| E  | 60.0                  | 90.0                 |
| W  | 75.0                  | 110.0                |
| F  | 90.0                  | 140.0                |
| D  | 110.0                 | 170.0                |
| G  | 140.0                 | 220.0                |
| J  | 220.0                 | 325.0                |
| Y  | 325.0                 | 500.0                |
| USER   | 32.18<br>(default)    | 68.22<br>(default)   |
| *) The band formerly referred to as "A" is now named "KA". |                       |                      |

**[SENSe:]MIXer<x>:HARMonic:HIGH[:VALue] <HarmOrder>**

Specifies the harmonic order to be used for the high (second) range.

**Suffix:**

<x>                      1..n  
                             irrelevant

**Parameters:**

<HarmOrder>            Range:        2 to 128 (USER band); for other bands: see band definition

**Example:**

MIX:HARM:HIGH:STAT ON  
MIX:HARM:HIGH 3

**Manual operation:** See "[Harmonic Order](#)" on page 267

**[SENSe:]MIXer<x>:HARMonic:TYPE <OddEven>**

Specifies whether the harmonic order to be used should be odd, even, or both.

Which harmonics are supported depends on the mixer type.

**Suffix:**

<x>                      1..n  
                             irrelevant

**Parameters:**

<OddEven>            ODD | EVEN | EODD  
                          **ODD | EVEN | EODD**  
                          \*RST:        EVEN

**Example:**

MIX:HARM:TYPE ODD

**Manual operation:** See ["Harmonic Type"](#) on page 267

**[SENSe:]MIXer<x>:HARMonic[:LOW] <HarmOrder>**

Specifies the harmonic order to be used for the low (first) range.

**Suffix:**

<x>                    1..n  
                          irrelevant

**Parameters:**

<HarmOrder>        Range:        2 to 128 (USER band); for other bands: see band  
                                                             definition  
                          \*RST:        2 (for band F)

**Example:**

MIX:HARM 3

**Manual operation:** See ["Harmonic Order"](#) on page 267

**[SENSe:]MIXer<x>:LOSS:HIGH <Average>**

Defines the average conversion loss to be used for the entire high (second) range.

**Suffix:**

<x>                    1..n

**Parameters:**

<Average>           Range:        0 to 100  
                          \*RST:        24.0 dB  
                          Default unit: dB

**Example:**

MIX:LOSS:HIGH 20dB

**Manual operation:** See ["Conversion Loss"](#) on page 267

**[SENSe:]MIXer<x>:LOSS:TABLE:HIGH <FileName>**

Defines the conversion loss table to be used for the high (second) range.

**Suffix:**

<x>                    1..n

**Parameters:**

<FileName> String containing the path and name of the file, or the serial number of the external mixer whose file is required. The R&S ESW automatically selects the correct cvl file for the current IF. As an alternative, you can also select a user-defined conversion loss table (.ac1 file).

**Manual operation:** See ["Conversion Loss"](#) on page 267

**[SENSe:]MIXer<x>:LOSS:TABLE[:LOW] <FileName>**

Defines the file name of the conversion loss table to be used for the low (first) range.

**Suffix:**

<x> 1..n

**Parameters:**

<FileName> String containing the path and name of the file, or the serial number of the external mixer whose file is required. The R&S ESW automatically selects the correct cvl file for the current IF. As an alternative, you can also select a user-defined conversion loss table (.ac1 file).

**Example:**

```
MIX:LOSS:TABL '101567'
MIX:LOSS:TABL?
//Result:
'101567_MAG_6_B5000_3G5.B5G'
```

**Manual operation:** See ["Conversion Loss"](#) on page 267

**[SENSe:]MIXer<x>:LOSS[:LOW] <Average>**

Defines the average conversion loss to be used for the entire low (first) range.

**Suffix:**

<x> 1..n

**Parameters:**

<Average> Range: 0 to 100  
 \*RST: 24.0 dB  
 Default unit: dB

**Example:**

```
MIX:LOSS 20dB
```

**Manual operation:** See ["Conversion Loss"](#) on page 267

**[SENSe:]MIXer<x>:PORTs <PortType>**

Selects the mixer type.

**Suffix:**

<x> 1..n  
irrelevant

**Parameters:**

<PortType> 2 | 3  
2  
Two-port mixer.  
3  
Three-port mixer.  
\*RST: 2

**Example:** MIX:PORT 3

**Manual operation:** See ["Mixer Type"](#) on page 266

**[SENSe:]MIXer<x>:RFOVerrange[:STATe] <State>**

If enabled, the band limits are extended beyond "RF Start" and "RF Stop" due to the capabilities of the used harmonics.

**Suffix:**

<x> 1..n  
irrelevant

**Parameters:**

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

**Manual operation:** See ["RF Overrange"](#) on page 266

**[SENSe:]MIXer<x>:SIGNal <State>**

Specifies whether automatic signal detection is active or not.

Note that automatic signal identification is only available for measurements that perform frequency sweeps (not in vector signal analysis or the I/Q Analyzer, for instance).

The "Auto ID" function is now also available for [Spectrum emission mask \(SEM\) measurement](#) and [Spurious emissions measurement](#) using an external mixer.

**Suffix:**

<x> 1..n  
irrelevant

**Parameters:**

<State> OFF | ON | AUTO | ALL  
**OFF | ON | AUTO | ALL**  
**OFF**  
No automatic signal detection is active.  
**ON**  
Automatic signal detection (Signal ID) is active.

**AUTO**

Automatic signal detection (Auto ID) is active.

**ALL**

Both automatic signal detection functions (Signal ID+Auto ID) are active.

\*RST: OFF

**Manual operation:** See ["Signal ID"](#) on page 269  
See ["Auto ID"](#) on page 269

**[SENSe:]MIXer<x>:THReshold <Value>**

Defines the maximum permissible level difference between test sweep and reference sweep to be corrected during automatic comparison (see [\[SENSe:\]MIXer<x>:SIGNal](#) on page 642).

**Suffix:**

<x> 1..n  
irrelevant

**Parameters:**

<Value> <numeric value>  
Range: 0.1 dB to 100 dB  
\*RST: 10 dB  
Default unit: DB

**Example:** MIX:PORT 3

**Manual operation:** See ["Auto ID Threshold"](#) on page 269

**[SENSe:]MIXer<x>[:STATe] <State>**

Activates or deactivates the use of a connected external mixer as input for the measurement. This command is only available if the optional External Mixer is installed and an external mixer is connected.

**Suffix:**

<x> 1..n  
irrelevant

**Parameters:**

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

**Example:** MIX ON

**Manual operation:** See ["External Mixer \(State\)"](#) on page 265

**[SENSe:]MIXer<x>:HARMonic:HIGH:STATe <State>**

Specifies whether a second (high) harmonic is to be used to cover the band's frequency range.

**Suffix:**

&lt;x&gt; 1..n

**Parameters:**

<State> ON | OFF  
 \*RST: ON

**Example:** MIX:HARM:HIGH:STAT ON**Manual operation:** See ["Range 1/Range 2"](#) on page 267**[SENSe:]MIXer<x>:LOPower <Level>**

Specifies the LO level of the external mixer's LO port.

**Suffix:**

<x> 1..n  
 irrelevant

**Parameters:**

<Level> Range: 13.0 dBm to 17.0 dBm  
 Increment: 0.1 dB  
 \*RST: 15.5 dBm  
 Default unit: DBM

**Example:** MIX:LOP 16.0dBm**Manual operation:** See ["LO Level"](#) on page 268**6.8.1.5 General output configuration**

|   |     |
|---|-----|
| OUTPut:IF:IFFrequency.....              | 644 |
| OUTPut:IF[:SOURce].....                 | 645 |
| OUTPut<ou>:PROBe<pb>[:POWer].....       | 645 |
| OUTPut:TRIGger<tp>:DIRection.....       | 645 |
| OUTPut:TRIGger<tp>:LEVel.....           | 646 |
| OUTPut:TRIGger<tp>:OTYPE.....           | 646 |
| OUTPut:TRIGger<tp>:PULSe:IMMediate..... | 647 |
| OUTPut:TRIGger<tp>:PULSe:LENGth.....    | 647 |
| OUTPut:UPORt[:VALue].....               | 647 |
| OUTPut:UPORt:STATe.....                 | 648 |

**OUTPut:IF:IFFrequency <Frequency>**

Defines the frequency for the IF output of the R&S ESW. The IF frequency of the signal is converted accordingly.

Is available in the time domain and if the IF/VIDEO/DEMODO output is configured for IF.

For more information see [Chapter 4.1.1, "IF and video signal output"](#), on page 221.

**Parameters:**

<Frequency> \*RST: 50.0 MHz  
 Default unit: HZ



**OUTPut:IF[:SOURce] <Source>**

Defines the type of signal available at one of the output connectors of the R&S ESW.

**Parameters:**

<Source>

**IF**

The measured IF value is available at the IF/VIDEO/DEMODO output connector.

**VIDeo**

The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMODO output connector.

This setting is required to provide demodulated audio frequencies at the output.

\*RST: IF

**Example:**

OUTP:IF VID

Selects the video signal for the IF/VIDEO/DEMODO output connector.

**OUTPut<ou>:PROBe<pb>[:POWER] <State>**

This command selects the probe connector that is supplied with power.

**Suffix:**

<ou> irrelevant

<pb> Selects the probe power connector.

**Parameters:**

<State> ON | OFF | 1 | 0

**Example:**

//Supply 5-pin probe connector with power

OUTP:PROB2 ON

**Manual operation:** See ["Probe Power Supply"](#) on page 279

**OUTPut:TRIGger<tp>:DIRection <Direction>**

Selects the trigger direction for trigger ports that serve as an input as well as an output.

**Suffix:**

<tp> Selects the used trigger port.  
2 = trigger port 2 (front)  
3 = trigger port 3 (rear panel)

**Parameters:**

<Direction> INPut | OUTPut

**INPut**

Port works as an input.

**OUTPut**

Port works as an output.

\*RST: INPut

**Manual operation:** See ["Trigger 2/3"](#) on page 280

### OUTPut:TRIGger<tp>:LEVel <Level>

Defines the level of the (TTL compatible) signal generated at the trigger output.

Works only if you have selected a user-defined output with [OUTPut:TRIGger<tp>:OTYPe](#).

#### Suffix:

<tp> 1..n  
Selects the trigger port to which the output is sent.  
2 = trigger port 2 (front)  
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 281

### OUTPut:TRIGger<tp>:OTYPe <OutputType>

Selects the type of signal generated at the trigger output.

#### Suffix:

<tp> 1..n  
Selects the trigger port to which the output is sent.  
2 = trigger port 2 (front)  
3 = trigger port 3 (rear)

#### Parameters:

<OutputType> **DEVICE**  
Sends a trigger signal when the R&S ESW has triggered internally.  
**TARMed**  
Sends a trigger signal when the trigger is armed and ready for an external trigger event.  
**UDEFined**  
Sends a user-defined trigger signal. For more information, see [OUTPut:TRIGger<tp>:LEVel](#).  
\*RST: DEVice

**Manual operation:** See ["Output Type"](#) on page 280

**OUTPut:TRIGger<tp>:PULSe:IMMediate**

Generates a pulse at the trigger output.

**Suffix:**

<tp> 1..n  
 Selects the trigger port to which the output is sent.  
 2 = trigger port 2 (front)  
 3 = trigger port 3 (rear)

**Manual operation:** See ["Send Trigger"](#) on page 281

**OUTPut:TRIGger<tp>:PULSe:LENGth <Length>**

Defines the length of the pulse generated at the trigger output.

**Suffix:**

<tp> Selects the trigger port to which the output is sent.  
 2 = trigger port 2 (front)  
 3 = trigger port 3 (rear)

**Parameters:**

<Length> Pulse length in seconds.  
 Default unit: S

**Example:** OUTPut:TRIG2:PULS:LENG 0.02

**Manual operation:** See ["Pulse Length"](#) on page 281

**OUTPut:UPORt[:VALue] <Value>**

Sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

| Bit | 7   | 6   | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-----|-----|---|---|---|---|---|---|
| Pin | N/A | N/A | 5 | 3 | 4 | 7 | 6 | 2 |

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern.

If the user port is programmed to input instead of output (see [INPut:UPORt:STATe](#) on page 622), the output value is temporarily stored.

**Parameters:**

<Value> bit values in hexadecimal format  
 TTL type voltage levels (max. 5V)  
 Range: #B00000000 to #B00111111

**Example:** OUTPut:UPOR #B00100100  
 Sets pins 5 and 7 to 5 V.

**OUTPut:UPORt:STATe <State>**

Toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S ESW.

**Parameters:**

<State>                    ON | OFF | 0 | 1  
                              **OFF | 0**  
                              User port is switched to INPut  
                              **ON | 1**  
                              User port is switched to OUTPut

**Example:**                OUTP:UPOR:STAT ON

**6.8.1.6 Programming example for external generator control**

The following example demonstrates how to work with an external generator in a remote environment.

It assumes that a signal generator of the type SMW06 is connected to the R&S ESW, including TTL synchronization, as described in the R&S ESW User Manual.

```
//-----Preparing the instrument -----

//Reset the instrument
*RST

//Set the frequency span.
SENS:FREQ:STAR 10HZ
SENS:FREQ:STOP 1MHZ

//-----Configuring the interface -----

//Set the generator type to SMW06 with a frequency range of 100 kHz to 4GHz
SYST:COMM:RDEV:GEN:TYPE 'SMW06'

//Set the interface used to the GPIB address 28
SYST:COMM:RDEV:GEN:INT GPIB
SYST:COMM:GPIB:RDEV:GEN:ADDR 28

//Activate the use of TTL synchronization to optimize measurement speed
SYST:COMM:RDEV:GEN:LINK TTL

//Activate the use of the external reference frequency at 10 MHz on the generator
SOUR:EXT:ROSC EXT

//-----Configuring the calibration measurement -----

//Activate external generator control.
SOUR:EXT:STAT ON
//Set the generator output level to -10 dBm.
```

```

SOUR:EXT:POW -10DBM
//Set the frequency coupling to automatic
SOUR:EXT:FREQ:COUP:STAT ON

//-----Configuring the generator frequency range -----

//Define a series of frequencies (one for each sweep point) based on the current
//frequency at the RF input of the analyzer; the generator frequency is half the
//frequency of the analyzer, with an offset of 100 kHz;
// analyzer start:          10 Hz
// analyzer stop:           1 MHz
// analyzer span:           999.99 KHz
// generator frequency start: 100.005 KHz
// generator frequency stop:  600 KHz
// generator span:          499.995 KHz

SOUR:EXT:FREQ:FACT:NUM 1
SOUR:EXT:FREQ:FACT:DEN 2
SOUR:EXT:FREQ:OFFS 100KHZ

//-----Performing the calibration measurement -----

//Perform a transmission measurement with direct connection between the generator
//and the analyzer and wait till the end
SENS:CORR:METH TRAN
SENS:CORR:COLL:ACQ THR; *WAI

//-----Retrieving the calibration trace results -----

//Retrieve the measured frequencies (10 Hz - 600 kHz)
TRAC:DATA:X? TRACE1

//Retrieve the measured power levels; = 0 between 10 Hz and 100 kHz (below
//generator minimum frequency); nominal -5dBm as of 100 kHz;
TRAC:DATA? TRACE1

//-----Normalizing the calibration trace results -----

//Retrieve the normalized power levels (= power offsets from calibration results)
//Should be 0 for all sweep points directly after calibration
SENS:CORR:STAT ON
TRAC:DATA? TRACE1

//-----Changing the display of the calibration results -----
//Shift the reference line so the -5 dB level is displayed in the center
DISP:TRAC:Y:SCAL:RVAL -5DB
DISP:TRAC:Y:SCAL:RPOS 50PCT

```

### 6.8.1.7 Programming example: working with an external mixer

This example demonstrates how to work with an external mixer in a remote environment. It is performed in the Spectrum application in the default layout configuration. Note that without a real input signal and connected mixer, this measurement will not return useful results.

```
//-----Preparing the instrument -----
//Reset the instrument
*RST
//Activate the use of the connected external mixer.
SENS:MIX ON
//----- Configuring basic mixer behavior -----
//Set the LO level of the mixer's LO port to 15 dBm.
SENS:MIX:LOP 15dBm
//Set the bias current to -1 mA .
SENS:MIX:BIAS:LOW -1mA
//----- Configuring the mixer and band settings -----
//Use band "V" to full possible range extent for assigned harmonic (6).
SENS:MIX:HARM:BAND V
SENS:MIX:RFOV ON
//Query the possible range
SENS:MIX:FREQ:STAR?
//Result: 47480000000 (47.48 GHz)
SENS:MIX:FREQ:STOP?
//Result: 138020000000 (138.02 GHz)
//Use a 3-port mixer type
SENS:MIX:PORT 3
//Split the frequency range into two ranges;
//range 1 covers 47.48 GHz GHz to 80 GHz; harmonic 6, average conv. loss of 20 dB
//range 2 covers 80 GHz to 138.02 GHz; harmonic 8, average conv.loss of 30 dB
SENS:MIX:HARM:TYPE EVEN
SENS:MIX:HARM:HIGH:STAT ON
SENS:MIX:FREQ:HAND 80GHz
SENS:MIX:HARM:LOW 6
SENS:MIX:LOSS:LOW 20dB
SENS:MIX:HARM:HIGH 8
SENS:MIX:LOSS:HIGH 30dB
//----- Activating automatic signal identification functions -----
//Activate both automatic signal identification functions.
SENS:MIX:SIGN ALL
//Use auto ID threshold of 8 dB.
SENS:MIX:THR 8dB

//-----Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a basic frequency sweep and wait until the sweep has finished.
INIT;*WAI
//-----Retrieving Results-----
```

```
//Return the trace data for the input signal without distortions
//(default screen configuration)
TRAC:DATA? TRACE3
```

### Configuring a conversion loss table for a user-defined band

```
//-----Preparing the instrument -----
//Reset the instrument
*RST
//Activate the use of the connected external mixer.
SENS:MIX ON
//-----Configuring a new conversion loss table -----
//Define cvl table for range 1 of band as described in previous example
// (extended V band)
SENS:CORR:CVL:SEL 'UserTable'
SENS:CORR:CVL:COMM 'User-defined conversion loss table for USER band'
SENS:CORR:CVL:BAND USER
SENS:CORR:CVL:HARM 6
SENS:CORR:CVL:BIAS -1mA
SENS:CORR:CVL:MIX 'FS_Z60'
SENS:CORR:CVL:SNUM '123.4567'
SENS:CORR:CVL:PORT 3
//Conversion loss is linear from 55 GHz to 75 GHz
SENS:CORR:CVL:DATA 55GHZ,-20DB,75GHZ,-30DB
//----- Configuring the mixer and band settings -----
//Use user-defined band and assign new cvl table.
SENS:MIX:HARM:BAND USER
//Define band by two ranges;
//range 1 covers 47.48 GHz to 80 GHz; harmonic 6, cvl table 'UserTable'
//range 2 covers 80 GHz to 138.02 GHz; harmonic 8, average conv.loss of 30 dB
SENS:MIX:HARM:TYPE EVEN
SENS:MIX:HARM:HIGH:STAT ON
SENS:MIX:FREQ:HAND 80GHz
SENS:MIX:HARM:LOW 6
SENS:MIX:LOSS:TABL:LOW 'UserTable'
SENS:MIX:HARM:HIGH 8

SENS:MIX:LOSS:HIGH 30dB
//Query the possible range
SENS:MIX:FREQ:STAR?
//Result: 47480000000 (47.48 GHz)
SENS:MIX:FREQ:STOP?
//Result: 138020000000 (138.02 GHz)

//-----Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a basic frequency sweep and wait until the sweep has finished.
INIT;*WAI
```

```
//-----Retrieving Results-----
//Return the trace data (default screen configuration)
TRAC:DATA? TRACel
```

## 6.8.2 Frequency configuration

|   |     |
|---|-----|
| [SENSe:]FREQUENCY:CENTer.....                         | 652 |
| [SENSe:]FREQUENCY:CENTer:STEP.....                    | 653 |
| [SENSe:]FREQUENCY:CENTer:STEP:AUTO.....               | 653 |
| [SENSe:]FREQUENCY:CENTer:STEP:LINK.....               | 653 |
| [SENSe:]FREQUENCY:CENTer:STEP:LINK:FACTor.....        | 654 |
| [SENSe:]FREQUENCY:OFFSet.....                         | 654 |
| [SENSe:]FREQUENCY:SPAN.....                           | 654 |
| [SENSe:]FREQUENCY:SPAN:FULL.....                      | 655 |
| [SENSe:]FREQUENCY:STARt.....                          | 655 |
| [SENSe:]FREQUENCY:STOP.....                           | 655 |
| CALCulate<n>:MARKer<m>:FUNCTION:CENTer.....           | 655 |
| CALCulate<n>:MARKer<m>:FUNCTION:CSTep.....            | 656 |
| CALCulate<n>:MARKer<m>:FUNCTION:STRack[:STATe].....   | 656 |
| CALCulate<n>:MARKer<m>:FUNCTION:STRack:BANDwidth..... | 656 |
| CALCulate<n>:MARKer<m>:FUNCTION:STRack:THReshold..... | 657 |
| CALCulate<n>:MARKer<m>:FUNCTION:STRack:TRACe.....     | 657 |
| DEVIce:INFO:HWBand?.....                              | 657 |

---

### [SENSe:]FREQUENCY:CENTer <Frequency>

Defines the center frequency.

#### Parameters:

<Frequency> For the allowed range and  $f_{\max}$ , refer to the specifications document.

#### 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.
```

**Manual operation:** See "Center Frequency" on page 285  
See "Frequency" on page 316



---

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

Defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see [\[SENSe:\]FREQuency:CENTer](#) on page 652.

**Parameters:**

**<StepSize>** For  $f_{\max}$ , refer to the specifications document.  
Range: 1 to  $f_{\max}$   
\*RST: 0.1 x span  
Default unit: Hz

**Example:**

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

**Manual operation:** See ["Center Frequency Stepsize"](#) on page 286

---

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

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

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

**Parameters:**

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

**Example:**

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

---

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

Couples and decouples the center frequency step size to the span or the resolution bandwidth.

**Parameters:**

**<CouplingType>** SPAN | RBW | OFF

**SPAN**

Couples the step size to the span. Available for measurements in the frequency domain.

**RBW**

Couples the step size to the resolution bandwidth. Available for measurements in the time domain.

**OFF**

Decouples the step size.

\*RST: SPAN

**Example:**               //Couple step size to span  
                   FREQ:CENT:STEP:LINK SPAN

**Manual operation:** See ["Center Frequency Stepsize"](#) on page 286

**[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>**

Defines a step size factor if the center frequency step size is coupled to the span or the resolution bandwidth.

**Parameters:**

<Factor>               1 to 100 PCT  
                   \*RST:       10  
                   Default unit: PCT

**Example:**               //Couple frequency step size to span and define a step size factor  
                   FREQ:CENT:STEP:LINK SPAN  
                   FREQ:CENT:STEP:LINK:FACT 20PCT

**Manual operation:** See ["Center Frequency Stepsize"](#) on page 286

**[SENSe:]FREQuency:OFFSet <Offset>**

Defines a frequency offset.

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

See also ["Frequency Offset"](#) on page 287.

**Parameters:**

<Offset>               Range:       -1 THz to 1 THz  
                   \*RST:       0 Hz  
                   Default unit: HZ

**Example:**               FREQ:OFFS 1GHZ

**Manual operation:** See ["Frequency Offset"](#) on page 287

**[SENSe:]FREQuency:SPAN <Span>**

Defines the frequency span.

If you set a span of 0 Hz in the Spectrum application, the R&S ESW starts a measurement in the time domain.

**Parameters:**

<Span> The minimum span for measurements in the frequency domain is 10 Hz.  
 For SEM and spurious emission measurements, the minimum span is 20 Hz.  
 Range: 0 Hz to fmax  
 \*RST: Full span  
 Default unit: Hz

**Manual operation:** See ["Zero Span"](#) on page 20  
 See ["Span"](#) on page 285  
 See ["Zero Span"](#) on page 286  
 See ["Last Span"](#) on page 286

**[SENSe:]FREQuency:SPAN:FULL**

Restores the full span.

**Manual operation:** See ["Full Span"](#) on page 286

**[SENSe:]FREQuency:STARt <Frequency>**

Defines a start frequency for measurements in the frequency domain.

**Parameters:**

<Frequency> 0 to (fmax - min span)  
 \*RST: 0  
 Default unit: HZ

**Example:** `FREQ:STAR 20MHz`

**Manual operation:** See ["Frequency Sweep"](#) on page 20  
 See ["Start / Stop"](#) on page 285

**[SENSe:]FREQuency:STOP <Frequency>**

Defines a stop frequency for measurements in the frequency domain.

**Parameters:**

<Frequency> min span to fmax  
 \*RST: fmax  
 Default unit: HZ

**Example:** `FREQ:STOP 2000 MHz`

**Manual operation:** See ["Frequency Sweep"](#) on page 20  
 See ["Start / Stop"](#) on page 285

**CALCulate<n>:MARKer<m>:FUNCTion:CENTer**

Matches the center frequency to the frequency of a marker.

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

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Example:**

CALC:MARK2:FUNC:CENT

Sets the center frequency to the frequency of marker 2.

**Manual operation:** See ["Center Frequency = Marker Frequency"](#) on page 406

**CALCulate<n>:MARKer<m>:FUNCTION:CSTep**

Matches the center frequency step size to the current marker frequency.

The command turns delta markers into normal markers.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**CALCulate<n>:MARKer<m>:FUNCTION:STRack[:STATE] <State>**

Turns signal tracking on and off.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

```
//Activate signal tracking to keep the center frequency on the signal peak
//After each sweep the maximum on trace 1 is searched within a range of 20MHz
//around the center frequency. It must have a minimum power of -90dBm.
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
```

**Manual operation:** See ["Signal Tracking"](#) on page 288

**CALCulate<n>:MARKer<m>:FUNCTION:STRack:BANDwidth <Bandwidth>**

Defines the bandwidth around the center frequency that is included in the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<Bandwidth> Range: 10 Hz to Max span  
 \*RST: (= span/10 on activating the function)  
 Default unit: Hz

**Manual operation:** See ["Signal Tracking"](#) on page 288

**CALCulate<n>:MARKer<m>:FUNCTION:STRack:THReshold <Level>**

Defines the threshold level for the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<Level> The unit depends on [CALCulate<n>:UNIT:POWer](#).  
 Range: -130 dBm to 30 dBm  
 \*RST: -120 dBm  
 Default unit: DBM

**Manual operation:** See ["Signal Tracking"](#) on page 288

**CALCulate<n>:MARKer<m>:FUNCTION:STRack:TRACe <TraceNumber>**

Selects the trace on which the largest signal is searched for.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<TraceNumber> 1 to 6  
 Range: 1 to 6  
 \*RST: 1

**Manual operation:** See ["Signal Tracking"](#) on page 288

**DEVIce:INFO:HWBand?**

Queries the frequency bands used for measurement by the R&S ESW hardware. The start frequency of each band is provided.

The bands are instrument-specific and depend on the currently defined RBW, VBW and YIG preselector state. The precise frequency bands are required to define correction data for the correct bands, in particular for frequency-drifting DUTs.

This query is only available in zero span mode.

**Return values:**

<StartFreq>

**Example:**

```
//Set to zero span mode
FREQ:SPAN 0
//Set RBW
BAND:RES 1000000
//Set VBW
BAND:VID 10000
//Activate YIG filter
INP:FILT:YIG ON
//Query used hardware bands
DEV:INFO:HWB?
//Result:
//0,500000000,450000000,1000000000,3000000000,4000000000,5200000000,...
```

The used bands for this instrument and measurement setup are:

0 Hz to 499999999 Hz  
 500000000 Hz to 449999999  
 450000000 Hz to 999999999  
 1000000000 Hz to 2999999999  
 3000000000 Hz to 3999999999  
 4000000000 Hz to 5199999999  
 5200000000 Hz to ...

**Usage:** Query only

### 6.8.3 Amplitude configuration

Remote commands to configure level characteristics described elsewhere:

- [INPut:COUPling](#) on page 621

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:REFERENCE</a> .....                                 | 658 |
| <a href="#">CALCulate&lt;n&gt;:UNIT:POWER</a> .....   | 659 |
| <a href="#">DISPlay[:WINDow&lt;n&gt;][:SUBWindow&lt;w&gt;]:TRACe&lt;t&gt;:Y[:SCALE]:RLEVel</a> .....        | 659 |
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| <a href="#">INPut:ATTenuation[:VALue]</a> .....   | 660 |
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| <a href="#">INPut:GAIN:STATe</a> .....  | 661 |

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:REFERENCE**

Matches the reference level to the power level of a marker.

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

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Example:**

CALC:MARK2:FUNC:REF

Sets the reference level to the level of marker 2.

**Manual operation:** See ["Reference Level = Marker Level"](#) on page 406

**CALCulate<n>:UNIT:POWER <Unit>**

Selects the power unit.

The unit applies to all power-based measurement windows with absolute values.

In addition, the unit of the reference level is adapted to the same unit.

**Suffix:**

<n> irrelevant

**Parameters:**

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT |  
 DBUA | AMPere | DBM\_mhz | DBM\_hz | DBUa\_mhz |  
 DBUV\_mhz | DBmV\_mhz | DBpW\_mhz  
 \*RST: dBm

**Example:**

CALC:UNIT:POW DBM

Sets the power unit to dBm.

**Manual operation:** See ["Unit"](#) on page 293

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

Defines the reference level (for all traces in all windows).

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

**Suffix:**

<n> irrelevant

<w> subwindow  
 Not supported by all applications

<t> irrelevant

**Parameters:**

<ReferenceLevel> The unit is variable.  
 Range: see specifications document  
 \*RST: 0 dBm  
 Default unit: DBM

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

**Manual operation:** See ["Reference Level"](#) on page 292

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

Defines a reference level offset (for all traces in all windows).

**Suffix:**

|     |  |
|-----|--|
| <n> | irrelevant                                     |
| <w> | subwindow<br>Not supported by all applications |
| <t> | irrelevant                                     |

**Parameters:**

|          |                          |
|----------|--------------------------|
| <Offset> | Range: -200 dB to 200 dB |
|          | *RST: 0dB                |
|          | Default unit: DB         |

**Example:** `DISP:TRAC:Y:RLEV:OFFS -10dB`

**Manual operation:** See ["Shifting the Display \(Offset\)"](#) on page 167  
 See ["Shifting the Display \(Offset\)"](#) on page 293

**INPut:ATTenuation[:VALue] <Attenuation>**

This command defines the attenuation at the RF input.

To protect the input mixer, attenuation levels of 10 dB or less are possible only if you have turned off the input protection with [INPut:ATTenuation:PROTection\[:STATe\]](#) on page 661.

**Example:** `//Define attenuation`  
`INP:ATT 40dB`

**Manual operation:** See ["Attenuation"](#) on page 294

**INPut:ATTenuation:AUTO <State>**

This command turns automatic determination of the attenuation level on and off.

When you turn it on, the R&S ESW selects an attenuation that results in a good signal-to-noise ratio without overloading the RF input.

**Parameters:**

|         |  |
|---------|--|
| <State> | ON   OFF   |
|         | <b>ON</b><br>Selects automatic attenuation mode. |
|         | <b>OFF</b><br>Selects manual attenuation mode.   |
|         | *RST: ON   |



**Example:** //Turn on auto ranging  
INP:ATT:AUTO ON

**Manual operation:** See ["Attenuation"](#) on page 294

#### INPut:ATTenuation:PROTection[:STATe] <State>

This command turns the availability of attenuation levels of 10 dB or less on and off.

##### Parameters:

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

**Example:** //Turn on input protection  
INP:ATT:PROT ON

**Manual operation:** See ["10 dB Minimum Attenuation"](#) on page 294

#### INPut:GAIN:LNA:STATe <State>

This command turns the optional low noise amplifier on and off.

Note that it is not possible to use the low noise amplifier and the preamplifier at the same time.

##### Parameters:

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

**Example:** //Turn on low noise preamplifier  
INP:GAIN:LNA:STAT ON

**Manual operation:** See ["Preamplifier"](#) on page 294

#### INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

##### Parameters:

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

**Example:** //Turn on preamplifier  
INP:GAIN:STAT ON

**Manual operation:** See ["Preamplifier"](#) on page 294

## 6.8.4 Y-Axis scaling

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]..... 662  
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE..... 662  
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|  |     |
|--|-----|
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition..... | 663 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue.....    | 663 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing.....           | 664 |

---

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

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

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing`.

#### Suffix:

|     |  |
|-----|--|
| <n> | Window   |
| <w> | subwindow<br>Not supported by all applications |
| <t> | irrelevant                                     |

#### Parameters:

|         |   |
|---------|---|
| <Range> | Range: 1 dB to 200 dB<br>*RST: 100 dB<br>Default unit: HZ |
|---------|---|

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

**Manual operation:** See "Range" on page 295

---

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

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

#### Suffix:

|     |            |
|-----|------------|
| <n> | Window     |
| <t> | irrelevant |

**Manual operation:** See "Auto Scale Once" on page 296

---

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

Selects the type of scaling of the y-axis (for all traces).

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

#### Suffix:

|     |           |
|-----|-----------|
| <n> | Window    |
| <w> | subwindow |

<t> irrelevant

### Parameters:

<Mode>

## ABSolute

absolute scaling of the y-axis

## RELative

relative scaling of the y-axis

\*RST: ABSolute

**Example:**

DISP:TRAC:Y:MODE REL

**Manual operation:** See ["Scaling"](#) on page 296

```
Display[:Window<n>][:SubWindow<w>]:Trace<t>:Y[:Scale]:RPosition
<Position>
```

Defines the vertical position of the reference level on the display grid (for all traces).

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

For measurements with the optional external generator control, the command defines the position of the reference value.

**Suffix:**

<n>

## Window

 $\langle W \rangle$ 

subwindow

Not supported by all applications

<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

Default unit: PCT

**Example:**

DISP:TRAC:Y:RPOS 50PCT

**Manual operation:** See "Reference Position" on page 246

See "Ref Level Position" on page 295

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

Defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

**Suffix:**

 $\langle n \rangle$ 

## Window

 $\langle W \rangle$ 

subwindow

<|>

irrelevant

**Parameters:**

&lt;Value&gt; Default unit: DB

**Example:**

DISP:TRAC:Y:RVAL 0

Sets the value assigned to the reference position to 0 Hz

**Manual operation:** See ["Reference Value"](#) on page 246**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing <ScalingType>**

Selects the scaling of the y-axis (for all traces, &lt;t&gt; is irrelevant).

**Suffix:**<n> [Window](#)

&lt;w&gt; subwindow

<t> [Trace](#)**Parameters:**

&lt;ScalingType&gt;

**LOGarithmic**

Logarithmic scaling.

**LINear**

Linear scaling in %.

**LDB**

Linear scaling in the specified unit.

**PERCent**

Linear scaling in %.

\*RST: LOGarithmic

**Example:**

DISP:TRAC:Y:SPAC LIN

Selects linear scaling in %.

**Manual operation:** See ["Scaling"](#) on page 296

## 6.8.5 Bandwidth configuration

|  |     |
|--|-----|
| <a href="#">[SENSe:]BANDwidth[:RESolution]:AUTO</a>    | 664 |
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| <a href="#">[SENSe:]BANDwidth:VIDeo:TYPE</a>           | 667 |

**[SENSe:]BANDwidth[:RESolution]:AUTO <State>**

Couples and decouples the resolution bandwidth to the span.

**Parameters:**

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

**Example:**

BAND:AUTO OFF

Switches off the coupling of the resolution bandwidth to the span.

**Manual operation:**

See ["RBW"](#) on page 211  
 See ["Default Coupling"](#) on page 307

**[SENSe:]BANDwidth[:RESolution] <Bandwidth>**

Defines the resolution bandwidth and decouples the resolution bandwidth from the span.

For statistics measurements, this command defines the **demodulation** bandwidth.

**Parameters:**

<Bandwidth> refer to specifications document  
 \*RST: RBW: AUTO is set to ON; DBW: 3MHz  
 Default unit: Hz

**Example:**

BAND 1 MHz

Sets the resolution bandwidth to 1 MHz

**Manual operation:**

See ["Analysis Bandwidth"](#) on page 163  
 See ["RBW"](#) on page 211  
 See ["Res BW CISPR"](#) on page 212  
 See ["Res BW MIL"](#) on page 213  
 See ["RBW"](#) on page 316

**[SENSe:]BANDwidth[:RESolution]:RATio <Ratio>**

Defines the ratio between the resolution bandwidth (Hz) and the span (Hz).

Note that the ratio defined with this remote command (RBW/span) is reciprocal to that of the coupling ratio (span/RBW).

**Parameters:**

<Ratio> Range: 0.0001 to 1  
 \*RST: 0.01

**Example:**

BAND:RAT 0.1

**Manual operation:**

See ["Span/RBW"](#) on page 306

**[SENSe:]BANDwidth[:RESolution]:TYPE <FilterType>**

This command selects the resolution filter type.

When you change the filter type, the command selects the next larger filter bandwidth if the same bandwidth is unavailable for that filter.

**Parameters:**

<FilterType>

**CFILter**

Channel filters

Available in the spectrum application.

**NORMal**

Gaussian filters

**P5**

5-pole filters

Available for FFT sweeps in the spectrum application.

**RRC**

RRC filters

**CISPr | PULSe**

CISPR (6 dB)

Return value for query is always PULS.

**MIL**

MIL Std (6 dB)

\*RST: NORMal

**Example:**

BAND:TYPE NORM

**Example:**

See [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617.

**Manual operation:**

See ["Filter Type"](#) on page 210

See ["Res BW CISPR"](#) on page 212

See ["Res BW MIL"](#) on page 213

**[SENSe:]BANDwidth[:RESolution][:VALue] <Bandwidth>**

This command defines the measurement (or resolution) bandwidth.

The available bandwidths depend on the selected filter type.

A change of the resolution bandwidth automatically turns the coupling to the frequency off.

**Parameters:**

<Bandwidth>

<numeric value>

Refer to the datasheet for available bandwidths.

Default unit: Hz

**Example:**

//Select measurement bandwidth

BAND 3MHZ

**[SENSe:]BANDwidth:VIDeo <Bandwidth>**

Defines the video bandwidth.

The command decouples the video bandwidth from the resolution bandwidths.

**Parameters:**

<Bandwidth> refer to specifications document  
 \*RST: AUTO is set to ON  
 Default unit: HZ

**Example:** BAND:VID 10 kHz

**Manual operation:** See "[VBW](#)" on page 305

**[SENSe:]BANDwidth:VIDeo:AUTO <State>**

Couples and decouples the video bandwidth to the resolution bandwidth.

**Parameters:**

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

**Example:** BAND:VID:AUTO OFF

**Manual operation:** See "[VBW](#)" on page 305  
 See "[RBW/VBW](#)" on page 306  
 See "[Default Coupling](#)" on page 307

**[SENSe:]BANDwidth:VIDeo:RATio <Ratio>**

Defines the coupling ratio of the video bandwidth to the resolution bandwidth (VBW/RBW).

**Parameters:**

<Ratio> Range: 0,001 to 1000  
 \*RST: 1

**Example:** BAND:VID:RAT 3  
 Sets the video bandwidth to 3\*resolution bandwidth.

**Manual operation:** See "[RBW/VBW](#)" on page 306

**[SENSe:]BANDwidth:VIDeo:TYPE <Mode>**

Enables or disables the logarithmic amplifier in front of the video filter in the signal path.

**Parameters:**

<Mode> **LINear**

The logarithmic amplifier in front of the video filter is bypassed to process linear detector samples.

**LOGarithmic**

The logarithmic amplifier in front of the video filter is enabled to process logarithmic detector samples.

\*RST: LOGarithmic

**Example:** BAND:VID:TYPE LIN  
Logarithmic amplifier in front of the video filter is disabled.

**Manual operation:** See "VBW" on page 305

## 6.8.6 Sweep configuration

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---

### [SENSe:]AVERAge<n>:COUNT <AverageCount>

Defines the number of sweeps that the application uses to average traces.

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 200000

\*RST: 0

**Manual operation:** See "Average Count" on page 370

---

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

Turns averaging for a particular trace in a particular window on and off.

#### Suffix:

<n> Window

<t> Trace



**Parameters:**

<State> ON | OFF | 1 | 0

**[SENSe:]AVERage<n>:TYPE <Mode>**

Selects the trace averaging mode.

**Suffix:**

<n> 1..n  
Window

**Parameters:**

<Mode> **LOGarithmic**  
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.

**Example:**

AVER:TYPE LIN  
Switches to linear average calculation.

**Manual operation:** See "Average Mode" on page 369

**[SENSe:]BANDwidth[:RESolution]:FFT <FilterMode>**

Defines the filter mode to be used for FFT filters by defining the subspan size. The subspan is the span which is covered by one FFT analysis.

Is only available when using the sweep type "FFT".

**Note:** this command is maintained for compatibility reasons only. For new remote control programs, use the [SENSe:]SWEep:OPTimize command.

**Parameters:**

<FilterMode> WIDE | AUTO | NARRow

**AUTO**  
Automatically applies the sweep optimization mode that is best for the current measurement.

**NARRow**  
Optimizes the sweep mode for a large dynamic range.

**WIDE**  
Optimizes the sweep mode for high performance.

\*RST: AUTO

**Example:**

BAND:TYPE FFT  
Select FFT filter.

**Example:** `BAND:FFT NARR`  
Select narrow subspan for FFT filter.

---

### **[SENSe:]SWEep:COUNT <SweepCount>**

Defines the number of sweeps that the application uses to average traces.

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

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

#### **Parameters:**

**<SweepCount>** When you set a sweep count of 0 or 1, the R&S ESW performs one single sweep in single sweep mode.  
In continuous sweep mode, if the sweep count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 200000  
\*RST: 0

**Example:** `SWE:COUN 64`  
Sets the number of sweeps to 64.  
`INIT:CONT OFF`  
Switches to single sweep mode.  
`INIT;*WAI`  
Starts a sweep and waits for its end.

**Manual operation:** See ["Sweep/Average Count"](#) on page 307

---

### **[SENSe:]SWEep:DURation? <Time>**

Provides an estimation of the total time required to capture the data and process it. This time span may be considerably longer than the actual sweep time (see [\[SENSe:\]SWEep:TIME](#) on page 672).

**Tip:** To determine the necessary timeout for data capturing in a remote control program, double the estimated time and add 1 second.

#### **Return values:**

**<Time>**

**Example:** `SWE:TIME 1s`  
`SWE:DUR?`  
Reply:  
27.9734842578

**Usage:** Query only

**[SENSe:]SWEep:OPTimize <Mode>**

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *subspan*. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

**Table 6-5: Optimization parameters in FFT mode**

| Optimization mode | Description  |
|-------------------|--|
| DYNamic           | Optimizes the dynamic range by using the narrowest possible subspan (depending on the RBW).<br><br>The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.  |
| SPEed             | Optimizes the sweep rate by using the widest possible subspan (depending on the RBW).<br><br>The autorange function for the internal IF gain calculation is deactivated. (Note: set the reference level accordingly to optimize the control range for the A/D converter).<br><br>It is recommended that you set the <a href="#">Sweep Time</a> to "Auto" to optimize the sweep rate. |
| AUTO              | Uses a medium-sized subspan to obtain a compromise between a large dynamic range and a fast sweep rate.<br><br>The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.  |

**Note: FFT mode and external mixers (R&S ESW-B21)**

The subspan optimization modes "Dynamic" and "Auto" include automatic suppression of unwanted mixing products. Thus, when using external mixers (R&S ESW-B21), use the "Speed" mode to obtain similar results in FFT mode as in frequency sweep mode.

**Zero span mode**

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

**Table 6-6: Optimization parameters in zero span mode**

| Optimization mode | Description   |
|-------------------|---|
| DYNamic           | The narrowest filter possible (depending on the RBW) is used. |
| SPEed             | The widest filter possible (depending on the RBW) is used.    |
| AUTO              | A medium-sized prefilter is used.                             |

**Parameters:**

<Mode>                      \*RST:        AUTO

**Example:**

SWE:OPT DYN

Selects optimization for dynamic range.

**Manual operation:**    See ["Optimization"](#) on page 308

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

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

For EMI measurements, 512001 sweep points are available.

**Suffix:**

<n>

**Parameters:**

<SweepPoints>      <numeric value> (integer)  
 For zero span measurements with multiple traces, a maximum number of 1,000,001 sweep points are supported.  
 For zero span measurements with a single trace, a maximum number of 10,000,001 sweep points are supported.  
 Range:            101 to 100001  
 \*RST:            1001

**Example:**            SWE:POIN 251

**Manual operation:**    See ["Sweep Points"](#) on page 308

**[SENSe:]SWEep:TIME <Time>**

Defines the sweep time. It automatically decouples the time from any other settings.

In the Spectrum application, the command decouples the sweep time from the span and resolution and video bandwidths. Note that this command queries only the time required to capture the data, not to process it. To obtain an estimation of the total capture and processing time, use the [\[SENSe:\]SWEep:DURation?](#) command.

**Parameters:**

<Time>                refer to specifications document  
 \*RST:                depends on current settings (determined automatically)  
 Default unit: S

**Manual operation:**    See ["Sweep Time"](#) on page 61

**[SENSe:]SWEep:TIME:AUTO <State>**

Couples and decouples the sweep time to the span and the resolution and video bandwidths.

**Parameters:**

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

**Example:**            SWE:TIME:AUTO ON  
 Activates automatic sweep time.

**Manual operation:**    See ["Harmonic Sweep Time"](#) on page 183  
 See ["Sweep Time"](#) on page 306  
 See ["Default Coupling"](#) on page 307

**[SENSe:]SWEep:TYPE <Type>**

Selects the sweep type.

**Parameters:**

|                     |   |
|---------------------|---|
| <b>&lt;Type&gt;</b> | <b>AUTO</b>   |
|                     | Automatic selection of the sweep type between sweep mode and FFT. |
|                     | <b>FFT</b>  |
|                     | FFT mode  |
|                     | <b>SWE</b>  |
|                     | Sweep list  |
|                     | *RST:        AUTO   |

**Example:**                SWE:TYPE FFT

**Manual operation:**    See "[Sweep Type](#)" on page 309

**[SENSe:]SWEep:TYPE:USED**

Queries the sweep type if you have turned on automatic selection of the sweep type.

**Return values:**

|                     |              |
|---------------------|--------------|
| <b>&lt;Type&gt;</b> | <b>SWE</b>   |
|                     | Normal sweep |
|                     | <b>FFT</b>   |
|                     | FFT mode     |

## 6.8.7 Trigger configuration

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### 6.8.7.1 Trigger conditions

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---

**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  
 Default unit: S

**Manual operation:** See ["Drop-Out Time"](#) on page 319

---

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

Defines the time offset between the trigger event and the start of the sweep (data capturing).

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay affect the trigger offset as well.

**Suffix:**

<tp> irrelevant

**Parameters:**

<Offset> Range for measurements in the frequency domain:  
 0 s to 30 s  
 Range for measurements in the time domain:  
 negative sweep time to 30 s  
 \*RST: 0 s  
 Default unit: s

**Example:** //Define a trigger offset  
 TRIG:HOLD 500us

**Manual operation:** See ["Trigger Offset"](#) on page 319

---

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

Defines the holding time before the next trigger event.

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

**Note:** If you perform gated measurements in combination with the IF Power trigger, the R&S ESW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

**Parameters:**

<Period> Range: 0 s to 10 s  
 \*RST: 0 s  
 Default unit: S

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

**Manual operation:** See ["Trigger Holdoff"](#) on page 320

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

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

**Parameters:**

<Hysteresis>           Range:       3 dB to 50 dB  
                          \*RST:        3 dB  
                          Default unit: DB

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

**Manual operation:** See ["Hysteresis"](#) on page 320

### TRIGger<tp>[:SEQuence]:LEVel[:EXTErnal] <Level>

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

Note that the variable [Input/Output] connectors must be set for use as input using the [OUTPut:TRIGger<tp>:DIRection](#) command.

**Suffix:**

<tp>                   irrelevant

**Parameters:**

<Level>               Default unit: V

**Example:**           //Define a trigger level of 2 V for an external trigger source  
TRIG:SOUR EXT  
TRIG:LEV 2V

**Manual operation:** See ["Trigger Level"](#) on page 319

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

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

**Parameters:**

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

\*RST: -20 dBm

Default unit: DBM

**Example:**

TRIG:LEV:IFP -30DBM

**Manual operation:** See ["Trigger Level"](#) on page 319

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

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. If defined, a reference level offset is also considered.

**Parameters:**

<TriggerLevel> Range: -130 dBm to 30 dBm

\*RST: -20 dBm

Default unit: DBM

**Example:**

TRIG:LEV:IQP -30DBM

**Manual operation:** See ["Trigger Level"](#) on page 319

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

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

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

**Parameters:**

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

\*RST: -20 dBm

Default unit: DBM

**Example:**

TRIG:LEV:RFP -30dBm

**Manual operation:** See ["Trigger Level"](#) on page 319

**TRIGger[:SEQuence]:LEVel:VIDeo <Level>**

Defines the level the video signal must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

**Parameters:**

<Level> Range: 0 PCT to 100 PCT

\*RST: 50 PCT

Default unit: PCT



**Example:** TRIG:LEV:VID 50PCT

---

### TRIGger<tp>[:SEquence]:SLOPe <Type>

Selects the trigger slope.

**Suffix:**

<tp> irrelevant

**Parameters:**

<Type>

**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:** //Select trigger slope

TRIG:SLOP NEG

**Manual operation:** See ["Slope"](#) on page 320

---

### TRIGger<tp>[:SEquence]:SOURce <Source>

Selects the trigger source.

Using a trigger or gated measurements in the Spectrum application turns the squelch off (see [\[SENSe:\]DEMod:SQUelch\[:STATe\]](#) on page 757).

**Note on external triggers:**

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

**Suffix:**

<tp> irrelevant

**Parameters:**

<Source>

See table below.

\*RST: IMMEDIATE

**Example:** //Select external trigger input as source of the trigger signal

TRIG:SOUR EXT

**Manual operation:** See ["Trigger Source"](#) on page 317  
 See ["Free Run"](#) on page 317  
 See ["Ext. Trigger 1/2"](#) on page 317  
 See ["Video"](#) on page 317  
 See ["IF Power"](#) on page 318  
 See ["RF Power"](#) on page 318  
 See ["Time"](#) on page 319

Table 6-7: Available trigger sources

| SCPI parameter | Trigger source   |
|----------------|--|
| EXTernal       | Trigger signal from the [Trigger Input] connector.   |
| EXT2   EXT3    | Trigger signal from the [Trigger Input/Output] connector.<br>Note: Connector must be configured for "Input".                 |
| IFPower        | Second intermediate frequency.   |
| IMMediate      | Free Run trigger.  |
| IQPower        | Magnitude of sampled I/Q data.<br>For applications that process I/Q data, such as the I/Q analyzer or optional applications. |
| RFPower        | First intermediate frequency.  |
| TIME           | Time interval  |
| VIDeo          | Trigger source is the video signal.  |

**TRIGger[:SEquence]:TIME:RINTerval <Interval>**

Defines the repetition interval for the time trigger.

**Parameters:**

<Interval>                      numeric value  
                                      Range:        2 ms to 5000 s  
                                      \*RST:        1.0 s  
                                      Default unit: S

**Example:**

TRIG:SOUR TIME  
 Selects the time trigger input for triggering.  
 TRIG:TIME:RINT 5  
 The sweep starts every 5 s.

**Manual operation:** See ["Repetition Interval"](#) on page 319

**6.8.7.2 Gated measurements**

|   |     |
|---|-----|
| [SENSe:]SWEep:EGATe.....                    | 678 |
| [SENSe:]SWEep:EGATe:HOLDoff.....            | 679 |
| [SENSe:]SWEep:EGATe:LENGth.....             | 679 |
| [SENSe:]SWEep:EGATe:POLarity.....           | 680 |
| [SENSe:]SWEep:EGATe:SOURce.....             | 680 |
| [SENSe:]SWEep:EGATe:TYPE.....               | 681 |
| [SENSe:]SWEep:EGATe:CONTinuous[:STATe]..... | 681 |
| [SENSe:]SWEep:EGATe:CONTinuous:PCOunt.....  | 681 |
| [SENSe:]SWEep:EGATe:CONTinuous:PLENgtH..... | 682 |

**[SENSe:]SWEep:EGATe <State>**

Turns gated measurements on and off.

The measurement ends when a particular number of measurement points has been recorded.

(See [\[SENSe:\]SWEep\[:WINDow<n>\]:POINTs](#) on page 672).

Performing gated measurements turns the squelch off.

**Parameters:**

<State>                    ON | OFF | 0 | 1  
                              **OFF | 0**  
                              Switches the function off  
                              **ON | 1**  
                              Switches the function on

**Example:**

SWE:EGAT ON  
 Switches on the gate mode.  
 SWE:EGAT:TYPE EDGE  
 Switches on the edge-triggered mode.  
 SWE:EGAT:HOLD 100US  
 Sets the gate delay to 100 µs.  
 SWE:EGAT:LEN 500US  
 Sets the gate opening time to 500 µs.  
 INIT;\*WAI  
 Starts a sweep and waits for its end.

**Manual operation:**    See ["Gated Trigger"](#) on page 164  
                              See ["Gated Trigger"](#) on page 325

**[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>**

Defines the delay time between the gate signal and the continuation of the measurement.

**Note:** If you perform gated measurements in combination with the IF Power trigger, the R&S ESW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

**Parameters:**

<DelayTime>              Range:        0 s to 30 s  
                              \*RST:        0 s  
                              Default unit: S

**Example:**                SWE:EGAT:HOLD 100us

**Manual operation:**    See ["Gate Delay"](#) on page 326

**[SENSe:]SWEep:EGATe:LENGth <GateLength>**

Defines the gate length.

**Parameters:**

<GateLength>      Range:      125 ns to 30 s  
                          \*RST:      400µs  
                          Default unit: S

**Example:**              SWE:EGAT:LENG 10ms

**Manual operation:**   See ["Gate Length"](#) on page 326

**[SENSe:]SWEep:EGATe:POLarity <Polarity>**

Selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

**Parameters:**

<Polarity>              POSitive | NEGative  
                          \*RST:      POSitive

**Example:**              SWE:EGAT:POL POS

**Manual operation:**   See ["Slope"](#) on page 320

**[SENSe:]SWEep:EGATe:SOURce <Source>**

Selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information see ["Trigger Source"](#) on page 317.

**Parameters:**

<Source>              \*RST:      IFPower

**Example:**              SWE:EGAT:SOUR IFP  
                          Switches the gate source to IF power.

**Manual operation:**   See ["Trigger Source"](#) on page 317  
                          See ["RF Power"](#) on page 318

---

**[SENSe:]SWEep:EGATe:TYPE <Type>**

Selects the way gated measurements are triggered.

**Parameters:**

<Type>

**LEVeI**

The trigger event for the gate to open is a particular power level. After the gate signal has been detected, the gate remains open until the signal disappears.

**Note:** If you perform gated measurements in combination with the IF Power trigger, the R&S ESW ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

**EDGE**

The trigger event for the gate to open is the detection of the signal edge.

After the gate signal has been detected, the gate remains open until the gate length is over.

\*RST: EDGE

**Example:**

SWE:EGAT:TYPE EDGE

**Manual operation:** See ["Gate Mode"](#) on page 325

---

**[SENSe:]SWEep:EGATe:CONTinuous[:STATe] <State>**

Activates or deactivates continuous gating.

This setting is only available if [\[SENSe:\]SWEep:EGATe](#) is "On".

**Parameters:**

<State>

ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

\*RST: 0

**Example:**

SWE:EGAT ON

Activate gating

SWE:EGAT:CONT:STAT ON

Activate continuous gating

**Manual operation:** See ["Continuous Gate"](#) on page 326

---

**[SENSe:]SWEep:EGATe:CONTinuous:PCOunt <Amount>**

Defines the number of gate periods to be measured after a single trigger event.

**Parameters:**

<Amount> integer  
 Range: 1 to 65535  
 Increment: 1  
 \*RST: 100

**Example:** SWE:EGAT:CONT:PCO 50

**Manual operation:** See ["Gate Period Count"](#) on page 327

**[SENSe:]SWEep:EGATe:CONTinuous:PLENgtH <Time>**

Defines the length in seconds of a single gate period in continuous gating. The length is determined from the beginning of one gate measurement to the beginning of the next one.

**Parameters:**

<Time> Range: 125 ns to 30 s  
 \*RST: 5 ms  
 Default unit: S

**Example:** SWE:EGAT:CONT:PLEN 10

**Manual operation:** See ["Gate Period Length"](#) on page 327

**6.8.7.3 Trigger output**

Commands to configure the trigger output described elsewhere:

- [OUTPut:TRIGger<tp>:DIRectioN](#) on page 645
- [OUTPut:TRIGger<tp>:LEVel](#) on page 646
- [OUTPut:TRIGger<tp>:OTYPe](#) on page 646
- [OUTPut:TRIGger<tp>:PULSe:IMMediate](#) on page 647
- [OUTPut:TRIGger<tp>:PULSe:LENGth](#) on page 647

**6.8.8 Automatic configuration**

|  |     |
|--|-----|
| <a href="#">[SENSe:]ADJust:ALL</a> .....                           | 682 |
| <a href="#">[SENSe:]ADJust:CONFigure:LEVel:DURation</a> .....      | 683 |
| <a href="#">[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE</a> ..... | 683 |
| <a href="#">[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer</a> .....    | 684 |
| <a href="#">[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer</a> .....    | 684 |
| <a href="#">[SENSe:]ADJust:CONFigure:TRIGger</a> .....             | 684 |
| <a href="#">[SENSe:]ADJust:FREQuency</a> .....                     | 685 |
| <a href="#">[SENSe:]ADJust:LEVel</a> .....                         | 685 |

**[SENSe:]ADJust:ALL**

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

This includes:

- Reference level

**Example:** ADJ:ALL

**Manual operation:** See ["Adjusting all Determinable Settings Automatically \(Auto All\)"](#) on page 329

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

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

##### Parameters:

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

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

**Manual operation:** See ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 330

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

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

##### Parameters:

<Mode>            **AUTO**  
 The R&S ESW determines the measurement length automatically according to the current input data.  
                      **MANual**  
 The R&S ESW uses the measurement length defined by [SENSe:]ADJust:CONFigure:LEVel:DURation on page 683.  
 \*RST:            AUTO

**Manual operation:** See ["Resetting the Automatic Measurement Time \(Meas Time Auto\)"](#) on page 329  
 See ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 330

**[SENSe:]ADJust:CONFIgure:HYSTeresis:LOWer <Threshold>**

When the reference level is adjusted automatically using the [\[SENSe:\]ADJust:LEVel](#) on page 685 command, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

**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 is only adjusted when the signal level falls below 18 dBm.

**Manual operation:** See ["Lower Level Hysteresis"](#) on page 330

**[SENSe:]ADJust:CONFIgure:HYSTeresis:UPPer <Threshold>**

When the reference level is adjusted automatically using the [\[SENSe:\]ADJust:LEVel](#) on page 685 command, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

**Parameters:**

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

**Example:**

SENS:ADJ:CONF:HYST:UPP 2

**Example:**

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

**Manual operation:** See ["Upper Level Hysteresis"](#) on page 330

**[SENSe:]ADJust:CONFIgure:TRIGger <State>**

Defines the behavior of a triggered measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

**Parameters:**

<State>                            ON | OFF | 0 | 1  
                                       **ON | 1**  
                                       (default:) The measurement for adjustment waits for the next trigger.



**OFF | 0**

The measurement for adjustment is performed without waiting for a trigger (corresponds to "Continue" in manual operation).

\*RST: 0

**Example:**

```
//Use default ref level at 0.00 dBm.
//Define an RF power trigger at -20 dBm
:TRIG:SEQ:SOUR RFP
:TRIG:SEQ:LEV:RFP -20
//Perform adjustment measurement without waiting for trigger
SENS:ADJ:CONF:TRIG OFF
//Perform auto level adjustment
:SENS:ADJ:LEV;*WAI
```

**[SENSe:]ADJust:FREQuency**

Sets the center frequency to the frequency with the highest signal level in the current frequency range.

**Example:** ADJ:FREQ

**Manual operation:** See ["Adjusting the Center Frequency Automatically \(Auto Frequency\)"](#) on page 329

**[SENSe:]ADJust:LEVel**

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. Thus, the settings of the RF attenuation and the reference level are optimized for the signal level. The R&S ESW is not overloaded and the dynamic range is not limited by an S/N ratio that is too small.

**Example:** ADJ:LEV

**Manual operation:** See ["Setting the Reference Level Automatically \(Auto Level\)"](#) on page 293

## 6.9 Analysis

|  |     |
|--|-----|
| • <a href="#">Zoom</a> .....                 | 686 |
| • <a href="#">Trace configuration</a> .....  | 689 |
| • <a href="#">Marker configuration</a> ..... | 713 |
| • <a href="#">Lines</a> .....                | 770 |

### 6.9.1 Zoom

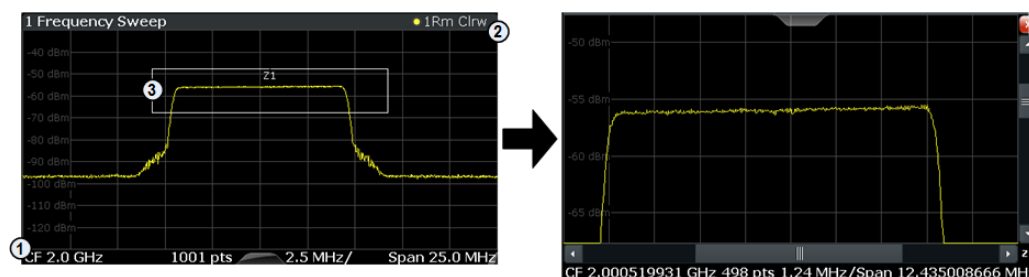
|   |     |
|---|-----|
| DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA.....                 | 686 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA.....    | 687 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATE]..... | 688 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATE].....              | 688 |

---

**DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>**

Defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)

2 = end point of system (x2 = 100, y2 = 100)

3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

#### Suffix:

<n>

Window

<w>

subwindow

Not supported by all applications

#### Parameters:

<x1>

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

Default unit: PCT

<y1>

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

Default unit: PCT

<x2>

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

Default unit: PCT

&lt;y2&gt;

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

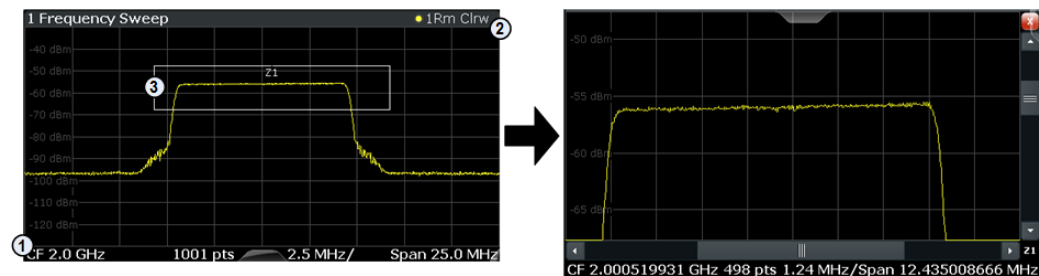
Default unit: PCT

**Manual operation:** See ["Single Zoom"](#) on page 340

**DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA**  
 <x1>,<y1>,<x2>,<y2>

Defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)

2 = end point of system (x2 = 100, y2 = 100)

3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

#### Suffix:

&lt;n&gt;

Window

&lt;w&gt;

subwindow

Not supported by all applications

&lt;zn&gt;

Selects the zoom window.

#### Parameters:

&lt;x1&gt;

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

Default unit: PCT

&lt;y1&gt;

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

Default unit: PCT

|      |   |
|------|---|
| <x2> | Diagram coordinates in % of the complete diagram that define the zoom area.<br>The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.<br>Range: 0 to 100<br>Default unit: PCT |
| <y2> | Diagram coordinates in % of the complete diagram that define the zoom area.<br>The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.<br>Range: 0 to 100<br>Default unit: PCT |

**Manual operation:** See ["Multi-Zoom"](#) on page 341

**DISPlay[:WINDow<n>][:SUBWIndow<w>]:ZOOM:MULTiple<zn>[:STATe] <State>**

Turns the multiple zoom on and off.

**Suffix:**

|      |  |
|------|--|
| <n>  | <a href="#">Window</a>   |
| <w>  | subwindow<br>Not supported by all applications   |
| <zn> | Selects the zoom window.<br>If you turn off one of the zoom windows, all subsequent zoom windows move up one position. |

**Parameters:**

|         |  |
|---------|--|
| <State> | ON   OFF   0   1<br><b>OFF   0</b><br>Switches the function off<br><b>ON   1</b><br>Switches the function on |
|---------|--|

**Manual operation:** See ["Multi-Zoom"](#) on page 341  
See ["Restore Original Display"](#) on page 342

**DISPlay[:WINDow<n>][:SUBWIndow<w>]:ZOOM[:STATe] <State>**

Turns the zoom on and off.

**Suffix:**

|     |  |
|-----|--|
| <n> | <a href="#">Window</a>                         |
| <w> | subwindow<br>Not supported by all applications |

**Parameters:**

|         |                  |
|---------|------------------|
| <State> | ON   OFF   0   1 |
|---------|------------------|

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

DISP:ZOOM ON

Activates the zoom mode.

**Manual operation:**See ["Single Zoom"](#) on page 340See ["Restore Original Display"](#) on page 342

## 6.9.2 Trace configuration

|  |     |
|--|-----|
| • <a href="#">Trace data retrieval</a> .....                           | 689 |
| • <a href="#">Trace settings</a> .....                                 | 692 |
| • <a href="#">Trace import and export</a> .....                        | 697 |
| • <a href="#">Trace copy</a> .....                                     | 702 |
| • <a href="#">Trace mathematics</a> .....                              | 703 |
| • <a href="#">Spectrogram configuration</a> .....                      | 705 |
| • <a href="#">Programming example: configuring a spectrogram</a> ..... | 711 |

### 6.9.2.1 Trace data retrieval

|   |     |
|---|-----|
| <a href="#">MMEMory:STORe&lt;n&gt;:TRACe</a> .....  | 689 |
| <a href="#">TRACe&lt;n&gt;[:DATA]</a> .....         | 690 |
| <a href="#">TRACe&lt;n&gt;[:DATA]:MEMory?</a> ..... | 691 |
| <a href="#">TRACe&lt;n&gt;[:DATA]:X?</a> .....      | 692 |

---

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

Exports trace data from the specified window to an ASCII file.

For details on the file format, see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 388.**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 limit reached" 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 ESW 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 699).

<FileName> String containing the path and name of the target file.

**Example:** `MMEM:STOR1:TRAC 1, 'C:\TEST.ASC'`  
Stores trace 1 from window 1 in the file TEST.ASC.

**Manual operation:** See ["Export Trace to ASCII File"](#) on page 373

**TRACe<n>[:DATA]** <Trace>,<Data>

**TRACe<n>[:DATA]? <ResultType>**

This command queries current trace data and measurement results.

In the Spectrum application only, you can use it as a setting command to transfer trace data from an external source to the R&S ESW.

The data format depends on [FORMat \[:DATA\]](#) on page 697.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Trace> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**  
Selects the trace to write the data to (Spectrum application only).

<Data> Contains the data to transfer (Spectrum application only).

**Query parameters:**

<ResultType> Selects the type of result to be returned. See [Table 6-8](#).  
Note that not all result types are available for all applications.  
See the application-specific documentation for details.

**Example:** (Spectrum application only:)  
`TRAC TRACE1,-30,-20,-10`  
Transfers trace data (-30,-20,-10) to trace 1.

**Example:** `TRAC? TRACE3`  
Queries the data of trace 3.

**Example:** See [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617.

**Example:** See [Chapter 6.7.6.11, "Example: SEM measurement"](#), on page 553.

**Manual operation:** See ["List Evaluation State \(result summary\)"](#) on page 131  
See ["Diagram"](#) on page 332

Table 6-8: Return values for result type parameters

| Parameter                | Result display / measurement   | Results   |
|--------------------------|--------------------------------|---|
| TRACE1   ...  <br>TRACE6 |                                | <p>Returns the trace data for the corresponding trace.</p> <p>The trace data consists of a list of measured power levels. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the configured unit.</p> <p>For the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.)</p> <p>For SEM or Spurious Emission measurement results, query the x-values as well, as they are not equidistant (see <a href="#">TRACe&lt;n&gt;[:DATA]:X?</a> on page 692).</p>  |
| LIST                     | SEM measurements               | Peak list evaluation, one peak per range is returned.   |
|                          | Spurious emission measurements | <p>Peak list evaluation;</p> <p>The number of peaks returned for each measurement range is defined by the "Peaks per Range" parameter (see <a href="#">CALCulate&lt;n&gt;:PEAKsearch:SUBRanges</a> on page 567), regardless of the "Details" setting.</p> <p>For each peak, the command returns 11 values in the following order:</p> <ul style="list-style-type: none"> <li>• &lt;No&gt;: range number</li> <li>• &lt;StartFreq&gt;,&lt;StopFreq&gt;: start and stop frequency of the range</li> <li>• &lt;RBW&gt;: resolution bandwidth</li> <li>• &lt;PeakFreq&gt;: frequency of the peak in a range</li> <li>• &lt;PowerAbs&gt;: absolute power of the peak in dBm</li> <li>• &lt;PowerRel&gt;: power of the peak in relation to the channel power in dBc</li> <li>• &lt;PowerDelta&gt;: distance from the peak to the limit line in dB, positive values indicate a failed limit check</li> <li>• &lt;LimitCheck&gt;: state of the limit check (0 = PASS, 1 = FAIL)</li> <li>• &lt;Unused1&gt;,&lt;Unused2&gt;: reserved (0.0)</li> </ul> |
| SPURious                 |                                | Peak list evaluation of Spurious Emission measurements.   |
| SPECTrogram  <br>SGRam   |                                | <p>For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the configured unit. Only REAL, 32 format is supported.</p>  |

**TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>**

Queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command returns the same results as `TRAC:DATA? TRACE1`.

For details on the returned values see the [TRAC:DATA? <TRACE...>](#) command.

**Suffix:**

&lt;n&gt;

[Window](#)

**Query parameters:**

|                |   |
|----------------|---|
| <Trace>        | TRACE1   TRACE2   TRACE3   TRACE4   TRACE5   TRACE6   |
| <OffsSwPoint>  | The offset in sweep points related to the start of the measurement at which data retrieval is to start. |
| <NoOfSwPoints> | Number of sweep points to be retrieved from the trace.  |

**Return values:**

&lt;SweepPointValues&gt;

**Example:**

TRAC:DATA:MEM? TRACE1,25,100

Retrieves 100 sweep points from trace 1, starting at sweep point 25.

**Usage:**

Query only

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

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.

This is especially useful for traces with non-equidistant x-values, e.g. for SEM or Spurious Emissions measurements.

**Suffix:**<n> [Window](#)**Query parameters:**

|               |   |
|---------------|---|
| <TraceNumber> | Trace number.<br><b>TRACE1   TRACE2   TRACE3   TRACE4   TRACE5   TRACE6</b> |
|---------------|---|

**Return values:**

&lt;X-Values&gt;

**Example:**

TRAC3:X? TRACE1

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

**Usage:**

Query only

**6.9.2.2 Trace settings**

|   |     |
|---|-----|
| [SENSe:][WINDow<n>:]DETEctor<t>[:FUNCTION]:AUTO.....                | 692 |
| [SENSe:][WINDow<n>:]DETEctor<t>[:FUNCTION].....                     | 693 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture..... | 694 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE.....               | 694 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONTinuous.....   | 695 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe].....  | 695 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe].....            | 696 |
| DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing.....          | 696 |

**[SENSe:][WINDow<n>:]DETEctor<t>[:FUNCTION]:AUTO <State>**

Couples and decouples the detector to the trace mode.



**Suffix:**

&lt;n&gt; Window

&lt;t&gt; Trace

**Parameters:**

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

\*RST: 1

**Example:**

DET:AUTO OFF

The selection of the detector is not coupled to the trace mode.

**Manual operation:** See "Detector" on page 368**[SENSe:][WINDow<n>:]DETEctor<t>[:FUNction] <Detector>**

Defines the trace detector to be used for trace analysis.

For details see [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 345.**Suffix:**

&lt;n&gt; Window

&lt;t&gt; Trace

**Parameters:**

&lt;Detector&gt;

**APEak**

Autopoint

**NEGative**

Negative peak

**POSitive**

Positive peak

**QPEak**

Quasipeak (CISPR filter only)

**SAMPlE**

First value detected per trace point

**RMS**

RMS value

**AVERage**

Average

**CAVerage**

CISPR Average (CISPR filter only)

**CRMS**

CISPR RMS (CISPR filter only)

\*RST: APEak

**Example:**

DET POS

Sets the detector to "positive peak".

**Manual operation:** See "Detector" on page 368

---

**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture**  
**<Aperture>**

Defines the degree (aperture) of the trace smoothing, if `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATE]` `TRUE`.

**Suffix:**

|     |           |
|-----|-----------|
| <n> | Window    |
| <w> | subwindow |
| <t> | Trace     |

**Parameters:**

|            |                   |
|------------|-------------------|
| <Aperture> | 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

**Manual operation:** See "Smoothing" on page 369

---

**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE <Mode>**

Selects the trace mode. If necessary, the selected trace is also activated.

**Suffix:**

|     |  |
|-----|--|
| <n> | Window   |
| <w> | subwindow<br>Not supported by all applications |
| <t> | Trace  |

**Parameters:**

|        |   |
|--------|---|
| <Mode> | <b>WRITe</b><br>(default:) Overwrite mode: the trace is overwritten by each sweep.<br><b>AVERage</b><br>The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.<br><b>MAXHold</b><br>The maximum value is determined over several sweeps and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.<br><b>MINHold</b><br>The minimum value is determined from several measurements and displayed. The R&S ESW 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 ["Trace Mode"](#) on page 367

**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous  
<State>**

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](#)

<w> subwindow

<t> [Trace](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

DISP:WIND:TRAC3:MODE:HCON ON

Switches off the reset function.

**Manual operation:** See ["Hold"](#) on page 369

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

Turns trace smoothing for a particular trace on and off.

If enabled, the trace is smoothed by the value specified using `DISPlay[:WINDow<n>][:SUBWIndow<w>]:TRACe<t>:SMOothing:APERture` on page 694.

For more information see [Chapter 5.3.1.5, "Trace smoothing"](#), on page 355.

**Suffix:**

<n> [Window](#)

<w> subwindow

<t> [Trace](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

`DISP3:TRAC2:SMO ON`

Turns on trace smoothing for trace 2 in window 3

**Manual operation:** See ["Smoothing"](#) on page 369

**DISPlay[:WINDow<n>][:SUBWIndow<w>]:TRACe<t>[:STATe] <State>**

Turns a trace on and off.

The measurement continues in the background.

**Suffix:**

<n> [Window](#)

Irrelevant in the Receiver application.

<w> subwindow

Not supported by all applications

<t> [Trace](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

`DISP:TRAC3 ON`

**Manual operation:** See ["Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6"](#) on page 367

See ["Trace 1/ Trace 2/ Trace 3/ Trace 4 \(Softkeys\)"](#) on page 370

**DISPlay[:WINDow<n>][:SUBWIndow<w>]:TRACe<t>:X:SPACIng <Scale>**

Selects the scaling of the x-axis.

**Suffix:**

|     |                        |
|-----|------------------------|
| <n> | <a href="#">Window</a> |
| <w> | subwindow              |
| <t> |                        |

**Parameters:**

|         |  |
|---------|--|
| <Scale> | <b>LOGarithmic</b><br>Logarithmic scaling. |
|         | <b>LINear</b><br>Linear scaling.           |
| *RST:   | LINear                                     |

**Example:** `DISP:TRAC:X:SPAC LOG`

**Manual operation:** See ["Frequency Axis Scaling"](#) on page 212

**6.9.2.3 Trace import and export**

|  |     |
|--|-----|
| <a href="#">FORMat[:DATA]</a> .....                | 697 |
| <a href="#">FORMat:DEXPort:DSEPARATOR</a> .....    | 698 |
| <a href="#">FORMat:DEXPort:CSEPARATOR</a> .....    | 698 |
| <a href="#">FORMat:DEXPort:FORMat</a> .....        | 699 |
| <a href="#">FORMat:DEXPort:HEADer</a> .....        | 699 |
| <a href="#">FORMat:DEXPort:TRACes</a> .....        | 699 |
| <a href="#">FORMat:DEXPort:XDIStrib</a> .....      | 700 |
| <a href="#">FORMat:DIMPort:TRACes</a> .....        | 700 |
| <a href="#">MMEMory:LOAD&lt;n&gt;:TRACe</a> .....  | 701 |
| <a href="#">MMEMory:STORe&lt;n&gt;:TRACe</a> ..... | 701 |
| <a href="#">MMEMory:STORe&lt;n&gt;:LIST</a> .....  | 702 |

**FORMat[:DATA] <Format>[, <BitLength>]**

Selects the data format that is used for transmission of trace data from the R&S ESW to the controlling computer.

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

For details on data formats, see [Chapter 5.3.4.2, "Formats for returned values: ASCII format and binary format"](#), on page 391.

**Parameters:**

|          |   |
|----------|---|
| <Format> | <b>ASCii</b><br>ASCii format, separated by commas.<br>This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats can be. |
|----------|---|

**REAL**

Floating-point numbers (according to IEEE 754) in the "definite length block format".

The format setting **REAL** is used for the binary transmission of trace data.

<BitLength>

Length in bits for floating-point results

**16**

16-bit floating-point numbers.

Compared to **REAL**, 32 format, half as many numbers are returned.

**32**

32-bit floating-point numbers

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

**64**

64-bit floating-point numbers

Compared to **REAL**, 32 format, twice as many numbers are returned.

**Example:**

FORM REAL, 32

**FORMat:DEXPort:DSEParator <Separator>**

Selects the decimal separator for data exported in ASCII format.

**Parameters:**

<Separator>

POINT | COMMa

**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 ["Saving the Result Summary \(Evaluation List\) to a File"](#) on page 132  
See ["Save Evaluation List"](#) on page 155  
See ["Decimal Separator"](#) on page 372  
See ["Export Peak List"](#) on page 427

**FORMat:DEXPort:CSEParator <Separator>**

Selects the column separator for exported trace data.

The selected value is not affected by a preset. The command therefore has no reset value.

**Parameters:**

<Separator>

**COMMa**

Selects a comma as a separator.

**SEMIColon**

Selects a semicolon as a separator.

**TAB**

Selects a tabulator as a separator.

\*RST: n/a

**Example:**

```
//Select column separator
FORM:DEXP:CSEP TAB
```

**Manual operation:** See ["Column Separator"](#) on page 374

**FORMat:DEXPort:FORMat <FileFormat>**

Determines the format of the ASCII file to be imported or exported. Depending on the external program that creates the data file or evaluates it, a comma-separated list (CSV) or a plain data format (DAT) file is required.

**Parameters:**

<FileFormat>

CSV | DAT

\*RST: DAT

**Example:**

```
FORM:DEXP:FORM CSV
```

**Manual operation:** See ["File Type"](#) on page 373

**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 5.3.4.1, "Reference: ASCII file export format"](#), on page 388 for details.

**Parameters:**

<State>

ON | OFF | 0 | 1

\*RST: 1

**Manual operation:** See ["Include Instrument & Measurement Settings"](#) on page 372

**FORMat:DEXPort:TRACes <Selection>**

Selects the data to be included in a data export file (see [MMEMory:STORe<n>:TRACe](#) on page 689).

For details on exporting data, see [Chapter 5.3.2.2, "Exporting and importing traces"](#), on page 371.

**Parameters:**

<Selection> SINGle | ALL

**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

**Manual operation:** See ["Export all Traces and all Table Results"](#) on page 372

**FORMat:DEXPort:XDIStrib** <XDistribution>

Defines how the x-values of the trace are determined in the frequency domain.

**Parameters:**

<XDistribution> STARTstop | BINCentered

**BINCentered**

The full measurement span is divided by the number of sweep points to obtain *bins*. The x-value of the sweep point is defined as the x-value at the center of the bin (bin/2).

**STARTstop**

(Default): The x-value of the first sweep point corresponds to the starting point of the full measurement span. The x-value of the last sweep point corresponds to the end point of the full measurement span. All other sweep points are divided evenly between the first and last points.

**Example:** FORM:DEXP:XDIS BINC

**Manual operation:** See ["X-Value Distribution"](#) on page 372

**FORMat:DIMPort:TRACes** <Selection>

Selects the data to be included in a data import file (see `MMEMory:LOAD<n>:TRACe` on page 701).

For details on importing data see [Chapter 5.3.3.3, "How to import traces"](#), on page 384.

**Parameters:**

<Selection> SINGle | ALL



**SINGLE**

Only a single trace is selected for import, namely the one specified by the `MMEMory:LOAD<n>:TRACe` on page 701 command.

**ALL**

Imports several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

The <trace> parameter for the `MMEMory:LOAD<n>:TRACe` on page 701 command is ignored.

\*RST: SINGLE

**Manual operation:** See ["Import All Traces/Import to Trace"](#) on page 374  
See ["Import ASCII File to Trace"](#) on page 375

**MMEMory:LOAD<n>:TRACe** <Trace>, <FileName>

Imports trace data from the specified window to an ASCII file.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Trace> Number of the trace to be stored  
(This parameter is ignored for `FORMat:DIMPort:TRACesALL`).

<FileName> String containing the path and name of the import file.

**MMEMory:STORe<n>:TRACe** <Trace>, <Filename>

Exports trace data from the specified window to an ASCII file.

For details on the file format see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 388.

**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 limit reached" 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 ESW User Manual.

**Suffix:**

<n> [Window](#)

**Setting 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 699).

<Filename> String containing the path and name of the target file.

**Example:** `MMEM:STOR1:TRAC 1, 'C:\TEST.ASC'`  
Stores trace 1 from window 1 in the file `TEST.ASC`.

**Usage:** Setting only

**MMEMory:STORe<n>:LIST <FileName>**

Exports the SEM and spurious emission list evaluation to a file.

The file format is \*.dat.

**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 limit reached" 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 ESW User Manual.

**Suffix:**

<n> [Window](#)

**Parameters:**

<FileName> String containing the path and name of the target file.

**Example:** `MMEM:STOR:LIST 'test'`  
Stores the current list evaluation results in the `test.dat` file.

**Manual operation:** See ["Saving the Result Summary \(Evaluation List\) to a File"](#) on page 132  
See ["Save Evaluation List"](#) on page 155

**6.9.2.4 Trace copy**

[TRACe<n>:COPY](#) ..... 702

**TRACe<n>:COPY <TraceNumber>, <TraceNumber>**

Copies data from one trace to another.

**Suffix:**

<n> [Window](#)

**Parameters:**

<TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**  
 The first parameter is the destination trace, the second parameter is the source.  
 (Note the 'e' in the parameter is required!)

**Example:**

TRAC:COPY TRACE1,TRACE2  
 Copies the data from trace 2 to trace 1.

**Manual operation:** See ["Copy Trace"](#) on page 375

**6.9.2.5 Trace mathematics**

|   |     |
|---|-----|
| CALCulate<n>:MATH<t>[:EXPRession][:DEFine]..... | 703 |
| CALCulate<n>:MATH<t>:MODE.....                  | 703 |
| CALCulate<n>:MATH<t>:POSition.....              | 704 |
| CALCulate<n>:MATH<t>:STATe.....                 | 704 |

**CALCulate<n>:MATH<t>[:EXPRession][:DEFine] <Expression>**

Selects the mathematical expression for trace mathematics.

Before you can use the command, you have to turn trace mathematics on.

**Suffix:**

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

**Parameters:**

<Expression> **(TRACE1-TRACE2)**  
 Subtracts trace 2 from trace 1.  
**(TRACE1-TRACE3)**  
 Subtracts trace 3 from trace 1.  
**(TRACE1-TRACE4)**  
 Subtracts trace 4 from trace 1.

**Example:**

CALC:MATH:STAT ON  
 Turns trace mathematics on.  
 CALC:MATH:EXPR:DEF (TRACE1-TRACE3)  
 Subtracts trace 3 from trace 1.

**Manual operation:** See ["Trace Math Function"](#) on page 376

**CALCulate<n>:MATH<t>:MODE <Mode>**

Selects the way the R&S ESW calculates trace mathematics.

**Suffix:**

<n> [Window](#)

<t> irrelevant

**Parameters:**

<Mode> For more information on the way each mode works see [Trace Math Mode](#).

**LINEar**

Linear calculation.

**LOGarithmic**

Logarithmic calculation.

**POWER**

Linear power calculation.

\*RST: LOGarithmic

**Example:**

CALC:MATH:MODE LIN  
Selects linear calculation.

**Manual operation:** See "[Trace Math Mode](#)" on page 377

**CALCulate<n>:MATH<t>:POSition <Position>**

Defines the position of the trace resulting from the mathematical operation.

**Suffix:**

<n> [Window](#)

<t> irrelevant

**Parameters:**

<Position> Vertical position of the trace in % of the height of the diagram area.  
100 PCT corresponds to the upper diagram border.  
Range: -100 to 200  
\*RST: 50  
Default unit: PCT

**Example:**

CALC:MATH:POS 100  
Moves the trace to the top of the diagram area.

**Manual operation:** See "[Trace Math Position](#)" on page 377

**CALCulate<n>:MATH<t>:STATe <State>**

Turns the trace mathematics on and off.

**Suffix:**

<n> [Window](#)

<t> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MATH:STAT ON

Turns on trace mathematics.

**Manual operation:**See ["Trace Math Function"](#) on page 376See ["Trace Math Off"](#) on page 377**6.9.2.6 Spectrogram configuration**

|   |     |
|---|-----|
| CALCulate<n>:SPECtrogram:CLEar[:IMMediate]    | 705 |
| CALCulate<n>:SPECtrogram:CONTInuous           | 705 |
| CALCulate<n>:SPECtrogram:FRAME:COUNT          | 706 |
| CALCulate<n>:SPECtrogram:FRAME:SElect         | 706 |
| CALCulate<n>:SPECtrogram:HDEPth               | 707 |
| CALCulate<n>:SPECtrogram:TSTamp:DATA?         | 707 |
| CALCulate<n>:SPECtrogram:TSTamp[:STATe]       | 708 |
| CALCulate<n>:SPECtrogram[:STATe]              | 708 |
| DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault | 709 |
| DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWER   | 709 |
| DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE   | 709 |
| DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPER   | 709 |
| DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLE] | 710 |
| MMEMory:STORe<n>:SPECtrogram                  | 710 |

**CALCulate<n>:SPECtrogram:CLEar[:IMMediate]**

Resets the spectrogram and clears the history buffer.

**Suffix:**<n> [Window](#)**Example:**

//Reset the result display and clear the memory

CALC:SGR:CLE

**Manual operation:**See ["Clear Spectrogram"](#) on page 311**CALCulate<n>:SPECtrogram:CONTInuous <State>**

Determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

This setting applies to all spectrograms in the channel.

**Suffix:**<n> [Window](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

```
INIT:CONT OFF
```

Selects single sweep mode.

```
INIT; *WAI
```

Starts the sweep and waits for the end of the sweep.

```
CALC:SGR:CONT ON
```

Repeats the single sweep measurement without deleting the results of the last measurement.

**Manual operation:** See ["Single Sweep / Run Single"](#) on page 309  
See ["Continue Frame"](#) on page 311

**CALCulate<n>:SPECTrogram:FRAME:COUNT <Frames>**

Defines the number of frames to be recorded in a single sweep.

This value applies to all spectrograms in the channel.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Frames> The maximum number of frames depends on the history depth.  
Range: 1 to history depth  
Increment: 1  
\*RST: 1

**Example:**

```
//Select single sweep mode
```

```
INIT:CONT OFF
```

```
//Set the number of frames to 200
```

```
CALC:SGR:FRAM:COUNT 200
```

**Manual operation:** See ["Frame Count"](#) on page 311

**CALCulate<n>:SPECTrogram:FRAME:SELEct <Frame> | <Time>**

Selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

**Suffix:**

<n> [Window](#)

**Parameters:**

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.  
The range depends on the history depth.  
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

**Example:** INIT:CONT OFF  
Stop the continuous sweep.  
CALC:SGR:FRAM:SEL -25  
Selects frame number -25.

**Manual operation:** See ["Select Frame"](#) on page 311

### CALCulate<n>:SPECtrogram:HDEPth <History>

Defines the number of frames to be stored in the R&S ESW memory.

**Suffix:**  
<n> [Window](#)

**Parameters:**  
<History> The maximum number of frames depends on the number of sweep points.  
Range: 781 to 20000  
Increment: 1  
\*RST: 3000

**Example:** //Set the history depth to 1500  
CALC:SGR:SPEC 1500

**Manual operation:** See ["History Depth"](#) on page 379

### CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

Queries the starting time of the frames.

The return values consist of four values for each frame. If the "Spectrogram" is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with TRAC:DATA? SGR

See [TRACE<n>\[:DATA\]](#) on page 690.

**Suffix:**  
<n> [Window](#)

**Query parameters:**  
<Frames> **CURRent**  
Returns the starting time of the current frame.  
**ALL**  
Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

**Return values:**

|               |  |
|---------------|--|
| <Seconds>     | Number of seconds that have passed since 01.01.1970 until the frame start  |
| <Nanoseconds> | Number of nanoseconds that have passed <i>in addition to the</i> <Seconds> since 01.01.1970 until the frame start. |
| <Reserved>    | The third value is reserved for future uses.   |
| <Reserved>    | The fourth value is reserved for future uses.  |

**Example:**

CALC:SGR:TST:DATA? ALL

Returns the starting times of all frames sorted in a descending order.

**Usage:**

Query only

**Manual operation:** See ["Time Stamp"](#) on page 379

**CALCulate<n>:SPECtrogram:TSTamp[:STATe] <State>**

Activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- [CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe](#) on page 739
- [CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe](#) on page 736
- [CALCulate<n>:SPECtrogram:FRAMe:SElect](#) on page 706

**Suffix:**

<n> 1..n  
[Window](#)

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off  
**ON | 1**  
Switches the function on

**Example:**

//Activates the time stamp  
CALC:SGR:TST ON

**Manual operation:** See ["Time Stamp"](#) on page 379

**CALCulate<n>:SPECtrogram[:STATe] <State>**

Turns the spectrogram on and off.

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off



**ON | 1**

Switches the function on

**Example:**

CALC:SGR ON

Activates the Spectrogram result display.

**Manual operation:**See ["State"](#) on page 379**DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault**

Restores the original color map.

**Suffix:**

&lt;n&gt;

[Window](#)**Manual operation:**See ["Set to Default"](#) on page 382**DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>**

Defines the starting point of the color map.

**Suffix:**

&lt;n&gt;

[Window](#)**Parameters:**

&lt;Percentage&gt;

Statistical frequency percentage.

Range: 0 to 66

\*RST: 0

Default unit: %

**Example:**

DISP:WIND:SGR:COL:LOW 10

Sets the start of the color map to 10%.

**Manual operation:**See ["Start / Stop"](#) on page 381**DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE <Shape>**

Defines the shape and focus of the color curve for the spectrogram result display.

**Suffix:**

&lt;n&gt;

[Window](#)**Parameters:**

&lt;Shape&gt;

Shape of the color curve.

Range: -1 to 1

\*RST: 0

**Manual operation:**See ["Shape"](#) on page 381**DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>**

Defines the end point of the color map.

**Suffix:**<n> [Window](#)**Parameters:**

<Percentage> Statistical frequency percentage.  
 Range: 0 to 66  
 \*RST: 0  
 Default unit: %

**Example:**

DISP:WIND:SGR:COL:UPP 95  
 Sets the start of the color map to 95%.

**Manual operation:** See ["Start / Stop"](#) on page 381

**DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLE] <ColorScheme>**

Selects the color scheme.

**Parameters:**

<ColorScheme> **HOT**  
 Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

**COLD**  
 Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

**RADar**  
 Uses a color range from black over green to light turquoise with shades of green in between.

**GRAYscale**  
 Shows the results in shades of gray.  
 \*RST: HOT

**Example:**

DISP:WIND:SPEC:COL GRAY  
 Changes the color scheme of the spectrogram to black and white.

**Manual operation:** See ["Hot/Cold/Radar/Grayscale"](#) on page 382

**MMEMory:STORe<n>:SPECtrogram <FileName>**

Exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

**Secure User Mode**

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "memory limit reached" 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 ESW User Manual.

**Suffix:**

<n> [Window](#)

**Parameters:**

<FileName> String containing the path and name of the target file.

**Example:**

MMEM:STOR:SGR 'Spectrogram'  
Copies the spectrogram data to a file.

**Manual operation:** See ["Export Trace to ASCII File"](#) on page 373

### 6.9.2.7 Programming example: configuring a spectrogram

This example demonstrates how to configure a spectrogram for a basic frequency sweep in a remote environment. The spectrogram is displayed in addition to the spectrum display, in a new window. In addition, the usage of special spectrogram markers is demonstrated (see [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 735).



Basic trace settings are demonstrated in the [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617.

```
//-----Preparing the Measurement -----
*RST
//Resets the instrument
LAY:ADD? '1',BEL,SGR
//Displays a new window below window 1 and activates spectrogram display.
//The new window name is returned as a result: '2'.
//The spectrogram is updated with each new sweep.
INIT:CONT OFF
//Selects single sweep mode.

//-----Configuring the Spectrogram-----
CALC:SGR:CLE
//Clears the displayed spectrogram to start a new one.
CALC:SGR:CONT ON
//Configures a continuous spectrogram for a series of measurements.
//The display is not cleared when a new measurement is started.
CALC:SGR:FRAM:COUN 100
//Sets the number of frames to be recorded per sweep to 100.
CALC:SGR:HDEP 1000
//Sets the number of frames to be stored to 1000 (=10 sweeps)
CALC:SGR:TST ON
```

```

//Activates a time stamp for each frame.

//-----Configuring the Color Map-----
DISP:WIND:SGR:COL GRAY
//Defines a gray-scaled coloring: low values light gray, high values dark gray.
DISP:WIND:SGR:COL:LOW 30
DISP:WIND:SGR:COL:UPP 70
DISP:WIND:SGR:COL:SHAP 0.8
//Defines a color map for a range that comprises 40% of the measurement range,
//excluding 30% at each end. The colors are not scaled linearly; the light gray
//colors are stretched to distinguish low values better.

//-----Performing the Measurement-----
SWE:COUN 10
//Defines 10 sweeps to be performed per measurement.
INIT;*WAI
//Initiates a new measurement and waits until the sweeps have finished.
//The spectrogram is updated with each new sweep.

//-----Positioning Markers-----
CALC:MARK:SGR:SAR MEM
//Includes all frames in the memory in the search area

CALC:MARK1:SGR:FRAM -1s
//Sets marker 1 to the frame 1 second after measurement begin. (Note the
//negative value!
CALC:MARK1:MIN
//Sets marker 1 to the minimum level in this frame.
CALC:MARK1:SGR:Y:MIN
//Sets marker 1 to the minimum level for the same frequency the marker is
//currently positioned at in all frames.

CALC:MARK2:SGR:XY:MAX
//Sets marker 2 to the maximum level in the entire spectrogram.

CALC:DELT1:SGR:FRAM 3s
//Sets the deltamarker 1 to the frame captured 3 seconds after marker 1. By default
//it is set to the peak of that frame and displays the level difference to marker 1.
//Note the positive value!
CALC:DELT1:MIN
//Sets deltamarker 1 to the minimum level in this frame.

CALC:DELT3:SGR:XY:MAX
//Sets deltamarker 3 to the maximum level in the entire spectrogram. By default
//its value is the difference to marker 1. We will change it to refer to marker 2.
CALC:DELT3:MREF 2
//Deltamarker 3 now refers to marker 2, both are positioned on the maximum of the
//spectrogram. Thus, D3=0. We will move deltamarker 3 to the next peak level
//for the same frequency.

```

```

CALC:DELT3:SGR:Y:MAX:NEXT

//-----Retrieving Results-----
CALC:MARK1:X?
CALC:MARK1:Y?
CALC:MARK1:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of marker 1.

CALC:MARK2:X?
CALC:MARK2:Y?
CALC:MARK2:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of marker 2.

CALC:DELT1:X?
CALC:DELT1:Y?
CALC:DELT1:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of deltamarker 1.

CALC:DELT3:X?
CALC:DELT3:Y?
CALC:DELT3:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of deltamarker 3.

CALC:SGR:TST:DATA? ALL
//Queries the time stamps of all stored frames.
CALC:SGR:FRAM:SEL -1
//Selects the frame that was captured 1 second after measurement start (Note the
//negative value!). This frame is displayed in the Spectrum window.
TRAC:DATA? SGR
//Retrieves the trace data for the spectrogram. For each frame, the power level
//and frequency at each sweep point are returned.
TRAC:DATA? TRACE1
//Retrieves the trace data for the selected frame only.

```

### 6.9.3 Marker configuration

|   |     |
|---|-----|
| • <a href="#">Individual marker configuration</a> .....                             | 714 |
| • <a href="#">General marker configuration</a> .....                                | 720 |
| • <a href="#">Marker search</a> .....   | 724 |
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### 6.9.3.1 Individual marker configuration

|  |     |
|--|-----|
| CALCulate<n>:DELTamarker<m>:AOFF.....                | 714 |
| CALCulate<n>:DELTamarker<m>:LINK.....                | 714 |
| CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>..... | 715 |
| CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTA<md>.....  | 716 |
| CALCulate<n>:DELTamarker<m>:MODE.....                | 716 |
| CALCulate<n>:DELTamarker<m>:MREFerence.....          | 716 |
| CALCulate<n>:DELTamarker<m>[:STATe].....             | 717 |
| CALCulate<n>:DELTamarker<m>:TRACe.....               | 717 |
| CALCulate<n>:DELTamarker<m>:X.....                   | 718 |
| CALCulate<n>:MARKer<m>:AOFF.....                     | 718 |
| CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>.....      | 718 |
| CALCulate<n>:MARKer<m>[:STATe].....                  | 719 |
| CALCulate<n>:MARKer<m>:TRACe.....                    | 719 |
| CALCulate<n>:MARKer<m>:X.....                        | 720 |

---

#### CALCulate<n>:DELTamarker<m>:AOFF

Turns off *all* delta markers.

##### Suffix:

<n> [Window](#)

<m> irrelevant

##### Example:

CALC:DELT:AOFF

Turns off all delta markers.

---

#### CALCulate<n>:DELTamarker<m>:LINK <State>

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.

**Tip:** to link any marker to a different marker than marker 1, use the [CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>](#) or [CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>](#) commands.

##### Suffix:

<n> [Window](#)

<m> [Marker](#)

##### Parameters:

<State> ON | OFF | 0 | 1

##### OFF | 0

Switches the function off

##### ON | 1

Switches the function on

##### Example:

CALC:DELT2:LINK ON

**Manual operation:** See ["Linking to Another Marker"](#) on page 208  
See ["Linking to Another Marker"](#) on page 397

---

### CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

Links the delta source marker <ms> to any active destination marker <md> (normal or delta marker).

In Spectrum mode only:

- If <md> is a delta marker, it is turned into a normal marker. To maintain the delta marker, use `CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md>` on page 716.
- If <md> is the reference marker for the delta marker <ms>, the delta marker is initially set to the same horizontal position as the normal marker. To change the relative distance (delta) value again, use `CALCulate<n>:DELTamarker<m>:X` on page 718. Then the delta between the two markers is maintained when you move the normal marker.

In I/Q Analyzer mode, if <md> is the reference marker for the delta marker <ms>, the relative distance (delta) between the two markers is maintained when you move the normal marker.

In other applications, the delta marker is set to the same horizontal position as the marker <md>, and if <md> is moved along the x-axis, <ms> follows to the same horizontal position.

#### Suffix:

<n> [Window](#)  
 <ms> source marker, see [Marker](#)  
 <md> destination marker, see [Marker](#)

#### Parameters:

<State> ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

**Example:** `CALC:DELT4:LINK:TO:MARK2 ON`  
 Links the delta marker 4 to the marker 2.

**Example:** D2 and D3 are active.  
`CALC:DELT2:LINK:TO:MARK3 ON`  
 Converts D3 into M3 and links D2 and M3

**Manual operation:** See ["Linking to Another Marker"](#) on page 208  
See ["Linking to Another Marker"](#) on page 397

**CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md> <State>**

Links the delta source marker <ms> to any active destination delta marker <md>.

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

**Suffix:**

|      |  |
|------|--|
| <n>  | <a href="#">Window</a>                         |
| <ms> | source marker, see <a href="#">Marker</a>      |
| <md> | destination marker, see <a href="#">Marker</a> |

**Parameters:**

|         |                           |
|---------|---------------------------|
| <State> | ON   OFF   0   1          |
|         | <b>OFF   0</b>            |
|         | Switches the function off |
|         | <b>ON   1</b>             |
|         | Switches the function on  |

**Example:** `CALC:DELT2:LINK:TO:DELT3 ON`  
Links D2 and D3.

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

Defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker. Note that this setting applies to *all* windows.

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 718)!

**Suffix:**

|     |            |
|-----|------------|
| <n> | irrelevant |
| <m> | irrelevant |

**Parameters:**

|        |  |
|--------|--|
| <Mode> | <b>ABSolute</b>  |
|        | Delta marker position in absolute terms.                 |
|        | <b>RELative</b>  |
|        | Delta marker position in relation to a reference marker. |
|        | *RST:       RELative                                     |

**Example:** `CALC:DELT:MODE ABS`  
Absolute delta marker position.

**CALCulate<n>:DELTamarker<m>:MREFerence <Reference>**

Selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.



**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**<Reference> **FIXed**  
Selects the fixed reference as the reference.**Example:**

CALC:DELT3:MREF 2  
 Specifies that the values of delta marker 3 are relative to marker 2.

**Manual operation:** See ["Reference Marker"](#) on page 207**CALCulate<n>:DELTamarker<m>[:STATe] <State>**

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 | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

**Example:**

CALC:DELT2 ON  
 Turns on delta marker 2.

**Manual operation:** See ["Marker State"](#) on page 207  
 See ["Marker Type"](#) on page 207  
 See ["Select Marker"](#) on page 209

**CALCulate<n>:DELTamarker<m>:TRACe <Trace>**

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>**

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:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Position> Numeric value that defines the marker position on the x-axis.  
The position is relative to the reference marker.

A query returns the absolute position of the delta marker.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Default unit: HZ

**Example:**

CALC:DELT:X?

Outputs the absolute x-value of delta marker 1.

**Manual operation:**

See ["Marker 1/Marker 2/Marker 3/Marker 4"](#) on page 191

See ["Marker 1/Marker 2/Marker 3"](#) on page 196

See ["Marker Position X-value"](#) on page 207

**CALCulate<n>:MARKer<m>:AOFF**

Turns off all markers.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Example:**

CALC:MARK:AOFF

Switches off all markers.

**Manual operation:**

See ["All Markers Off"](#) on page 398

**CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>**

Links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

**Suffix:**<n> [Window](#)<ms> source marker, see [Marker](#)<md> destination marker, see [Marker](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK4:LINK:TO:MARK2 ON

Links marker 4 to marker 2.

**Manual operation:** See ["Linking to Another Marker"](#) on page 208See ["Linking to Another Marker"](#) on page 397**CALCulate<n>:MARKer<m>[:STATe] <State>**

Turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK3 ON

Switches on marker 3.

**Manual operation:** See ["Marker State"](#) on page 207See ["Marker Type"](#) on page 207See ["Select Marker"](#) on page 209**CALCulate<n>:MARKer<m>:TRACe <Trace>**

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> **1 to 6**  
Trace number the marker is assigned to.

**Example:** //Assign marker to trace 1  
CALC:MARK3:TRAC 2

**Manual operation:** See ["Assigning the Marker to a Trace"](#) on page 208

**CALCulate<n>:MARKer<m>:X <Position>**

Moves a marker to a specific 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:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Position> Numeric value that defines the marker position on the x-axis.  
The unit depends on the result display.  
Range: The range depends on the current x-axis range.  
Default unit: Hz

**Example:** CALC:MARK2:X 1.7MHz  
Positions marker 2 to frequency 1.7 MHz.

**Manual operation:** See ["Marker 1/Marker 2/Marker 3/Marker 4"](#) on page 191  
See ["Marker 1/Marker 2/Marker 3"](#) on page 196  
See ["Marker Position X-value"](#) on page 207  
See ["Marker Table"](#) on page 332  
See ["Marker Peak List"](#) on page 332

### 6.9.3.2 General marker configuration

|  |     |
|--|-----|
| CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:MAXimum[:PEAK] | 720 |
| CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:X              | 721 |
| CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y              | 721 |
| CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y:OFFSet       | 722 |
| CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed[:STATe]               | 722 |
| CALCulate<n>:MARKer<m>:X:SSIZe                                   | 722 |
| DISPlay[:WINDow<n>]:MINFo[:STATe]                                | 723 |
| DISPlay[:WINDow<n>]:MTABLe                                       | 723 |

**CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:MAXimum[:PEAK]**

Moves the fixed reference marker to the peak power.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Example:**

CALC:DELT:FUNC:FIX:RPO:MAX

Sets the reference point level for delta markers to the peak of the selected trace.

**Manual operation:**See ["Defining a Fixed Reference"](#) on page 400See ["Defining Reference Point"](#) on page 414**CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:X <RefPoint>**

Defines the horizontal position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

&lt;RefPoint&gt; Numeric value that defines the horizontal position of the reference.

For frequency domain measurements, it is a frequency in Hz.

For time domain measurements, it is a point in time in s.

\*RST: Fixed Reference: OFF

Default unit: HZ

**Example:**

CALC:DELT:FUNC:FIX:RPO:X 128 MHz

Sets the frequency reference to 128 MHz.

**Manual operation:**See ["Defining a Fixed Reference"](#) on page 400See ["Defining Reference Point"](#) on page 414**CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y <RefPointLevel>**

Defines the vertical position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

&lt;RefPoint&gt; Numeric value that defines the vertical position of the reference. The unit and value range is variable.

\*RST: Fixed Reference: OFF

Default unit: DBM

**Example:**

CALC:DELT:FUNC:FIX:RPO:Y -10dBm

Sets the reference point level for delta markers to -10 dBm.

**Manual operation:** See ["Defining a Fixed Reference"](#) on page 400  
 See ["Defining Reference Point"](#) on page 414

---

### CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:Y:OFFSet <Offset>

Defines a level offset for the fixed delta marker reference point.

#### Suffix:

<n> [Window](#)

<m> [Marker](#)

#### Parameters:

<Offset> Numeric value  
 \*RST: 0  
 Default unit: dB

---

### CALCulate<n>:DELTaMarker<m>:FUNction:FIXed[:STATe] <State>

Activates or deactivates a marker that defines a fixed reference point for relative marker analysis.

If necessary, the command activates a marker and positions it on the peak power.

Subsequently, you can change the coordinates of the fixed reference independent of the marker. The fixed reference is independent of the trace and is applied to all active delta markers.

#### Suffix:

<n> [Window](#)

<m> [Marker](#)

#### Parameters:

<State> ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

#### Example:

CALC:DELT:FUNC:FIX ON  
 Switches on the measurement with fixed reference value for all delta markers.  
 CALC:DELT:FUNC:FIX:RPO:X 128 MHZ  
 Sets the frequency reference to 128 MHz.  
 CALC:DELT:FUNC:FIX:RPO:Y 30 DBM  
 Sets the reference level to +30 dBm.

**Manual operation:** See ["Defining a Fixed Reference"](#) on page 400

---

### CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

Selects the marker step size mode for *all* markers in *all* windows.

It therefore takes effect in manual operation only.

**Suffix:**

<n> irrelevant  
<m> irrelevant

**Parameters:**

<StepSize> **STANdard**  
the marker moves from one pixel to the next  
**POINTs**  
the marker moves from one sweep point to the next  
\*RST: POINTs

**Example:**

CALC:MARK:X:SSIZ STAN  
Sets the marker step size to one pixel.

**Manual operation:** See "[Marker Stepsize](#)" on page 400

**DISPlay[:WINDow<n>]:MINFo[:STATe] <State>**

Turns the marker information in all diagrams on and off.

**Suffix:**

<n> irrelevant

**Parameters:**

<State> **ON | 1**  
Displays the marker information in the diagrams.  
**OFF | 0**  
Hides the marker information in the diagrams.  
\*RST: 1

**Example:**

DISP:MINF OFF  
Hides the marker information.

**Manual operation:** See "[Marker Info](#)" on page 399

**DISPlay[:WINDow<n>]:MTABle <DisplayMode>**

Turns the marker table on and off.

**Suffix:**

<n> irrelevant

**Parameters:**

<DisplayMode> **ON | 1**  
Turns on the marker table.  
**OFF | 0**  
Turns off the marker table.  
**AUTO**  
Turns on the marker table 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 399

### 6.9.3.3 Marker search

|  |     |
|--|-----|
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:LOEXclude</code> .....              | 724 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:PEXCursion</code> .....             | 724 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:X:SLIMits:LEFT</code> .....         | 725 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:X:SLIMits:RIGHT</code> .....        | 725 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:X:SLIMits:ZOOM[:STATe]</code> ..... | 726 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:X:SLIMits[:STATe]</code> .....      | 726 |
| <code>CALCulate&lt;n&gt;:THReshold</code> .....                              | 727 |
| <code>CALCulate&lt;n&gt;:THReshold:STATe</code> .....                        | 727 |

---

#### **CALCulate<n>:MARKer<m>:LOEXclude <State>**

Turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows).

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1

\*RST: 1

**Example:** `CALC:MARK:LOEX ON`

**Manual operation:** See ["Exclude LO"](#) on page 402

---

#### **CALCulate<n>:MARKer<m>:PEXCursion <Excursion>**

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   |
| Receiver                   | dB   |

**Suffix:**

<n> irrelevant

<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

\*RST: 6 dB

**Example:**

CALC:MARK:PEXC 10dB

Defines peak excursion as 10 dB.

**Manual operation:** See ["Peak Excursion"](#) on page 402

**CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>**

Defines the left limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<SearchLimit> The value range depends on the frequency range or sweep time.

The unit is Hz for frequency domain measurements and s for time domain measurements.

\*RST: left diagram border

Default unit: HZ

**Example:**

CALC:MARK:X:SLIM ON

Switches the search limit function on.

CALC:MARK:X:SLIM:LEFT 10MHz

Sets the left limit of the search range to 10 MHz.

**Manual operation:** See ["Search Limits \(Left / Right\)"](#) on page 98  
 See ["Left Limit / Right Limit"](#) on page 176  
 See ["Search Limits \(Left / Right\)"](#) on page 403

**CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <SearchLimit>**

Defines the right limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<Limit> The value range depends on the frequency range or sweep time.  
 The unit is Hz for frequency domain measurements and s for time domain measurements.  
 \*RST: right diagram border  
 Default unit: HZ

**Example:**

CALC:MARK:X:SLIM ON  
 Switches the search limit function on.  
 CALC:MARK:X:SLIM:RIGH 20MHz  
 Sets the right limit of the search range to 20 MHz.

**Manual operation:** See ["Search Limits \(Left / Right\)"](#) on page 98  
 See ["Left Limit / Right Limit"](#) on page 176  
 See ["Search Limits \(Left / Right\)"](#) on page 403

**CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>**

Adjusts the marker search range to the zoom area for *all* markers in *all* windows.

**Suffix:**

<n> irrelevant  
 <m> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

**Example:**

CALC:MARK:X:SLIM:ZOOM ON  
 Switches the search limit function on.  
 CALC:MARK:X:SLIM:RIGH 20MHz  
 Sets the right limit of the search range to 20 MHz.

**Manual operation:** See ["Use Zoom Limits"](#) on page 403

**CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>**

Turns marker search limits on and off for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

**Suffix:**

<n> irrelevant  
 <m> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK:X:SLIM ON

Switches on search limitation.

**Manual operation:**See ["Search Limits \(Left / Right\)"](#) on page 98See ["Search Limits Off"](#) on page 98See ["Limit State"](#) on page 176See ["Search Limits \(Left / Right\)"](#) on page 403See ["Search Limits Off"](#) on page 403**CALCulate<n>:THReshold <Level>**Defines a threshold level for the marker peak search (for *all* markers in *all* windows).Note that you must enable the use of the threshold using [CALCulate<n>:THReshold:STATe](#) on page 727.**Suffix:**

&lt;n&gt; irrelevant

**Parameters:**

&lt;Level&gt; Numeric value. The value range and unit are variable.

\*RST: -120 dBm

Default unit: DBM

**Example:**

CALC:THR:STAT ON

**Example:**

CALC:THR -82DBM

Enables the search threshold and sets the threshold value to -82 dBm.

**Manual operation:** See ["Search Threshold"](#) on page 403**CALCulate<n>:THReshold:STATe <State>**Turns a threshold for the marker peak search on and off (for *all* markers in *all* windows).**Suffix:**

&lt;n&gt; irrelevant

**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:** `CALC:THR:STAT ON`  
Switches on the threshold line.

**Manual operation:** See ["Search Limits Off"](#) on page 98  
See ["Search Threshold"](#) on page 403  
See ["Search Limits Off"](#) on page 403

#### 6.9.3.4 Markers positioning

|   |     |
|---|-----|
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MAXimum:LEFT</code> .....   | 728 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MAXimum:NEXT</code> .....   | 728 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MAXimum:RIGHT</code> .....  | 729 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MAXimum[:PEAK]</code> ..... | 729 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MINimum:LEFT</code> .....   | 729 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MINimum:NEXT</code> .....   | 730 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MINimum:RIGHT</code> .....  | 730 |
| <code>CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:MINimum[:PEAK]</code> ..... | 730 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MAXimum:AUTO</code> .....        | 730 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MAXimum:LEFT</code> .....        | 731 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MAXimum:NEXT</code> .....        | 731 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MAXimum:RIGHT</code> .....       | 731 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MAXimum[:PEAK]</code> .....      | 732 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MINimum:AUTO</code> .....        | 732 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MINimum:LEFT</code> .....        | 733 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MINimum:NEXT</code> .....        | 733 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MINimum:RIGHT</code> .....       | 733 |
| <code>CALCulate&lt;n&gt;:MARKer&lt;m&gt;:MINimum[:PEAK]</code> .....      | 733 |

---

##### `CALCulate<n>:DELTaMarker<m>:MAXimum:LEFT`

Moves a delta marker to the next positive peak value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

##### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Peak"](#) on page 405

---

##### `CALCulate<n>:DELTaMarker<m>:MAXimum:NEXT`

Moves a marker to the next positive peak value.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> 1..n  
Window

<m> 1..n  
Marker

**Manual operation:** See ["Search Next Peak"](#) on page 405

**CALCulate<n>:DELTaMarker<m>:MAXimum:RIGHT**

Moves a delta marker to the next positive peak value on the trace.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> Window

<m> Marker

**Manual operation:** See ["Search Next Peak"](#) on page 405

**CALCulate<n>:DELTaMarker<m>:MAXimum[:PEAK]**

Moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

**Suffix:**

<n> Window

<m> Marker

**Manual operation:** See ["Peak Search"](#) on page 405

**CALCulate<n>:DELTaMarker<m>:MINimum:LEFT**

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> Window

<m> Marker

**Manual operation:** See ["Search Next Minimum"](#) on page 406

---

#### **CALCulate<n>:DELTaMarker<m>:MINimum:NEXT**

Moves a marker to the next minimum peak value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

##### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Minimum"](#) on page 406

---

#### **CALCulate<n>:DELTaMarker<m>:MINimum:RIGHT**

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

##### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Minimum"](#) on page 406

---

#### **CALCulate<n>:DELTaMarker<m>:MINimum[:PEAK]**

Moves a delta marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

##### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Minimum"](#) on page 405

---

#### **CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>**

Turns an automatic marker peak search for a trace maximum on and off (using marker 1). The R&S ESW performs the peak search after each sweep.

**Suffix:**<n> [Window](#)

&lt;m&gt; irrelevant

**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK:MAX:AUTO ON

Activates the automatic peak search function for marker 1 at the end of each particular sweep.

**Manual operation:** See ["Auto Max Peak Search / Auto Min Peak Search"](#) on page 402**CALCulate<n>:MARKer<m>:MAXimum:LEFT**

Moves a marker to the next positive peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Manual operation:** See ["Search Next Peak"](#) on page 405**CALCulate<n>:MARKer<m>:MAXimum:NEXT**

Moves a marker to the next positive peak.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Manual operation:** See ["Search Next Peak"](#) on page 405**CALCulate<n>:MARKer<m>:MAXimum:RIGHT**

Moves a marker to the next positive peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Peak"](#) on page 405

### **CALCulate<n>:MARKer<m>:MAXimum[:PEAK]**

Moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Peak Search"](#) on page 405

### **CALCulate<n>:MARKer<m>:MINimum:AUTO <State>**

Turns an automatic marker peak search for a trace minimum on and off (using marker 1). The R&S ESW performs the peak search after each sweep.

**Suffix:**

<n> [Window](#)

<m> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK:MIN:AUTO ON

Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

**Manual operation:** See ["Auto Max Peak Search / Auto Min Peak Search"](#) on page 402



---

**CALCulate<n>:MARKer<m>:MINimum:LEFT**

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Minimum"](#) on page 406

---

**CALCulate<n>:MARKer<m>:MINimum:NEXT**

Moves a marker to the next minimum peak value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Minimum"](#) on page 406

---

**CALCulate<n>:MARKer<m>:MINimum:RIGHT**

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Manual operation:** See ["Search Next Minimum"](#) on page 406

---

**CALCulate<n>:MARKer<m>:MINimum[:PEAK]**

Moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Manual operation:** See ["Search Minimum"](#) on page 405**6.9.3.5 Marker results**

Commands to retrieve marker positions described elsewhere.

- [CALCulate<n>:DELTaMarker<m>:X](#) on page 718
- [CALCulate<n>:MARKer<m>:X](#) on page 720

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:X:RELative?</a> ..... | 734 |
| <a href="#">CALCulate&lt;n&gt;:DELTaMarker&lt;m&gt;:Y?</a> .....          | 734 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:Y?</a> .....               | 735 |

**CALCulate<n>:DELTaMarker<m>:X:RELative?**

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:**

&lt;Position&gt; 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

**Manual operation:** See ["Marker 1/Marker 2/Marker 3/Marker 4"](#) on page 191  
See ["Marker 1/Marker 2/Marker 3"](#) on page 196

**CALCulate<n>:DELTaMarker<m>:Y?**

Queries the result at the position of the specified delta marker.

**Suffix:**

&lt;n&gt; 1..n

&lt;m&gt; 1..n

**Return values:**

<Result> Result at the position of the delta marker.  
The unit is variable and depends on the one you have currently set.  
Default unit: DBM

**Usage:** Query only

---

#### **CALCulate<n>:MARKer<m>:Y?**

Queries the result at the position of the specified marker.

##### **Suffix:**

<n> 1..n

<m> 1..n

##### **Return values:**

<Result> Default unit: DBM

**Usage:** Query only

**Manual operation:** See "Marker Table" on page 332  
See "Marker Peak List" on page 332

### **6.9.3.6 Spectrogram markers**

- [Marker configuration](#)..... 735
- [Delta markers](#)..... 738

#### **Marker configuration**

Commands to configure markers in spectrograms described elsewhere.

- [CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 731
- [CALCulate<n>:MARKer<m>:MAXimum:NEXT](#) on page 731
- [CALCulate<n>:MARKer<m>:MAXimum\[:PEAK\]](#) on page 732
- [CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 731
- [CALCulate<n>:MARKer<m>:MINimum:LEFT](#) on page 733
- [CALCulate<n>:MARKer<m>:MINimum:NEXT](#) on page 733
- [CALCulate<n>:MARKer<m>:MINimum\[:PEAK\]](#) on page 733
- [CALCulate<n>:MARKer<m>:MINimum:RIGHT](#) on page 733

|  |     |
|--|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:FRAME</a> .....             | 736 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:SARea</a> .....             | 736 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:XY:MAXimum[:PEAK]</a> ..... | 736 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:XY:MINimum[:PEAK]</a> ..... | 736 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MAXimum:ABOVE</a> .....   | 737 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MAXimum:BELOW</a> .....   | 737 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MAXimum:NEXT</a> .....    | 737 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MAXimum[:PEAK]</a> .....  | 737 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MINimum:ABOVE</a> .....   | 738 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MINimum:BELOW</a> .....   | 738 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MINimum:NEXT</a> .....    | 738 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:SPECtrogram:Y:MINimum[:PEAK]</a> .....  | 738 |

---

**CALCulate<n>:MARKer<m>:SPECtrogram:FRAME <Frame> | <Time>**

Positions a marker on a particular frame.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.  
The range depends on the history depth.  
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.  
The number is the (negative) distance to frame 0 in seconds.  
The range depends on the history depth.

**Example:**

CALC:MARK:SGR:FRAM -20

Sets the marker on the 20th frame before the present.

CALC:MARK2:SGR:FRAM -2s

Sets second marker on the frame 2 seconds ago.

**Manual operation:** See ["Frame \(Spectrogram only\)"](#) on page 396

---

**CALCulate<n>:MARKer<m>:SPECtrogram:SAREa <SearchArea>**

Defines the marker search area for all spectrogram markers in the channel.

**Parameters:**

<SearchArea>

**VISible**

Performs a search within the visible frames.

Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

**MEMory**

Performs a search within all frames in the memory.

\*RST: VISible

**Manual operation:** See ["Marker Search Area"](#) on page 404

---

**CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]**

Moves a marker to the highest level of the spectrogram.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]**

Moves a marker to the minimum level of the spectrogram.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVE**

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELOW**

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT**

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]**

Moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVE**

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELOW**

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT**

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

---

**CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]**

Moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Delta markers**

Commands to configure delta markers in spectrograms described elsewhere.

- [CALCulate<n>:DELTamarker<m>:MAXimum:LEFT](#) on page 728

- [CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 728
- [CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 729
- [CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 729
- [CALCulate<n>:DELTamarker<m>:MINimum:LEFT](#) on page 729
- [CALCulate<n>:DELTamarker<m>:MINimum:NEXT](#) on page 730
- [CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 730
- [CALCulate<n>:DELTamarker<m>:MINimum:RIGHT](#) on page 730

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:FRAME</a> .....             | 739 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:SARea</a> .....             | 740 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:XY:MAXimum[:PEAK]</a> ..... | 740 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:XY:MINimum[:PEAK]</a> ..... | 740 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MAXimum:ABOVE</a> .....   | 740 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MAXimum:BELOW</a> .....   | 740 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MAXimum:NEXT</a> .....    | 741 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MAXimum[:PEAK]</a> .....  | 741 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MINimum:ABOVE</a> .....   | 741 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MINimum:BELOW</a> .....   | 741 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MINimum:NEXT</a> .....    | 742 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:SPECTrogram:Y:MINimum[:PEAK]</a> .....  | 742 |

---

### **CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAME <Frame>**

Positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

#### **Suffix:**

<n>                      [Window](#)

<m>                      [Marker](#)

#### **Parameters:**

<Frame>                      Selects a frame either by its frame number or time stamp.  
                                     The frame number is available if the time stamp is off. The range depends on the history depth.  
                                     The time stamp is available if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.  
                                     Default unit: S

#### **Example:**

```
CALC:DELT4:SGR:FRAM -20
Sets fourth deltamarker 20 frames below marker 1.
CALC:DELT4:SGR:FRAM 2 s
Sets fourth deltamarker 2 seconds above the position of marker 1.
```

**Manual operation:**    See ["Frame \(Spectrogram only\)"](#) on page 396

**CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>**

Defines the marker search area for *all* spectrogram markers in the channel.

**Parameters:**

&lt;SearchArea&gt;

**VISible**

Performs a search within the visible frames.

Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

**MEMory**

Performs a search within all frames in the memory.

\*RST: VISible

**Manual operation:** See "[Marker Search Area](#)" on page 404

**CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]**

Moves a marker to the highest level of the spectrogram over all frequencies.

**Suffix:**

&lt;n&gt;

[Window](#)

&lt;m&gt;

[Marker](#)**CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]**

Moves a delta marker to the minimum level of the spectrogram over all frequencies.

**Suffix:**

&lt;n&gt;

[Window](#)

&lt;m&gt;

[Marker](#)**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVE**

Moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

**Suffix:**

&lt;n&gt;

[Window](#)

&lt;m&gt;

[Marker](#)**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELOW**

Moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.



**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT**

Moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]**

Moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVE**

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)

---

**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELOW**

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

**Suffix:**<n> [Window](#)<m> [Marker](#)

**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT**

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]**

Moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**6.9.3.7 Marker functions**

|   |     |
|---|-----|
| • <a href="#">Signal count</a> .....        | 742 |
| • <a href="#">Noise marker</a> .....        | 744 |
| • <a href="#">Phase noise marker</a> .....  | 745 |
| • <a href="#">N db down marker</a> .....    | 748 |
| • <a href="#">Band power marker</a> .....   | 751 |
| • <a href="#">Marker demodulation</a> ..... | 754 |
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**Signal count**

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:COUNT</a> .....            | 742 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:COUNT:FREQuency?</a> ..... | 743 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:COUNT:RESolution</a> ..... | 744 |

**CALCulate<n>:MARKer<m>:COUNT <State>**

Turns the frequency counter at the marker position on and off.

The frequency counter works for one marker only. If you perform a frequency count with another marker, the R&S ESW deactivates the frequency count of the first marker.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

INIT:CONT OFF

Switches to single sweep mode.

CALC:MARK ON

Switches on marker 1.

CALC:MARK:COUN ON

Switches on the frequency counter for marker 1.

INIT;\*WAI

Starts a sweep and waits for the end.

CALC:MARK:COUN:FREQ?

Outputs the measured value.

**Manual operation:** See ["Signal Count Marker State"](#) on page 408**CALCulate<n>:MARKer<m>:COUNT:FREQUENCY?**

Queries the frequency at the marker position.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Before you can use the command, you have to turn on the frequency counter.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Return values:**

&lt;Frequency&gt; Frequency at the marker position.

**Example:**

INIT:CONT OFF

Switches to single sweep mode.

CALC:MARK ON

Switches on marker 2.

CALC:MARK:COUN ON

Activates the frequency counter for marker 1.

INIT;\*WAI

Starts a sweep and waits for the end.

CALC:MARK:COUN:FREQ?

Outputs the measured value of marker 1.

**Usage:** Query only

**Manual operation:** See ["Signal Count Marker State"](#) on page 408

---

#### CALCulate<n>:MARKer<m>:COUNT:RESolution <Resolution>

Defines the resolution of the frequency counter.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Resolution> 0.001 | 0.01 | 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz

\*RST: 0.1 Hz

Default unit: HZ

**Example:** CALC:MARK:COUN:RES 1kHz  
Sets the resolution of the frequency counter to 1 kHz.

**Manual operation:** See ["Resolution"](#) on page 409

#### Noise marker

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe:RESult?](#).....744

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe\[:STATe\]](#).....745

---

#### CALCulate<n>:MARKer<m>:FUNCTION:NOISe:RESult?

Queries the result of the noise measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<NoiseLevel> Current noise level. The unit is the one currently active.

**Example:** INIT:CONT OFF  
Switches to single sweep mode.  
CALC:MARK2 ON  
Switches on marker 2.  
CALC:MARK2:FUNC:NOIS ON  
Switches on noise measurement for marker 2.  
INIT;\*WAI  
Starts a sweep and waits for the end.  
CALC:MARK2:FUNC:NOIS:RES?  
Outputs the noise result of marker 2.

**Usage:** Query only

**Manual operation:** See ["Noise Measurement State"](#) on page 411

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:NOISe[:STATe] <State>**

Turns the noise measurement at the marker position on and off.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK:FUNC:NOIS ON

Switches on the noise measurement.

**Manual operation:** See ["Noise Measurement State"](#) on page 411  
See ["Switching All Noise Measurement Off"](#) on page 411

#### **Phase noise marker**

|  |     |
|--|-----|
| CALCulate<n>:DELTaMarker<m>:FUNCTION:PNOise:AUTO.....    | 745 |
| CALCulate<n>:DELTaMarker<m>:FUNCTION:PNOise:RESult?..... | 746 |
| CALCulate<n>:DELTaMarker<m>:FUNCTION:PNOise[:STATe]..... | 746 |
| CALCulate<n>:MARKer<m>:FUNCTION:PNOise:RESult?.....      | 747 |
| CALCulate<n>:MARKer<m>:FUNCTION:PNOise[:STATe].....      | 747 |

---

#### **CALCulate<n>:DELTaMarker<m>:FUNCTION:PNOise:AUTO <State>**

Turns an automatic peak search for the fixed reference marker at the end of a sweep on and off.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:** `CALC:DELT:FUNC:PNO:AUTO ON`  
 Activates an automatic peak search for the reference marker in a phase-noise measurement.

**Manual operation:** See ["Defining Reference Point"](#) on page 414

### **CALCulate<n>:DELTaMarker<m>:FUNCTION:PNOise:RESult?**

Queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

Is only available in the Spectrum application.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<PhaseNoise> numeric value  
 The difference in level between the reference point and the noise power density at the position of the specified delta marker.

**Example:** `CALC:DELT2:FUNC:PNO:RES?`  
 Outputs the result of phase-noise measurement of the delta-marker 2.

**Usage:** Query only

**Manual operation:** See ["Phase Noise Measurement State"](#) on page 413

### **CALCulate<n>:DELTaMarker<m>:FUNCTION:PNOise[:STATe] <State>**

Turns the phase noise measurement at the delta marker position on and off.

The reference marker for phase noise measurements is either a normal marker or a fixed reference. If necessary, the command turns on the reference marker.

The correction values for the bandwidth and the log amplifier are taken into account in the measurement.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

- Example:** `CALC:DELT:FUNC:PNO ON`  
Switches on the phase-noise measurement with all delta markers.  
`CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`  
Sets the frequency reference to 128 MHz.  
`CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`  
Sets the reference level to +30 dBm
- Manual operation:** See ["Phase Noise Measurement State"](#) on page 413  
See ["Switching All Phase Noise Measurements Off"](#) on page 414

---

### **CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?**

Queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<PhaseNoise> numeric value  
The difference between the measured carrier power and the noise power at the position of the specified (normal) marker.

**Example:** `CALC:MARK2:FUNC:PNO:RES?`  
Outputs the result of phase-noise measurement of the marker 2.

**Usage:** Query only

---

### **CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] <State>**

Turns the phase noise measurement at the marker position on and off.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
Switches the function off  
**ON | 1**  
Switches the function on

**Example:** `CALC:MARK2:FUNC:PNO ON`  
Switches on the phase-noise measurement for the marker 2.

**N db down marker**

|   |     |
|---|-----|
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| CALCulate<n>:MARKer<m>:FUNction:NDBDown:FREquency?..... | 748 |
| CALCulate<n>:MARKer<m>:FUNction:NDBDown:QFACTOR?.....   | 749 |
| CALCulate<n>:MARKer<m>:FUNction:NDBDown:RESult?.....    | 749 |
| CALCulate<n>:MARKer<m>:FUNction:NDBDown:STATe.....      | 750 |
| CALCulate<n>:MARKer<m>:FUNction:NDBDown:TIME?.....      | 750 |

**CALCulate<n>:MARKer<m>:FUNction:NDBDown <Distance>**

Defines the distance of the n dB down markers to the reference marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Distance> Distance of the temporary markers to the reference marker in dB.  
 For a positive offset, the markers T1 and T2 are placed *below* the active reference point.  
 For a negative offset (for example for notch filter measurements), the markers T1 and T2 are placed *above* the active reference point.  
 \*RST: 6dB  
 Default unit: DB

**Example:**

CALC:MARK:FUNC:NDBD 3dB

Sets the distance to the reference marker to 3 dB.

**CALCulate<n>:MARKer<m>:FUNction:NDBDown:FREquency?**

Queries the position of the n dB down markers on the x-axis when measuring in the frequency domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<Frequency> **<frequency 1>**  
 absolute frequency of the n dB marker to the left of the reference marker in Hz  
**<frequency 2>**  
 absolute frequency of the n dB marker to the right of the reference marker in Hz.



**Example:**

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:NDBD ON
Switches on the n dB down function.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:NDBD:FREQ?
```

This command would return, for example, 100000000, 200000000, meaning that the first marker position is at 100 MHz, the second marker position is at 200 MHz

**Usage:** Query only

**Manual operation:** See "[n dB down Value](#)" on page 416

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:QFACTOR?**

Queries the Q factor of n dB down measurements.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<QFactor>

**Usage:** Query only

---

#### **CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:RESult?**

Queries the distance of the n dB down markers from each other.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<Distance>

The result depends on the span.

In case of frequency domain measurements, the command returns the bandwidth between the two n dB down markers in Hz.

In case of time domain measurements, the command returns the pulse width between the two n dB down markers in seconds.

**Example:**

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:NDBD ON
Switches on the n dB down function.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:NDBD:RES?
Outputs the measured value.
```

**Usage:** Query only

**Manual operation:** See "[n dB down Marker State](#)" on page 416

#### **CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:STATe <State>**

Turns the n dB Down marker function on and off.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

```
CALC:MARK:FUNC:NDBD:STAT ON
Turns the n dB Down marker on.
```

**Manual operation:** See "[n dB down Marker State](#)" on page 416

#### **CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:TIME?**

Queries the position of the n dB down markers on the x-axis when measuring in the time domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<TimeX1> absolute position in time of the n dB marker to the left of the reference marker in seconds

<TimeX2> absolute position in time of the n dB marker to the right of the reference marker in seconds

**Example:**

```
INIT:CONT OFF
Switches to single sweep mode
CALC:MARK:FUNC:NDBD ON
Switches on the n dB down function.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:NDBD:TIME?
Outputs the time values of the temporary markers.
```

**Usage:** Query only

**Manual operation:** See "[n dB down Value](#)" on page 416

### Band power marker

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:BPOWER:MODE</a>    | 751 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:BPOWER:RESult?</a> | 752 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:BPOWER:SPAN</a>    | 752 |
| <a href="#">CALCulate&lt;n&gt;:DELTamarker&lt;m&gt;:FUNCTION:BPOWER[:STATe]</a> | 752 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:BPOWER:RESult?</a>      | 753 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:BPOWER:SPAN</a>         | 753 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:BPOWER:MODE</a>         | 753 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:BPOWER[:STATe]</a>      | 754 |

---

### **CALCulate<n>:DELTamarker<m>:FUNCTION:BPOWER:MODE <Mode>**

Selects the way the results for a band power delta marker are displayed.

#### **Suffix:**

<n> [Window](#)

<m> [Marker](#)

#### **Parameters:**

<Mode>

#### **POWER**

Result is displayed as an absolute power. The power unit depends on the [CALCulate<n>:UNIT:POWER](#) setting.

#### **DENSITY**

Result is displayed as a density in dBm/Hz.

#### **RPOWER**

This setting is only available for a delta band power marker. The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.

*[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]*

For details see "[Relative band power markers](#)" on page 418.

\*RST: POWER

**Manual operation:** See "[Power Mode](#)" on page 420

**CALCulate<n>:DELTamarker<m>:FUNCTION:BPOWer:RESult?**

Queries the results of the band power measurement.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<Power> Signal power over the delta marker bandwidth.

**Usage:** Query only

**CALCulate<n>:DELTamarker<m>:FUNCTION:BPOWer:SPAN <Span>**

Defines the bandwidth around the delta marker position.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Span> Frequency. The maximum span depends on the marker position and R&S ESW model.

\*RST: 5% of current span

Default unit: Hz

**Manual operation:** See ["Span"](#) on page 420

**CALCulate<n>:DELTamarker<m>:FUNCTION:BPOWer[:STATe] <State>**

Turns delta markers for band power measurements on and off.

If necessary, the command also turns on a reference marker.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Manual operation:** See ["Band Power Measurement State"](#) on page 420  
See ["Switching All Band Power Measurements Off"](#) on page 421

**CALCulate<n>:MARKer<m>:FUNCTION:BPOWer:RESult?**

Queries the results of the band power measurement.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Return values:**

<Power> Signal power over the marker bandwidth.

**Example:**

Activate the band power marker:

CALC:MARK:FUNC:BPOW:STAT ON

Select the density mode for the result:

CALC:MARK:FUNC:BPOW:MODE DENS

Query the result:

CALC:MARK:FUNC:BPOW:RES?

Response:

20dBm/Hz

**Usage:** Query only

**CALCulate<n>:MARKer<m>:FUNCTION:BPOWer:SPAN <Span>**

Defines the bandwidth around the marker position.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Span> Frequency. The maximum span depends on the marker position and R&S ESW model.

\*RST: 5% of current span

Default unit: Hz

**Example:**

CALC:MARK:FUNC:BPOW:SPAN 2MHz

Measures the band power over 2 MHz around the marker.

**Manual operation:** See ["Span"](#) on page 420

**CALCulate<n>:MARKer<m>:FUNCTION:BPOWer:MODE <Mode>**

Selects the way the results for a band power marker are displayed.

(Note: relative power results are only available for delta markers,

see [.CALCulate<n>:DELTaMarker<m>:FUNCTION:BPOWer:MODE](#) on page 751

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Mode>

**POWer**

Result is displayed as an absolute power. The power unit depends on the [CALCulate<n>:UNIT:POWer](#) setting.

**DENSity**

Result is displayed as a density in dBm/Hz.

\*RST:       POWer

**Example:**

CALC:MARK4:FUNC:BPOW:MODE DENS

Configures marker 4 to show the measurement results in dBm/Hz.

**Manual operation:** See ["Power Mode"](#) on page 420

**CALCulate<n>:MARKer<m>:FUNCTION:BPOWer[:STATe] <State>**

Turns markers for band power measurements on and off.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<State>

ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK4:FUNC:BPOW:STAT ON

Activates or turns marker 4 into a band power marker.

**Manual operation:** See ["Band Power Measurement State"](#) on page 420  
See ["Switching All Band Power Measurements Off"](#) on page 421

**Marker demodulation**

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:DEModulation:CONTInuous</a> ..... | 754 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:DEModulation:HOLDoff</a> .....    | 755 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:DEModulation:SElect</a> .....     | 755 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:DEModulation[:STATe]</a> .....    | 756 |
| <a href="#">[SENSe:]DEMod:SQUelch:LEVel</a> .....   | 756 |
| <a href="#">[SENSe:]DEMod:SQUelch[:STATe]</a> .....                                       | 757 |

**CALCulate<n>:MARKer<m>:FUNCTION:DEModulation:CONTInuous <State>**

Turns continuous demodulation of the signal at the marker position in the frequency domain on and off.

In the time domain continuous demodulation is always on.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC2:MARK3:FUNC:DEM:CONT ON

Switches on the continuous demodulation.

**Manual operation:** See ["Continuous Demodulation"](#) on page 422**CALCulate<n>:MARKer<m>:FUNCTION:DEModulation:HOLDoff <Duration>**

Defines for how long the the signal at the marker position is demodulated.

In the time domain continuous demodulation is always on.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

<Duration> Range: 10 ms to 1000 s  
 \*RST: Marker demodulation = OFF  
 Default unit: S

**Example:**

CALC:MARK:FUNC:DEM:HOLD 3s

**Manual operation:** See ["Marker Stop Time"](#) on page 423**CALCulate<n>:MARKer<m>:FUNCTION:DEModulation:SElect <DemodMode>**

Selects the demodulation mode at the marker position.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

<DemodMode> **AM**  
 AM demodulation  
**FM**  
 FM demodulation  
**PM**  
 FM demodulation

**AC**

AC video demodulation

**AUDio**

Audio demodulation

\*RST: AM

**Example:** CALC:MARK:FUNC:DEM:SEL FM**Manual operation:** See ["Modulation"](#) on page 423**CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe] <State>**

Turns the audio demodulator on and off when the measurement reaches a marker position.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:** CALC:MARK3:FUNC:DEM ON  
Switches on the demodulation for marker 3.**Manual operation:** See ["Marker Demodulation State"](#) on page 422**[SENSe:]DEMod:SQUElch:LEVel <Level>**

This command defines the relative squelch level for audio output, below which the output is not demodulated.

If you are using the "Marker Demodulation" marker function in the spectrum application, the command instead selects the level below which the signal at the marker position is not demodulated.

**Parameters:**<Level> <numeric value>  
Default unit: PCT**Example:** //Configure squelch for audio output  
DEM:SQU ON  
DEM:SQU:LEV 10**Manual operation:** See ["Squelch Level"](#) on page 423



**[SENSe:]DEMod:SQUelch[:STATe] <State>**

This command turns a squelch for the audio output on and off.

The squelch is available for the following outputs.

- AM
- FM

If you are using the "Marker Demodulation" marker function in the spectrum application, the command instead turns selective demodulation at the marker position on and off. For selective demodulation, the R&S ESW turns on a video trigger whose level corresponds to the squelch level. Therefore it turns off other triggers or gates.

In both cases, you can define the squelch level with [\[SENSe:\]DEMod:SQUelch:LEVel](#).

**Parameters:**

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

**Example:**

```
//Configure squelch for audio output
DEMod:SQU ON
DEMod:SQU:LEV 10
```

**Manual operation:** See ["Squelch"](#) on page 423

**Marker peak list**

|   |     |
|---|-----|
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:ANNotation:LABel[:STATe]</a> ..... | 757 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:COUNt?</a> .....                   | 758 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks[:IMMediate]</a> .....              | 758 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:LIST:SIZE</a> .....                | 758 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:SORT</a> .....                     | 759 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:STATe</a> .....                    | 759 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:X?</a> .....                       | 760 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FPEaks:Y?</a> .....                       | 760 |
| <a href="#">CALCulate&lt;n&gt;:MARKer&lt;m&gt;:FUNCTION:FMEasurement:PEAKsearch:AUTO</a> .....    | 760 |
| <a href="#">MMEMory:STORe&lt;n&gt;:PEAK</a> .....   | 761 |

**CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:ANNotation:LABel[:STATe] <State>**

Turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

**Suffix:**

<n>                    [Window](#)  
<m>                    [Marker](#)

**Parameters:**

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

**Example:** `CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF`  
Removes the peak labels from the diagram

**Manual operation:** See ["Display Marker Numbers"](#) on page 427

### **CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:COUNT?**

Queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<NumberOfPeaks>

**Example:** `CALC:MARK:FUNC:FPE:COUN?`  
Queries the number of peaks.

**Usage:** Query only

### **CALCulate<n>:MARKer<m>:FUNCTION:FPEaks[:IMMEDIATE] <Peaks>**

Initiates a peak search.

**Suffix:**

<n> [Window](#)

<m> [Marker](#)

**Parameters:**

<Peaks> This parameter defines the number of peaks to find during the search.

Note that the actual number of peaks found during the search also depends on the peak excursion you have set with

[CALCulate<n>:MARKer<m>:PEXCursion](#).

Range: 1 to 200

**Example:** `CALC:MARK:PEXC 5`  
Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.  
`CALC:MARK:FUNC:FPE 10`  
Initiates a search for 10 peaks on the current trace.

### **CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:LIST:SIZE <MaxNoPeaks>**

Defines the maximum number of peaks that the R&S ESW looks for during a peak search.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

&lt;MaxNoPeaks&gt; Maximum number of peaks to be determined.

Range: 1 to 500

\*RST: 50

**Example:**

CALC:MARK:FUNC:FPE:LIST:SIZE 10

The marker peak list will contain a maximum of 10 peaks.

**Manual operation:** See ["Maximum Number of Peaks"](#) on page 427**CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT <SortMode>**

Selects the order in which the results of a peak search are returned.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**<SortMode> **X**

Sorts the peaks according to increasing position on the x-axis.

**Y**

Sorts the peaks according to decreasing position on the y-axis.

\*RST: X

**Example:**

CALC:MARK:FUNC:FPE:SORT Y

Sets the sort mode to decreasing y values

**Manual operation:** See ["Sort Mode"](#) on page 427**CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe <State>**

Turns a peak search on and off.

**Suffix:**<n> [Window](#)<m> [Marker](#)**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:MARK:FUNC:FPE:STAT ON

Activates marker peak search

**Manual operation:** See ["Peak List State"](#) on page 426

---

### CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:X?

Queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with [CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:SORT](#).

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

**Usage:** Query only

---

### CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:Y?

Queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with [CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:SORT](#).

**Suffix:**

<n> irrelevant

<m> irrelevant

**Return values:**

<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

**Usage:** Query only

---

### CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:PEAKsearch:AUTO <State>

Turns an automatic peak search on and off. If enabled, the search is performed automatically after each sweep.

**Suffix:**

<n> irrelevant

<m> irrelevant

**Parameters:**

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

**Example:**

CALC:MARK:FUNC:FME:PEAK:AUTO ON  
Activates automatic marker peak search after each sweep.

**Manual operation:** See ["Automatic Peak Search"](#) on page 211

---

### MMEMory:STORe<n>:PEAK <FileName>

Exports the marker peak list to a file.

#### Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "memory limit reached" 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 ESW User Manual.

#### Suffix:

<n> [Window](#)

#### Parameters:

<FileName> String containing the path,name and extension of the target file.

#### Example:

MMEM:STOR:PEAK 'test.dat'

Saves the current marker peak list in the file test.dat.

**Manual operation:** See ["Export Peak List"](#) on page 427

### 6.9.3.8 Programming examples for using markers and marker functions

Various programming examples on how to use markers and the special marker functions are provided here.



The use of spectrogram markers is demonstrated in [Chapter 6.9.2.7, "Programming example: configuring a spectrogram"](#), on page 711.

- [Example: basic markers](#).....762
- [Example: marker search in spectrograms](#).....763
- [Basic frequency sweep measurement for marker function examples](#).....764
- [Example: using a fixed reference marker](#).....764
- [Example: obtaining a marker peak list](#).....765
- [Example: measuring noise density](#).....765
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- [Example: measuring the power in a channel using band power markers](#).....767
- [Example: measuring characteristic bandwidths \(using the n db down marker\)](#)....767
- [Examples: demodulating marker values and providing audio output](#).....768
- [Example: performing a highly accurate frequency measurement using the signal count marker](#).....769

**Example: basic markers**

This example demonstrates how to configure and define markers for a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617 has been performed and thus does not begin by presetting the instrument.

```
//-----Configuring marker behavior -----
DISP:MTAB ON
//Marker information is always displayed in a separate table.
CALC:MARK:X:SSIZ STAN
//The marker moves from one pixel to the next instead of sweep points in manual op.
CALC:MARK:PEXC 6dB
//Defines a peak excursion of 6 dB.
CALC:MARK:X:SLIM ON
CALC:MARK:X:SLIM:LEFT 50MHz
CALC:MARK:X:SLIM:RIGH 150MHz
//Restricts the search area for peaks to the frequencies between 50 and 150 MHz.
CALC:THR -100dBm
CALC:THR:STAT ON
//Configures a threshold level for peak searches at -100 dBm.

//-----Defining and positioning markers -----
CALC:MARK1 ON
//Activates marker 1 and sets it to the peak of trace 1.
CALC:MARK2:TRAC 2
//Activates marker 2 and sets it to the peak of trace 2.
CALC:MARK3:X 150MHz
//Activates marker 3 and sets it to the freq. 150 MHz on trace 1.
CALC:MARK4:TRAC 4
//Activates marker 4 and sets it to the peak of trace 4.

CALC:MARK1:MAX:AUTO ON
//Moves M1 to the current peak of trace 1 after each sweep.
CALC:MARK2:MAX:NEXT
//Moves M2 to the next lower peak of trace 2.

CALC:DELT5 ON
CALC:DELT5:LINK ON
//Activates delta marker 5 and links it to marker 1. If M1 moves, so does D5.
CALC:DELT5:MREF 4
//Changes the reference for D5 to marker 4. D5 now shows the difference between
//the peak of trace 1 after each sweep and the value at the same position in
//trace 4, which is a copy of trace 1, averaged over 10 sweeps.
CALC:DELT5:MODE REL
//Shows the difference as relative values.

CALC:DELT6 ON
CALC:DELT6:MAX:NEXT
```

```
//Activates delta marker 6 and sets it to the next lower maximum of trace 1.
//Thus it shows the difference between the two highest peaks in trace 1.

//-----Retrieving marker values -----
CALC:MARK1:Y?
CALC:MARK2:Y?
CALC:MARK3:Y?
CALC:MARK4:Y?
CALC:DELT5:Y?
CALC:DELT6:Y?
//Retrieves the marker levels of each active normal and delta marker.
CALC:DELT5:X:REL?
CALC:DELT6:X:REL?
//Retrieves the frequency difference between the delta marker and marker 1.

//-----Deactivating all markers -----
//CALC:MARK:AOFF
//CALC:DELT:AOFF
```

### Example: marker search in spectrograms

This example demonstrates how to search for peak values in spectrograms in a remote environment. It assumes a spectrogram is already available (see [Chapter 6.9.2.7, "Programming example: configuring a spectrogram"](#), on page 711) and thus does not begin by presetting the instrument.

```
//----- Analyzing the results using markers -----
//Set marker1 on the peak power in the most recent spectrum and query
//its position
CALC2:SPEC:FRAM:SEL 0
CALC2:MARK1 ON
CALC2:MARK1:X?
CALC2:MARK1:Y?

//Set marker2 on the peak power in frame at -324ms and query its position
CALC2:MARK2 ON
CALC2:MARK2:SGR:FRAM -324ms
CALC2:MARK2:X?
CALC2:MARK2:Y?

//Set marker3 on peak power level in the entire spectrogram in memory and
//query its position
CALC2:MARK3 ON
CALC2:MARK:SPEC:SAR MEM
CALC2:MARK3:SPEC:XY:MAX
CALC2:MARK3:X?
CALC2:MARK3:Y?

//Move marker 3 to the next lower peak level for the same frequency
CALC2:MARK3:SPEC:Y:MAX:NEXT
CALC2:MARK3:X?
```

```
CALC2:MARK3:Y?
```

```
//Set marker 4 to the highest level in the (visible) spectrogram.
CALC2:MARK:SPEC:SAR VIS
CALC2:MARK4:SPEC:XY:MAX
//Move marker 4 to the next higher level in the frames above its current position.
CALC2:MARK4:SPEC:Y:MAX:ABOV
```

### Basic frequency sweep measurement for marker function examples

Since markers can only be placed on an existing trace, the following example provides a simple frequency sweep measurement to be used as a basis for the subsequent marker function scripts.

```
//----- Configuring the basic frequency sweep -----
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.
DISP:TRAC1:Y:RLEV 0dBm
//Sets the reference level to 0 dBm.

//----- Performing the measurement -----
INIT;*WAI
//Performs a measurement and waits for it to end
```

### Example: using a fixed reference marker

This example demonstrates how to configure and use reference markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "[Basic frequency sweep measurement for marker function examples](#)" on page 764 has been performed and thus does not begin by presetting the instrument.

```
//-----Configuring the reference marker -----
//Activate a fixed reference marker. It is set to the current maximum of trace 1.
CALC:DELT:FUNC:FIX ON
//Set the reference frequency to 128 MHz.
CALC:DELT:FUNC:FIX:RPO:X 128 MHZ
//Set the reference level to +30 dBm.
CALC:DELT:FUNC:FIX:RPO:Y 30 DBM

//Use the fixed reference marker as a reference for deltamarker 2
CALC:DELT2:MREF FIX

//Reset the reference marker to the current maximum of trace 1
CALC:DELT:FUNC:FIX:RPO:MAX
//Query the new position of the reference marker
```



```
CALC:DELT:FUNC:FIX:RPO:X?
CALC:DELT:FUNC:FIX:RPO:Y?
```

### Example: obtaining a marker peak list

This example demonstrates how to obtain a marker peak list in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 764 has been performed and thus does not begin by presetting the instrument.

In this example, the peak search is restricted to the frequency range of 50 MHz to 150 MHz. The top 5 power levels with a peak excursion of 10dB and a minimum of -100 dBm are to be determined and displayed with their marker numbers. The results are sorted by frequency values. The resulting peak list is then exported to a file.

```
//----- Configuring the peak search -----
CALC:MARK:X:SLIM ON
CALC:MARK:X:SLIM:LEFT 50MHz
CALC:MARK:X:SLIM:RIGH 150MHz
CALC:MARK:PEXC 10DB
CALC:THR -100DBM
CALC:THR:STAT ON

CALC:MARK:FUNC:FPE:STAT ON
CALC:MARK:FUNC:FPE:LIST:SIZE 5
CALC:MARK:FUNC:FPE:SORT X
CALC:MARK:FUNC:FPE:ANN:LAB ON

//----- Retrieving results -----
CALC:MARK:FUNC:FPE:COUN?
CALC:MARK:FUNC:FPE:X?
CALC:MARK:FUNC:FPE:Y?

//----- Exporting the peak list -----
MMEM:STOR:PEAK 'PeakList'
```

### Example: measuring noise density

This example demonstrates how to measure noise density using noise markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 764 has been performed and thus does not begin by presetting the instrument.

```
CALC:MARK1:FUNC:NOIS ON
//Switches on noise measurement at marker 1.

INIT;*WAI
//Performs a measurement and waits for it to end
```

```
CALC:MARK1:FUNC:NOIS:RES?
//Queries the measured noise level (per Hz bandwidth)
```

### Example: measuring phase noise

This example demonstrates how to measure phase noise using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 764 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the phase noise marker -----
DET SAMP
//Switches to Sample detector

CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level

CALC:DELT:FUNC:PNO ON
//Activates phase noise marker function

CALC:DELT1 ON
CALC:DELT1:X 100kHz

CALC:DELT2 ON
CALC:DELT2:X 500kHz

CALC:DELT3 ON
CALC:DELT3:X 1MHz

CALC:DELT4 ON
CALC:DELT4:X 1.5MHz

//Activates the phase noise measurement function for offsets 100kHz/500kHz/1MHz/1.5MHz.

BAND:VID?
//Queries the used VBW (= 0.1*RBW)

//----- Querying the phase noise results -----

CALC:DELT1:FUNC:PNO:RES?
CALC:DELT2:FUNC:PNO:RES?
CALC:DELT3:FUNC:PNO:RES?
CALC:DELT4:FUNC:PNO:RES?
//Queries the difference in level between the peak and the noise power density
//measured at the deltamarkers, referred to the carrier power level (dBc)
```

### Example: measuring the power in a channel using band power markers

This example demonstrates how to measure the power in a specific channel or band using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 764 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the band power marker -----
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around marker 1
CALC:MARK1:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:MARK1:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

CALC:DELT2 ON
//Activates deltamarker2
CALC:DELT2:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around deltamarker 2
CALC:DELT2:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:DELT2:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

CALC:DELT3 ON
//Activates deltamarker3
CALC:DELT3:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around deltamarker 3
CALC:DELT3:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:DELT3:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

//-----Retrieving Results-----
CALC:MARK1:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around marker 1.
CALC:DELT2:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around deltamarker 2.
CALC:DELT3:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around deltamarker 3.
```

### Example: measuring characteristic bandwidths (using the n db down marker)

This example demonstrates how to measure a characteristic bandwidth using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the n dB down marker -----
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:NDBD 3DB
//Sets the level offset to 3 dB
CALC:MARK1:FUNC:NDBD:STAT ON
//Activates the n dB down measurement

//-----Retrieving Results-----
CALC:MARK:FUNC:NDBD:RES?
//Returns the bandwidth at the specified power offset.
CALC:MARK:FUNC:NDBD:FREQ?
//Returns the frequencies of the temporary markers at the power offsets
CALC:MARK:FUNC:NDBD:QFAC?
//Returns the quality factor of the resulting bandwidth
```

### Examples: demodulating marker values and providing audio output

The following examples demonstrate how to demodulate markers and provide audio output in a remote environment.

- [Example: providing audio output for individual marker values](#)..... 768
- [Example: demodulating and providing audio output continuously](#)..... 769

#### Example: providing audio output for individual marker values

This example demonstrates how to demodulate markers and provide audio output in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617 has been performed and thus does not begin by presetting the instrument.

Audio output is provided for 5s each time the signal reaches its initial maximum, however only if it is higher than -90 dBm (10% of the total y-axis range) in order to ignore noise.

```
//----- Configuring the marker demodulation -----
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:DEM:SEL FM
//Selects FM demodulation
CALC:MARK1:FUNC:DEM:HOLD 5s
//Defines an output duration of 5s
DEM:SQU:LEV 10
//Sets a squelch level for noise
DEM:SQU ON
//Activates squelching
CALC:MARK1:FUNC:DEM ON
//Activates demodulation

//----- Performing the measurement -----
INIT;*WAI
```

```
//Performs a measurement and waits for it to end

//-----Retrieving Results-----
//Results are only provided as audio output!
```

### Example: demodulating and providing audio output continuously

This example demonstrates how to demodulate markers and provide audio output in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the marker demodulation -----
CALC:MARK1 ON
//Activates marker1
CALC:MARK1:FUNC:DEM:SEL FM
//Selects FM demodulation
DEM:SQU:LEV 10
//Sets a squelch level for noise
DEM:SQU ON
//Activates squelching
CALC:MARK1:FUNC:DEM:CONT ON
//Activates continuous demodulation

//----- Performing the measurement -----
INIT:CONT ON
//Performs a measurement and provides continuous audio output

//-----Retrieving Results-----
//Results are only provided as audio output!
```

### Example: performing a highly accurate frequency measurement using the signal count marker

This example demonstrates how to determine highly accurate frequency values using signal count markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.18, "Programming example: performing a basic frequency sweep"](#), on page 617 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the signal count marker -----
CALC:MARK1 ON
//Activates marker1
CALC:MARK1:COUN ON
//Switches on the frequency counter for marker 1.
CALC:MARK1:COUN:RES 1kHz
//Sets the resolution of the frequency counter to 1kHz

//----- Performing the measurement -----
INIT;*WAI
//Performs a measurement and waits for it to end
```

```
//-----Retrieving Results-----
CALC:MARK1:COUN:FREQ?
//Returns the signal counter value as the precise marker frequency.
```

## 6.9.4 Lines

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### 6.9.4.1 Display lines

|  |     |
|--|-----|
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| <a href="#">CALCulate&lt;n&gt;:DLINe&lt;dl&gt;:STATe</a> ..... | 770 |
| <a href="#">CALCulate&lt;n&gt;:FLINe&lt;dl&gt;</a> .....       | 771 |
| <a href="#">CALCulate&lt;n&gt;:FLINe&lt;dl&gt;:STATe</a> ..... | 771 |
| <a href="#">CALCulate&lt;n&gt;:TLINe&lt;dl&gt;</a> .....       | 772 |
| <a href="#">CALCulate&lt;n&gt;:TLINe&lt;dl&gt;:STATe</a> ..... | 772 |

---

#### **CALCulate<n>:DLINe<dl> <Position>**

Defines the (horizontal) position of a display line.

##### **Suffix:**

<n> [Window](#)

<dl> 1 | 2

##### **Parameters:**

<Position> The value range is variable.  
You can use any unit you want, the R&S ESW then converts the unit to the currently selected unit. If you omit a unit, the R&S ESW uses the currently selected unit.

\*RST: (state is OFF)

Default unit: DBM

##### **Example:**

CALC:DLIN2 -20dBm

Positions the second display line at -20 dBm.

**Manual operation:** See "[Horizontal Line 1/ Horizontal Line 2](#)" on page 434

---

#### **CALCulate<n>:DLINe<dl>:STATe <State>**

Turns a display line on and off

##### **Suffix:**

<n> [Window](#)

<dl> 1 | 2

##### **Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:DLIN2:STAT ON  
Turns on display line 2.

**CALCulate<n>:FLINe<dl> <Frequency>**

Defines the position of a frequency line.

**Suffix:**<n> [Window](#)

<dl> 1 to 4  
frequency line

**Parameters:**

<Frequency> Note that you can not set a frequency line to a position that is outside the current span.

Range: 0 Hz to Fmax

\*RST: (STATe to OFF)

Default unit: HZ

**Example:**

CALC:FLIN2 120MHz  
Sets frequency line 2 to a frequency of 120 MHz.

**Manual operation:** See "[Vertical Line <x>](#)" on page 433

**CALCulate<n>:FLINe<dl>:STATe <State>**

Turns a frequency line on and off

**Suffix:**<n> [Window](#)

<dl> 1 | 2  
frequency line

**Parameters:**

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

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Example:**

CALC:FLIN2:STAT ON  
Turns frequency line 2 on.

**CALCulate<n>:TLINe<dl> <Time>**

Defines the position of a time line.

**Suffix:**

<n> [Window](#)  
 <dl> 1 to 4  
 time line

**Parameters:**

<Time> Note that you can not set a time line to a position that is higher than the current sweep time.  
 Range: 0 s to 1600 s  
 \*RST: (STATe to OFF)  
 Default unit: S

**Example:** CALC:TLIN 10ms  
 Sets the first time line to 10 ms.

**Manual operation:** See "[Vertical Line <x>](#)" on page 433

**CALCulate<n>:TLINe<dl>:STATe <State>**

Turns a time line on and off

**Suffix:**

<n> [Window](#)  
 <dl> 1 | 2  
 time line

**Parameters:**

<State> ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

**Example:** CALC:TLIN:STAT ON  
 Turns the first time line on.

**6.9.4.2 Limit lines**

|  |     |
|--|-----|
| CALCulate<n>:LIMit<li>:ACTive?           | 773 |
| CALCulate<n>:LIMit<li>:CLEar[:IMMediate] | 773 |
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| CALCulate<n>:LIMit<li>:CONTRol[:DATA]    | 774 |
| CALCulate<n>:LIMit<li>:CONTRol:DOMain    | 774 |
| CALCulate<n>:LIMit<li>:CONTRol:MODE      | 775 |
| CALCulate<n>:LIMit<li>:CONTRol:OFFSet    | 775 |
| CALCulate<n>:LIMit<li>:CONTRol:SHIFt     | 776 |
| CALCulate<n>:LIMit<li>:CONTRol:SPACing   | 776 |



|   |     |
|---|-----|
| CALCulate<n>:LIMit<li>:COPY.....            | 776 |
| CALCulate<n>:LIMit<li>:DELeTe.....          | 777 |
| CALCulate<n>:LIMit<li>:FAIL?.....           | 777 |
| CALCulate<n>:LIMit<li>:LOWer[:DATA].....    | 777 |
| CALCulate<n>:LIMit<li>:LOWer:MARGIn.....    | 778 |
| CALCulate<n>:LIMit<li>:LOWer:MODE.....      | 778 |
| CALCulate<n>:LIMit<li>:LOWer:OFFSet.....    | 779 |
| CALCulate<n>:LIMit<li>:LOWer:SHIFt.....     | 779 |
| CALCulate<n>:LIMit<li>:LOWer:SPACIng.....   | 779 |
| CALCulate<n>:LIMit<li>:LOWer:STATe.....     | 780 |
| CALCulate<n>:LIMit<li>:LOWer:THReshold..... | 780 |
| CALCulate<n>:LIMit<li>:NAME.....            | 780 |
| CALCulate<n>:LIMit<li>:STATe.....           | 781 |
| CALCulate<n>:LIMit<li>:TRACe<t>.....        | 781 |
| CALCulate<n>:LIMit<li>:TRACe<t>:CHECK.....  | 782 |
| CALCulate<n>:LIMit<li>:UNIT.....            | 782 |
| CALCulate<n>:LIMit<li>:UPPer[:DATA].....    | 783 |
| CALCulate<n>:LIMit<li>:UPPer:MARGIn.....    | 783 |
| CALCulate<n>:LIMit<li>:UPPer:MODE.....      | 783 |
| CALCulate<n>:LIMit<li>:UPPer:OFFSet.....    | 784 |
| CALCulate<n>:LIMit<li>:UPPer:SHIFt.....     | 784 |
| CALCulate<n>:LIMit<li>:UPPer:SPACIng.....   | 784 |
| CALCulate<n>:LIMit<li>:UPPer:STATe.....     | 785 |
| CALCulate<n>:LIMit<li>:UPPer:THReshold..... | 785 |
| MMEMory:COPY.....                           | 785 |
| MMEMory:LOAD<n>:LIMit.....                  | 786 |
| MMEMory:STORe<n>:LIMit.....                 | 786 |
| CALCulate<n>:LIMit<li>:CHECK.....           | 786 |

---

### CALCulate<n>:LIMit<li>:ACTive?

Queries the names of *all* active limit lines.

#### Suffix:

|      |            |
|------|------------|
| <n>  | irrelevant |
| <li> | irrelevant |

#### Return values:

|              |  |
|--------------|--|
| <LimitLines> | String containing the names of all active limit lines in alphabetical order. |
|--------------|--|

#### Example:

CALC:LIM:ACT?

Queries the names of all active limit lines.

#### Usage:

Query only

**Manual operation:** See "[Visibility](#)" on page 441

---

### CALCulate<n>:LIMit<li>:CLEar[:IMMediate]

Deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time.

**Suffix:**

<n> [Window](#)

<li> irrelevant

**Example:**

CALC:LIM:CLE

Deletes the result of the limit check.

**CALCulate<n>:LIMit<li>:COMMeNT <Comment>**

Defines a comment for a limit line.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<Comment> String containing the description of the limit line.

**Manual operation:** See "[Comment](#)" on page 443

**CALCulate<n>:LIMit<li>:CONTRol[:DATA] <LimitLinePoints>...**

Defines the horizontal definition points of a limit line.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<LimitLinePoints> Variable number of x-axis values.  
 Note that the number of horizontal values has to be the same as the number of vertical values set with [CALCulate<n>:LIMit<li>:LOWer\[:DATA\]](#) or [CALCulate<n>:LIMit<li>:UPPer\[:DATA\]](#). If not, the R&S ESW either adds missing values or ignores surplus values.  
 The unit is Hz or s.

\*RST: -

Default unit: HZ

**Manual operation:** See "[Data Points](#)" on page 444

**CALCulate<n>:LIMit<li>:CONTRol:DOMain <SpanSetting>**

Selects the domain of the limit line.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<SpanSetting> FREQUENCY | TIME

**FREQUENCY**

For limit lines that apply to a range of frequencies.

**TIME**

For limit lines that apply to a period of time.

\*RST: FREQUENCY

**Example:**

CALC:LIM:CONT:DOM FREQ

Select a limit line in the frequency domain.

**Manual operation:** See ["X-Axis"](#) on page 444

**CALCulate<n>:LIMit<li>:CONTrol:MODE <Mode>**

Selects the horizontal limit line scaling.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<Mode>

**ABSolute**

Limit line is defined by absolute physical values (Hz or s).

**RELative**

Limit line is defined by relative values related to the center frequency (frequency domain) or the left diagram border (time domain).

\*RST: ABSolute

**Manual operation:** See ["X-Axis"](#) on page 444

**CALCulate<n>:LIMit<li>:CONTrol:OFFSet <Offset>**

Defines an offset for a complete limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<Offset>

Numeric value.

The unit depends on the scale of the x-axis.

\*RST: 0

Default unit: HZ

**Manual operation:** See ["X-Offset"](#) on page 441

---

#### **CALCulate<n>:LIMit<li>:CONTrol:SHIFt <Distance>**

Moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

##### **Suffix:**

<n> irrelevant

<li> [Limit line](#)

##### **Parameters:**

<Distance> Numeric value.  
The unit depends on the scale of the x-axis.  
Default unit: HZ

**Manual operation:** See ["Shift x"](#) on page 445

---

#### **CALCulate<n>:LIMit<li>:CONTrol:SPACing <InterpolMode>**

Selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

##### **Suffix:**

<n> [Window](#)

<li> [Limit line](#)

##### **Parameters:**

<InterpolMode> LINear | LOGarithmic  
\*RST: LIN

**Example:** CALC:LIM:CONT:SPAC LIN

**Manual operation:** See ["X-Axis"](#) on page 444

---

#### **CALCulate<n>:LIMit<li>:COPY <Line>**

Copies a limit line.

##### **Suffix:**

<n> [Window](#)

<li> [Limit line](#)

##### **Parameters:**

<Line> **1 to 8**  
number of the new limit line  
**<name>**  
String containing the name of the limit line.

**Example:** `CALC:LIM1:COPY 2`  
 Copies limit line 1 to line 2.  
`CALC:LIM1:COPY 'FM2'`  
 Copies limit line 1 to a new line named FM2.

**Manual operation:** See ["Copy Line"](#) on page 442

### **CALCulate<n>:LIMit<li>:DELeTe**

Deletes a limit line.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Manual operation:** See ["Delete Line"](#) on page 442

### **CALCulate<n>:LIMit<li>:FAIL?**

Queries the result of a limit check in the specified window.

Note that for SEM measurements, the limit line suffix <li> is irrelevant, as only one specific SEM limit line is checked for the currently relevant power class.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Return values:**

<Result>      **0**  
                  PASS  
                  **1**  
                  FAIL

**Example:** `INIT;*WAI`  
 Starts a new sweep and waits for its end.  
`CALC2:LIM3:FAIL?`  
 Queries the result of the check for limit line 3 in window 2.

**Usage:** Query only

**Manual operation:** See ["Limit Check <n>"](#) on page 119  
 See ["Limit Check"](#) on page 153

### **CALCulate<n>:LIMit<li>:LOWer[:DATA] <LimitLinePoints>...**

Defines the vertical definition points of a lower limit line.

**Suffix:**

&lt;n&gt; irrelevant

<li> [Limit line](#)**Parameters:**

<LimitLinePoints> Variable number of level values.  
 Note that the number of vertical values has to be the same as the number of horizontal values set with [CALCulate<n>:LIMit<li>:CONTrol\[:DATA\]](#). If not, the R&S ESW either adds missing values or ignores surplus values.  
 The unit depends on [CALCulate<n>:LIMit<li>:UNIT](#) on page 782.

\*RST: Limit line state is OFF  
 Default unit: DBM

**Manual operation:** See ["Data Points"](#) on page 444

**CALCulate<n>:LIMit<li>:LOWer:MARGin <Margin>**

Defines an area around a lower limit line where limit check violations are still tolerated.

**Suffix:**

&lt;n&gt; irrelevant

<li> [Limit line](#)**Parameters:**

<Margin> **numeric value**  
 \*RST: 0  
 Default unit: dB

**Manual operation:** See ["Margin"](#) on page 444

**CALCulate<n>:LIMit<li>:LOWer:MODE <Mode>**

Selects the vertical limit line scaling.

**Suffix:**<n> [Window](#)<li> [Limit line](#)**Parameters:**

<Mode> **ABSolute**  
 Limit line is defined by absolute physical values.  
 The unit is variable.

**RELative**  
 Limit line is defined by relative values related to the reference level (dB).  
 \*RST: ABSolute

**Manual operation:** See ["Y-Axis"](#) on page 444

**CALCulate<n>:LIMit<li>:LOWer:OFFSet <Offset>**

Defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Parameters:**

<Offset> Numeric value.

\*RST: 0

Default unit: dB

**Manual operation:** See ["Y-Offset"](#) on page 442

**CALCulate<n>:LIMit<li>:LOWer:SHIFt <Distance>**

Moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Parameters:**

<Distance> Defines the distance that the limit line moves.

The unit depends on [CALCulate<n>:LIMit<li>:UNIT](#) on page 782.

Default unit: DB

**Manual operation:** See ["Shift y"](#) on page 445

**CALCulate<n>:LIMit<li>:LOWer:SPACing <InterpolType>**

Selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Parameters:**

<InterpolType> LINear | LOGarithmic

\*RST: LIN

**Manual operation:** See ["Y-Axis"](#) on page 444

**CALCulate<n>:LIMit<li>:LOWer:STATe <State>**

Turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with [CALCulate<n>:LIMit<li>:NAME](#) on page 780.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

**Manual operation:** See "[Visibility](#)" on page 441

**CALCulate<n>:LIMit<li>:LOWer:THReshold <Threshold>**

Defines a threshold for relative limit lines.

The R&S ESW uses the threshold for the limit check, if the limit line violates the threshold.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<Threshold> Numeric value.  
The unit depends on [CALCulate<n>:LIMit<li>:UNIT](#) on page 782.

\*RST: -200 dBm

Default unit: DBM

**Manual operation:** See "[Threshold](#)" on page 443

**CALCulate<n>:LIMit<li>:NAME <Name>**

Selects a limit line that already exists or defines a name for a new limit line.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Parameters:**

<Name> String containing the limit line name.

\*RST: REM1 to REM8 for lines 1 to 8



**Manual operation:** See ["Name"](#) on page 443

---

### **CALCulate<n>:LIMit<li>:STATe <State>**

Turns the limit check for a specific limit line on and off.

To query the limit check result, use [CALCulate<n>:LIMit<li>:FAIL?](#).

Note that a new command exists to activate the limit check and define the trace to be checked in one step (see [CALCulate<n>:LIMit<li>:TRACe<t>:CHECK](#) on page 782).

#### **Suffix:**

<n> irrelevant

<li> [Limit line](#)

#### **Parameters:**

<State> ON | OFF | 0 | 1

**OFF | 0**

Switches the function off

**ON | 1**

Switches the function on

#### **Example:**

`CALC:LIM:STAT ON`

Switches on the limit check for limit line 1.

**Manual operation:** See ["Disable All Lines"](#) on page 442

---

### **CALCulate<n>:LIMit<li>:TRACe<t> <TraceNumber>**

Links a limit line to one or more traces.

Note that this command is maintained for compatibility reasons only. Limit lines no longer need to be assigned to a trace explicitly. The trace to be checked can be defined directly (as a suffix) in the new command to activate the limit check (see [CALCulate<n>:LIMit<li>:TRACe<t>:CHECK](#) on page 782).

#### **Suffix:**

<n> [Window](#)

<li> [Limit line](#)

<t> irrelevant

#### **Parameters:**

<TraceNumber> 1 to 6

\*RST: 1

#### **Example:**

`CALC:LIM2:TRAC 3`

Assigns limit line 2 to trace 3.

**CALCulate<n>:LIMit<li>:TRACe<t>:CHECK <State>**

Turns the limit check for a specific trace on and off.

To query the limit check result, use `CALCulate<n>:LIMit<li>:FAIL?`.

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- `CALCulate<n>:LIMit<li>:TRACe<t>` on page 781
- `CALCulate<n>:LIMit<li>:STATE` on page 781

**Suffix:**

|      |                            |
|------|----------------------------|
| <n>  | <a href="#">Window</a>     |
| <li> | <a href="#">Limit line</a> |
| <t>  | <a href="#">Trace</a>      |

**Parameters:**

|         |                           |
|---------|---------------------------|
| <State> | ON   OFF   0   1          |
|         | <b>OFF   0</b>            |
|         | Switches the function off |
|         | <b>ON   1</b>             |
|         | Switches the function on  |

**Example:**

`CALC:LIM3:TRAC2:CHECK ON`  
Switches on the limit check for limit line 3 on trace 2.

**Manual operation:** See ["Traces to be Checked"](#) on page 441

**CALCulate<n>:LIMit<li>:UNIT <Unit>**

Defines the unit of a limit line.

**Suffix:**

|      |                            |
|------|----------------------------|
| <n>  | irrelevant                 |
| <li> | <a href="#">Limit line</a> |

**Parameters:**

|        |   |
|--------|---|
| <Unit> | DBM   DBPW   WATT   DBUV   DBMV   VOLT   DBUA   AMPere   DB   DBUV_M   DBUA_M   DBM_hz   DBM_mhz   DBUV_mhz   DBMV_mhz   DBUa_mhz   DBUV_m   DBUa_m   DBUV_mmhz   DBUa_mmhz   DBPW_mhz   DBPT_mhz   DBPT   (unitless) |
|        | If you select a dB-based unit for the limit line, the command automatically turns the limit line into a relative limit line.  |
|        | *RST: DBM   |

**Manual operation:** See ["Y-Axis"](#) on page 444

**CALCulate<n>:LIMit<li>:UPPer[:DATA] <LimitLinePoints>...**

Defines the vertical definition points of an upper limit line.

**Suffix:**

<n> irrelevant  
 <li> [Limit line](#)

**Parameters:**

<LimitLinePoints> Variable number of level values.  
 Note that the number of vertical values has to be the same as the number of horizontal values set with [CALCulate<n>:LIMit<li>:CONTrol\[:DATA\]](#). If not, the R&S ESW either adds missing values or ignores surplus values.  
 The unit depends on [CALCulate<n>:LIMit<li>:UNIT](#) on page 782.  
 \*RST: Limit line state is OFF  
 Default unit: DBM

**Manual operation:** See ["Data Points"](#) on page 444

**CALCulate<n>:LIMit<li>:UPPer:MARGin <Margin>**

Defines an area around an upper limit line where limit check violations are still tolerated.

**Suffix:**

<n> irrelevant  
 <li> [Limit line](#)

**Parameters:**

<Margin> **numeric value**  
 \*RST: 0  
 Default unit: dB

**Manual operation:** See ["Margin"](#) on page 444

**CALCulate<n>:LIMit<li>:UPPer:MODE <Mode>**

Selects the vertical limit line scaling.

**Suffix:**

<n> [Window](#)  
 <li> [Limit line](#)

**Parameters:**

<Mode> **ABSolute**  
 Limit line is defined by absolute physical values.  
 The unit is variable.

**RELative**

Limit line is defined by relative values related to the reference level (dB).

\*RST: ABSolute

**Manual operation:** See "Y-Axis" on page 444

**CALCulate<n>:LIMit<li>:UPPer:OFFSet <Offset>**

Defines an offset for a complete upper limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<Offset> Numeric value.

\*RST: 0

Default unit: dB

**Manual operation:** See "Y-Offset" on page 442

**CALCulate<n>:LIMit<li>:UPPer:SHIFt <Distance>**

Moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

**Suffix:**

<n> irrelevant

<li> [Limit line](#)

**Parameters:**

<Distance> Defines the distance that the limit line moves.

The unit depends on [CALCulate<n>:LIMit<li>:UNIT](#) on page 782.

**Manual operation:** See "Shift y" on page 445

**CALCulate<n>:LIMit<li>:UPPer:SPACing <InterpolType>**

Selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

**Suffix:**

<n> [Window](#)

<li> [Limit line](#)

**Parameters:**

<InterpolType>      LINear | LOGarithmic  
 \*RST:                LIN

**Manual operation:**    See "[Y-Axis](#)" on page 444

**CALCulate<n>:LIMit<li>:UPPer:STATe <State>**

Turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with [CALCulate<n>:LIMit<li>:NAME](#) on page 780.

**Suffix:**

<n>                      irrelevant  
 <li>                     [Limit line](#)

**Parameters:**

<State>                ON | OFF | 0 | 1  
**OFF | 0**  
 Switches the function off  
**ON | 1**  
 Switches the function on

**Manual operation:**    See "[Visibility](#)" on page 441

**CALCulate<n>:LIMit<li>:UPPer:THReshold <Limit>**

Defines an absolute limit for limit lines with a relative scale.

The R&S ESW uses the threshold for the limit check, if the limit line violates the threshold.

**Suffix:**

<n>                      irrelevant  
 <li>                     [Limit line](#)

**Parameters:**

<Limit>                Numeric value.  
 The unit depends on [CALCulate<n>:LIMit<li>:UNIT](#) on page 782.  
 \*RST:                -200  
 Default unit: dBm

**Manual operation:**    See "[Threshold](#)" on page 443

**MMEMory:COpy <FileName>, <FileName>**

This command copies one or more files to another directory.

**Parameters:**

- <FileName> String containing the path and file name of the source file. Special behavior if optional external mixer is active and the destination is C:\R\_S\Instr\User\cv1\: the contents of the entire folder are copied. For details, see ["Conversion loss tables"](#) on page 258.
- <FileName> String containing the path and name of the target file. The path may be relative or absolute.

**Manual operation:** See ["Import Table"](#) on page 271

**MMEMory:LOAD<n>:LIMit <FileName>**

Loads the limit line from the selected file in .CSV format.

**Suffix:**

- <n> irrelevant

**Parameters:**

- <FileName> String containing the path and name of the CSV import file.

**Example:** MMEM:LOAD:LIM 'C:\TEST.CSV'

**Manual operation:** See ["Import"](#) on page 445

**MMEMory:STORe<n>:LIMit <FileName>, <LimitLineName>**

Exports limit line data to an ASCII (CSV) file.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 450.

**Suffix:**

- <n> irrelevant

**Parameters:**

- <FileName> String containing the path and name of the target file.
- <LimitLineName> Name of the limit line to be exported.

**Example:** MMEM:STOR:LIM 'C:\TEST', 'UpperLimitLine'  
Stores the limit line named "UpperLimitLine" in the file TEST.CSV.

**Manual operation:** See ["Export"](#) on page 446

**CALCulate<n>:LIMit<li>:CHECK <State>**

Checks the limits of all limit lines in pre-measurement.

**Suffix:**

- <n> 1..n  
[Window](#)

|                          |  |
|--------------------------|--|
| <lj>                     | 1..n<br><a href="#">Limit line</a>   |
| <b>Parameters:</b>       |  |
| <State>                  | ON   OFF   0   1<br><b>OFF   0</b><br>Switches the function off.<br><b>ON   1</b><br>Switches the function on. |
| <b>Example:</b>          | //Switch on the limit check<br>CALC:LIMIT:CHECK ON   |
| <b>Manual operation:</b> | See " <a href="#">Limit Check</a> " on page 442  |

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