

R&S[®]ESW

Spectrum Application

User Manual



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

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

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

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

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1 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.

- [Starting the Application](#)..... 11
- [Understanding the Display Information](#)..... 12
- [R&S MultiView](#)..... 13

1.1 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.

1.2 Understanding the Display Information

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

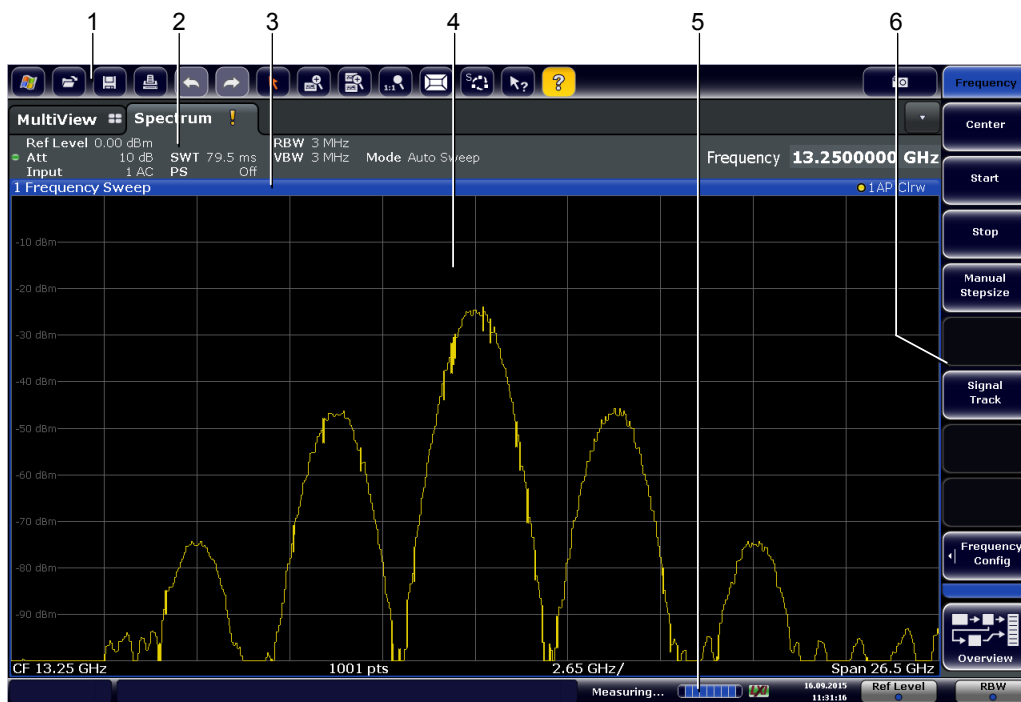


Figure 1-1: Screen layout of the noise figure measurement application

- 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.

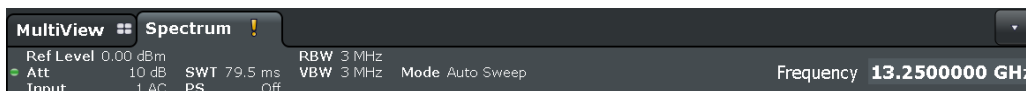


Figure 1-2: Channel bar of the Spectrum application

Ref Level	Reference level of the R&S ESW.
Att	Attenuation of the R&S ESW.
Input	Input and input coupling
SWT	Sweep time

PS	Preselector state
RBW	Resolution bandwidth
VBW	Video bandwidth
Mode	Currently selected measurement mode, including the sweep count.
Frequency	Center frequency

Window title bar information

For each diagram, the header provides the following information:



Figure 1-3: 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.

1.3 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 554

2 Measurements

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
- **Special 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.

• Available Measurement Functions	15
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• Carrier-to-Noise Measurements	89
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• Third Order Intercept (TOI) Measurement	181
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• Electromagnetic Interference (EMI) Measurement	193

2.1 Available Measurement Functions

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. They are selected in the "Select Measurement" dialog box that is displayed when you press the MEAS key or select "Select Measurement" in the configuration "Overview".

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

The easiest way to configure measurements is using the configuration "Overview", see [Chapter 3.2, "Configuration Overview"](#), on page 216.

In addition to the measurement-specific parameters, the general parameters can be configured as usual, see [Chapter 3, "Common Measurement Settings"](#), on page 216. Many measurement functions provide special result displays or evaluation methods;

however, in most cases the general evaluation methods are also available, see [Chapter 4, "Common Analysis and Display Functions"](#), on page 305.

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Frequency Sweep

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

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 3, "Common Measurement Settings"](#), on page 216).

Remote command:

[SENSe:] FREQuency: START on page 584, [SENSe:] FREQuency: STOP on page 585

INITiate<n>[:IMMediate] on page 407

INITiate<n>:CONTInuous on page 409

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 3, "Common Measurement Settings"](#), on page 216).

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 4, "Common Analysis and Display Functions"](#), on page 305).

Remote command:

[SENSe:] FREQuency: SPAN on page 584

INITiate<n>[:IMMediate] on page 407

INITiate<n>:CONTInuous on page 409

Ch Power ACLR

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

For details see [Chapter 2.3, "Channel Power and Adjacent-Channel Power \(ACLR\) Measurement"](#), on page 40.

Remote command:

CALC:MARK:FUNC:POW:SEL ACP, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer:SElect](#) on page 413

Results:

CALC:MARK:FUNC:POW:RES? ACP, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 411

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

C/N, C/No

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

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

For details see [Chapter 2.4, "Carrier-to-Noise Measurements"](#), on page 89.

Remote command:

CALC:MARK:FUNC:POW:SEL CN | CN0 [CALCulate<n>:MARKer<m>:FUNCTION:POWer:SElect](#) on page 413

Results:

CALC:MARK:FUNC:POW:RES? CN | CN0, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 411

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

OBW

Measures the occupied bandwidth, i.e. the bandwidth which must contain a defined percentage of the power, and opens a submenu to configure the measurement. For details see [Chapter 2.5, "Occupied Bandwidth Measurement \(OBW\)"](#), on page 93.

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

Remote command:

CALC:MARK:FUNC:POW:SEL OBW [CALCulate<n>:MARKer<m>:FUNCTION:POWer:SElect](#) on page 413

Results:

CALC:MARK:FUNC:POW:RES? OBW, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 411

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

Spectrum Emission Mask

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

For details see [Chapter 2.6, "Spectrum Emission Mask \(SEM\) Measurement"](#), on page 99.

Remote command:

SENS:SWE:MODE ESP, see [\[SENSe:\]SWEep:MODE](#) on page 455

Results:

CALC:MARK:FUNC:POW:RES? CPOW | PPOW, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 411

CALC:LIM:FAIL?, see [CALCulate<n>:LIMit<k>:FAIL?](#) on page 687

TRACe<n>[:DATA] on page 617

TRACe<n>[:DATA]:X? on page 618

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

Spurious Emissions

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

For details see [Chapter 2.7, "Spurious Emissions Measurement"](#), on page 143.

Remote command:

SENS:SWE:MODE LIST, see [\[SENSe:\]SWEep:MODE](#) on page 455

Results:

TRAC:DATA? SPUR, see [TRACe<n>\[:DATA\]](#) on page 617

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

APD

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

For details see [Chapter 2.8, "Statistical Measurements \(APD, CCDF\)"](#), on page 156.

Remote command:

[CALCulate<n>:STATistics:APD\[:STATe\]](#) on page 503

Results:

[CALCulate<n>:STATistics:RESult<t>?](#) on page 510

CCDF

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

For details see [Chapter 2.8, "Statistical Measurements \(APD, CCDF\)"](#), on page 156.

Remote command:

[CALCulate<n>:STATistics:CCDF\[:STATe\]](#) on page 503

Results:

[CALCulate<n>:STATistics:CCDF:X<t>?](#) on page 509

[CALCulate<n>:STATistics:RESult<t>?](#) on page 510

Time Domain Power

Measures the power in zero span and opens a submenu to configure the measurement. For details see [Chapter 2.2, "Basic Measurements"](#), on page 20.

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

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY[:STATe]` on page 514

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

TOI

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

For details see [Chapter 2.11, "Third Order Intercept \(TOI\) Measurement"](#), on page 181.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:TOI[:STATe]` on page 526

`CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?` on page 525

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

AM Mod Depth

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

For details see [Chapter 2.12, "AM Modulation Depth Measurement"](#), on page 190.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:MDEPth[:STATe]` on page 528

`CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult?` on page 528

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

Harmonic Distortion

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

For details see [Chapter 2.10, "Harmonic Distortion Measurement"](#), on page 175.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:HARMonics[:STATe]` on page 522

First harmonic: `CALCulate<n>:MARKer<m>:FUNCTION:CENTer` on page 585.

THD: `CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:DISTortion?` on page 524

List of harmonics: `CALCulate<n>:MARKer<m>:FUNCTION:HARMonics:LIST?` on page 524

All commands: [Chapter 5.3, "Configuring and Performing Measurements"](#), on page 407

EMI

Detects electromagnetic interference in the signal, and opens a submenu to configure the measurement.

For details see [Chapter 2.13, "Electromagnetic Interference \(EMI\) Measurement"](#), on page 193.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:FMEasurement:STATe` on page 539
[Chapter 5.3.15, "Remote Commands for EMI Measurements"](#), on page 539

Marker Functions

In addition to the measurement functions, some special marker functions are available. See [Chapter 4.4.4, "Marker Function Configuration"](#), on page 372.

All Functions Off

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

2.2 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 3, "Common Measurement Settings"](#), on page 216).

2.2.1 How to Perform a Basic Sweep Measurement

To perform one or more single sweeps

1. Configure the frequency and span to be measured ("Frequency" dialog box, see [Chapter 3.4, "Frequency and Span Configuration"](#), on page 253).
2. Configure the number of sweeps to be performed in a single measurement ("Sweep Config" dialog box, see ["Sweep / Average Count"](#) on page 279).
3. If necessary, configure how the signal is processed internally ("Bandwidth" dialog box, see ["Sweep Type"](#) on page 281).
4. If necessary, configure a trigger for the measurement ("Trigger/Gate Settings" dialog box, see [Chapter 3.7, "Trigger and Gate Configuration"](#), on page 285).
5. Define how the results are evaluated for display ("Trace" dialog box, see [Chapter 4.3.2.1, "Trace Settings"](#), on page 331).
6. If necessary, configure the vertical axis of the display ("Amplitude" dialog box, see [Chapter 3.5.3, "Scaling the Y-Axis"](#), on page 267).
7. To start the measurement, select one of the following:
 - RUN SINGLE key
 - "Single Sweep" softkey in the "Sweep" menu

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

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

To start continuous sweeping

1. If you want to average the trace or search for a maximum over more (or less) than 10 sweeps, configure the "Average/Sweep Count" ("Sweep Config" dialog box, see ["Sweep / Average Count"](#) on page 279).
2. To start the measurement, select one of the following:
 - RUN CONT key
 - "Continuous Sweep" softkey in the "Sweep" menu

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

2.2.2 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 presets.

NOTICE

High input values

If levels higher than +30 dBm (=1 W) are expected or are possible, a power attenuator must be inserted before the RF input of the analyzer. Otherwise, signal levels exceeding 30 dBm can damage the RF attenuator or the input mixer. The total power of all occurring signals must be taken into account.

Test setup

- Connect the RF output of the signal generator to the RF input of the R&S ESW.

Table 2-1: Signal generator settings (e.g. R&S SMW)

Frequency	128 MHz
Level	-30 dBm

- [Measuring the Level and Frequency Using Markers](#).....22
- [Measuring the Signal Frequency Using the Signal Counter](#)..... 23

2.2.2.1 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 the MODE key.
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 the PEAK SEARCH key or the "Peak" soft-key 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.

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 presettings, 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 the MKR -> key.
2. Select "Ref Lvl = Mkr Lvl".

The reference level is set to the current marker level.

2.2.2.2 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 4.4.1.5, "Performing a Highly Accurate Frequency Measurement \(Signal Count\)"](#), on page 355).

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 the MODE key.

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.

2.2.3 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 266
- [Chapter 3.5.1.1, "Reference Level"](#), on page 262
- [Chapter 3.6.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth"](#), on page 270
- [Chapter 3.6.1.2, "Smoothing the Trace Using the Video Bandwidth"](#), on page 271
- [Chapter 4.3.1.1, "Mapping Samples to sweep Points with the Trace Detector"](#), on page 317

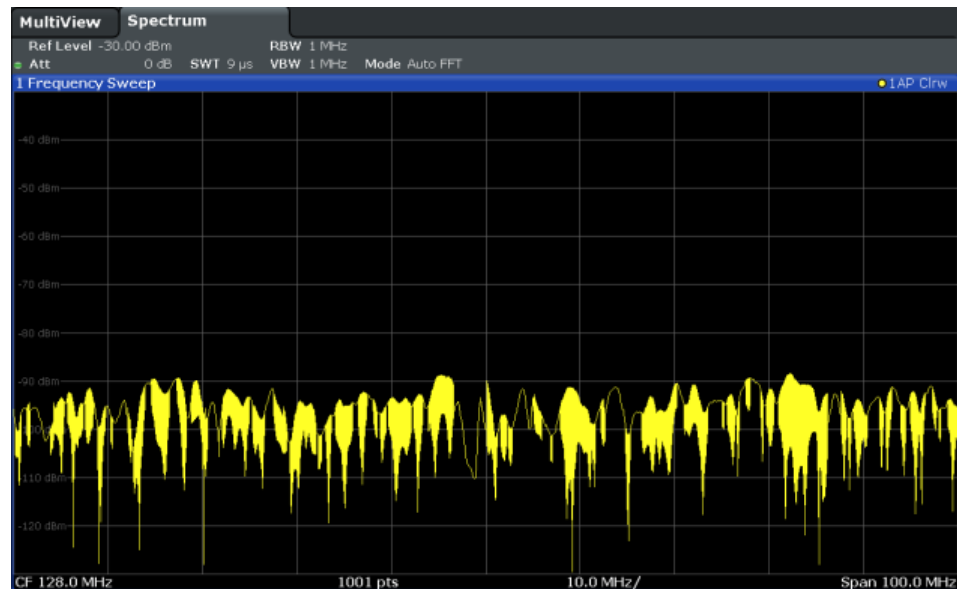
This measurement example shows the different factors influencing the S/N ratio.

Table 2-2: 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 the MODE key.
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 2-1: 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 332).

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.

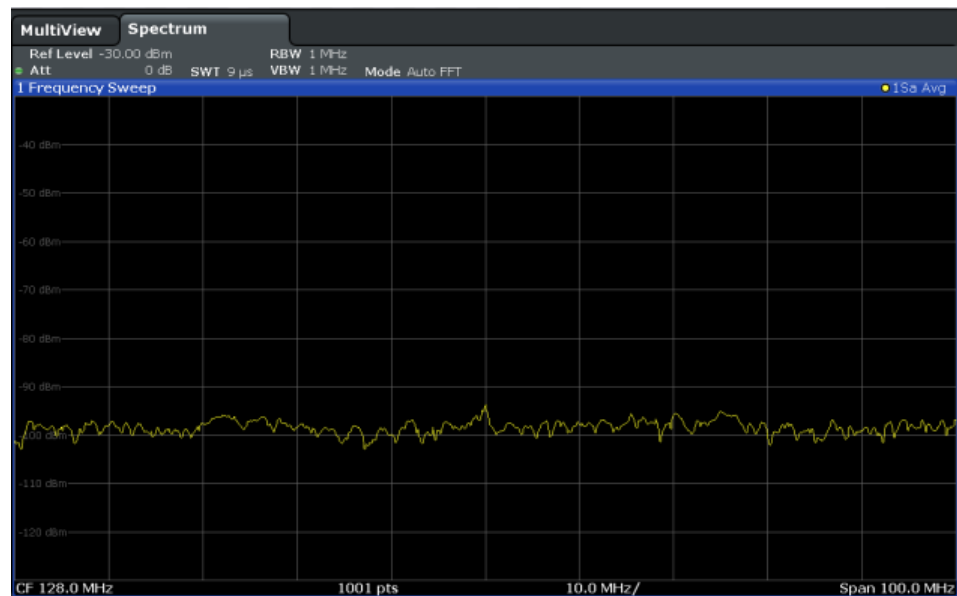


Figure 2-2: RF sine wave signal with low S/N ratio with an averaged trace

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.

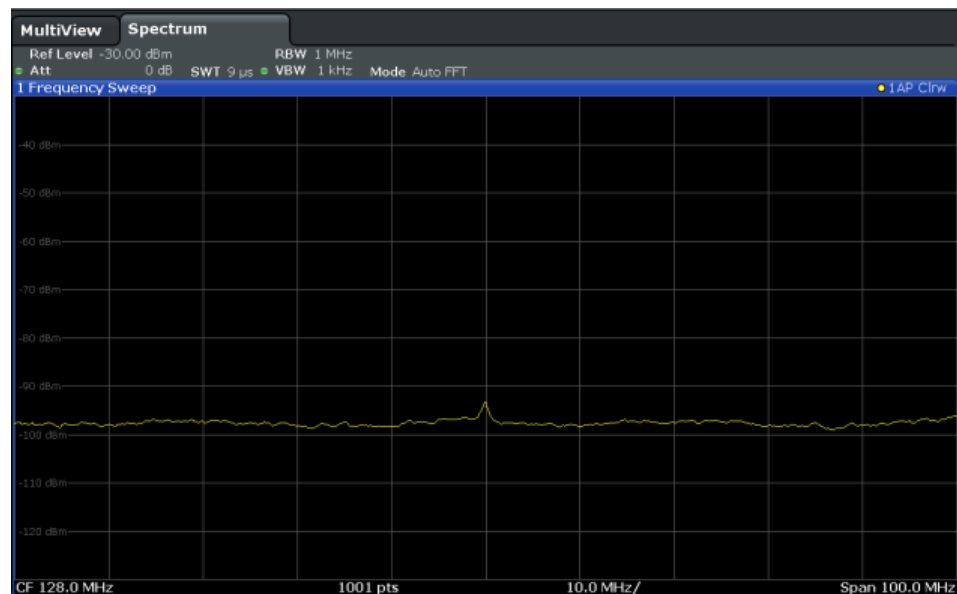


Figure 2-3: RF sine wave signal with low S/N ratio with a smaller video bandwidth

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.

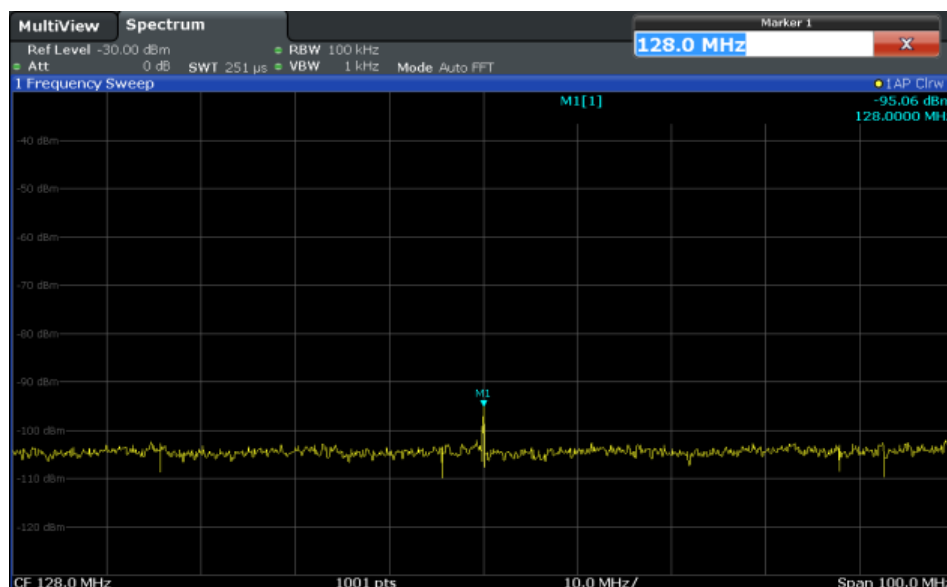


Figure 2-4: Reference signal at a smaller resolution bandwidth

2.2.4 Measurement Examples - Measuring Signal Spectra with Multiple Signals

- [Separating Signals by Selecting the Resolution Bandwidth](#)..... 27
- [Measuring the Modulation Depth of an AM-Modulated Carrier in the Frequency Domain](#).....31
- [Measuring AM-Modulated Signals](#)..... 32

2.2.4.1 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 3.6.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth"](#), on page 270).

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.

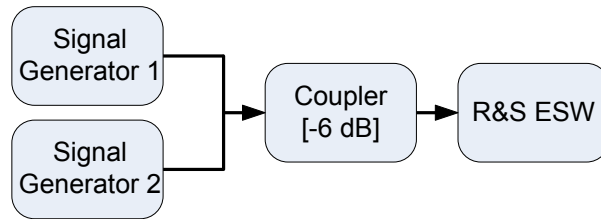


Figure 2-5: Test setup

Table 2-3: Signal generator settings (e.g. R&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 the MODE key.
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.

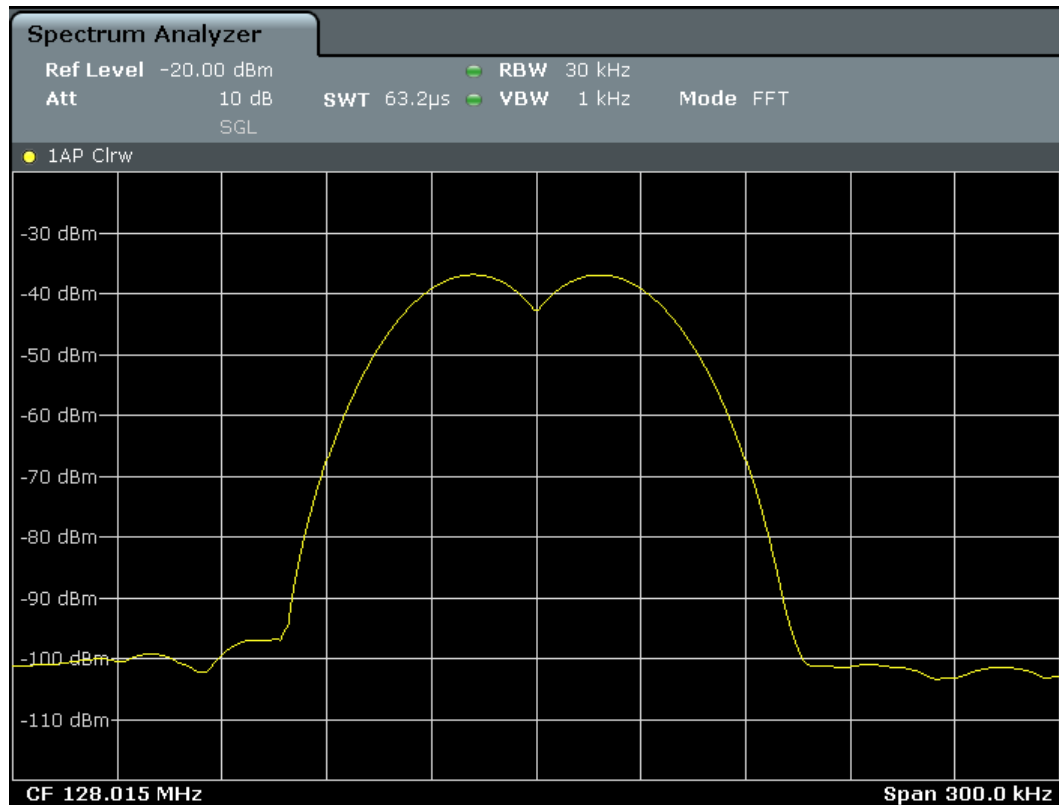


Figure 2-6: Measurement of two equally-leveled RF sinusoidal signals with the resolution bandwidth which corresponds to the frequency spacing of the signals

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.

- Set the resolution bandwidth to 100 kHz.

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

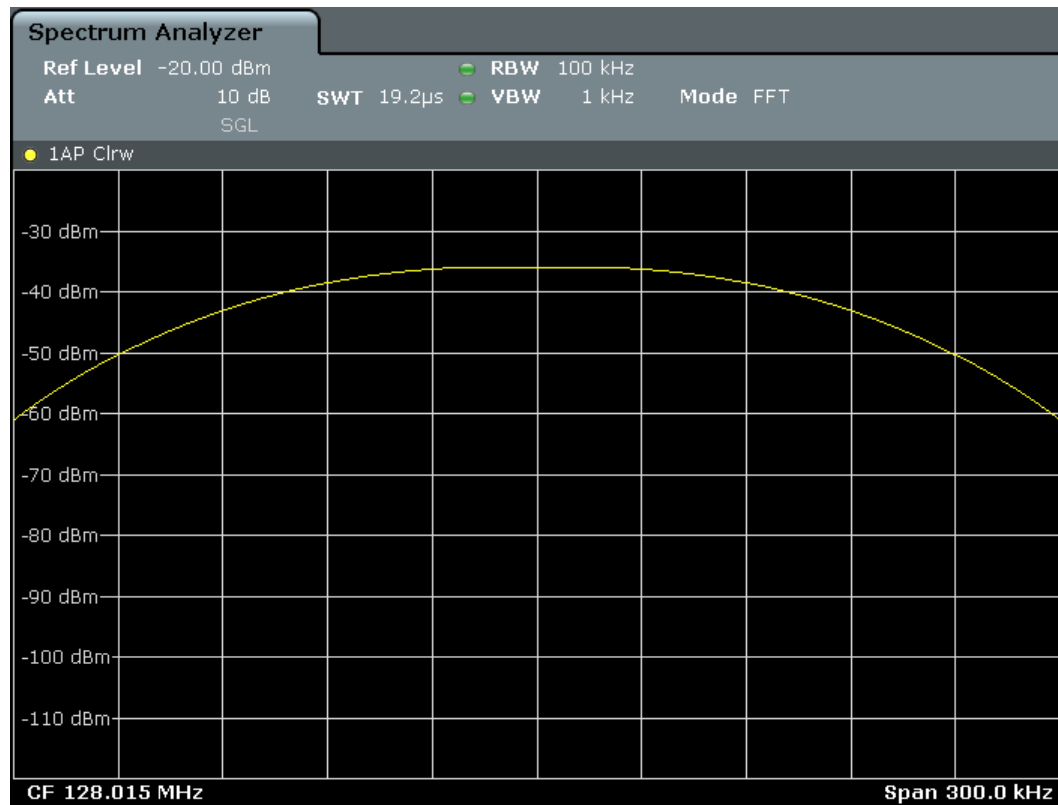


Figure 2-7: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth which is larger than their frequency spacing

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).

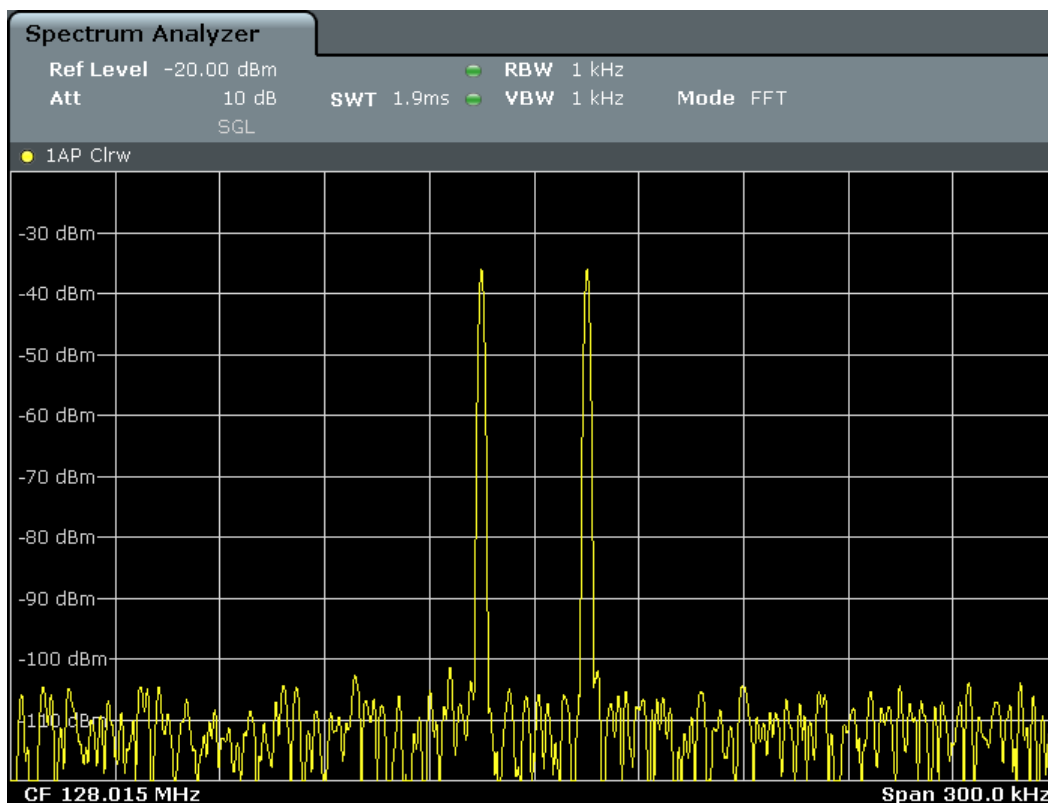


Figure 2-8: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth (1 kHz) which is significantly smaller than their frequency spacing

2.2.4.2 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.

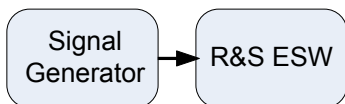


Figure 2-9: Test setup

Table 2-4: 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 the MODE key.
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.

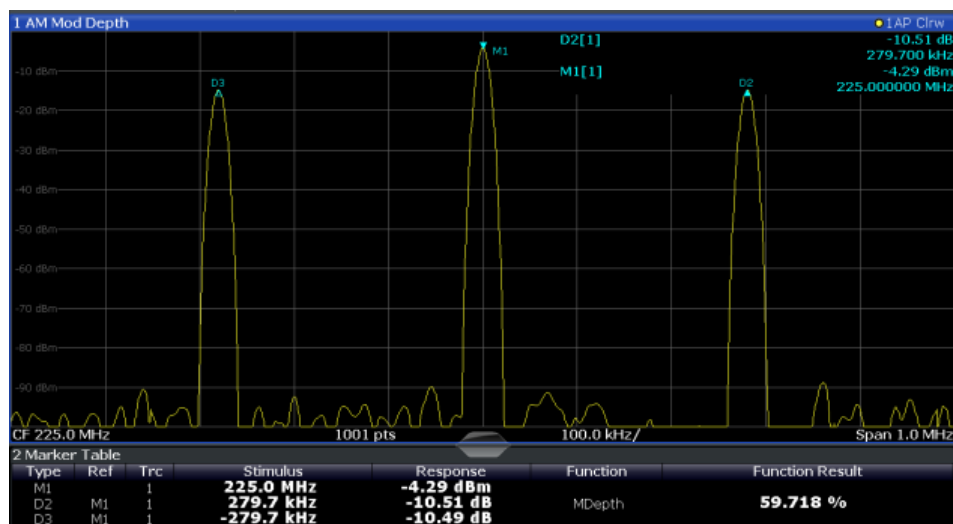


Figure 2-10: Measurement of the AM modulation depth

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

2.2.4.3 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)

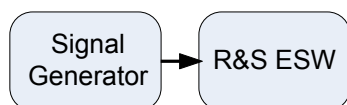


Figure 2-11: Test setup

Table 2-5: 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 the MODE key.
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 reference level to *6 dBm* and the display range to linear (AMPT > "Scale Config" > "Scaling: Linear Percent").
7. Define triggering in response to the AF signal using the video trigger to produce a static image.
 - a) Press the TRIG key.
 - 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.

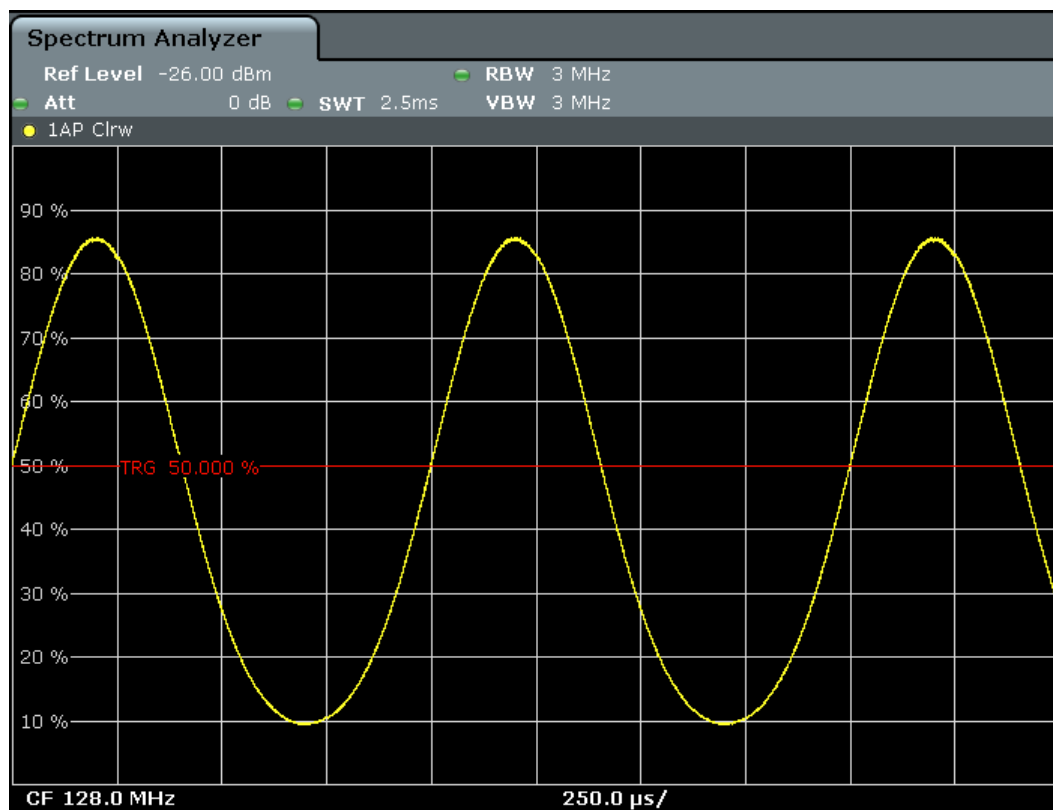


Figure 2-12: Measurement of the AF signal of a carrier that is AM-modulated with 1 kHz

8. Activate the internal AM demodulator to output the audio signal.
 - a) Press the MKR FUNC key.
 - 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 PHONES connector). If necessary, use the volume control to turn up the volume.

2.2.5 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](#)..... 35
- [Measuring the Signal-to-Noise Ratio of Burst Signals](#)..... 38

2.2.5.1 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

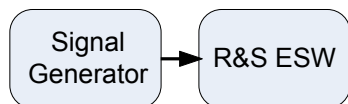


Figure 2-13: Test setup

Table 2-6: 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 the MODE key.
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 > "Sweeptime 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 the TRIG key.
 - b) Set the "Trg/Gate 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 the MEAS key.
 - 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.

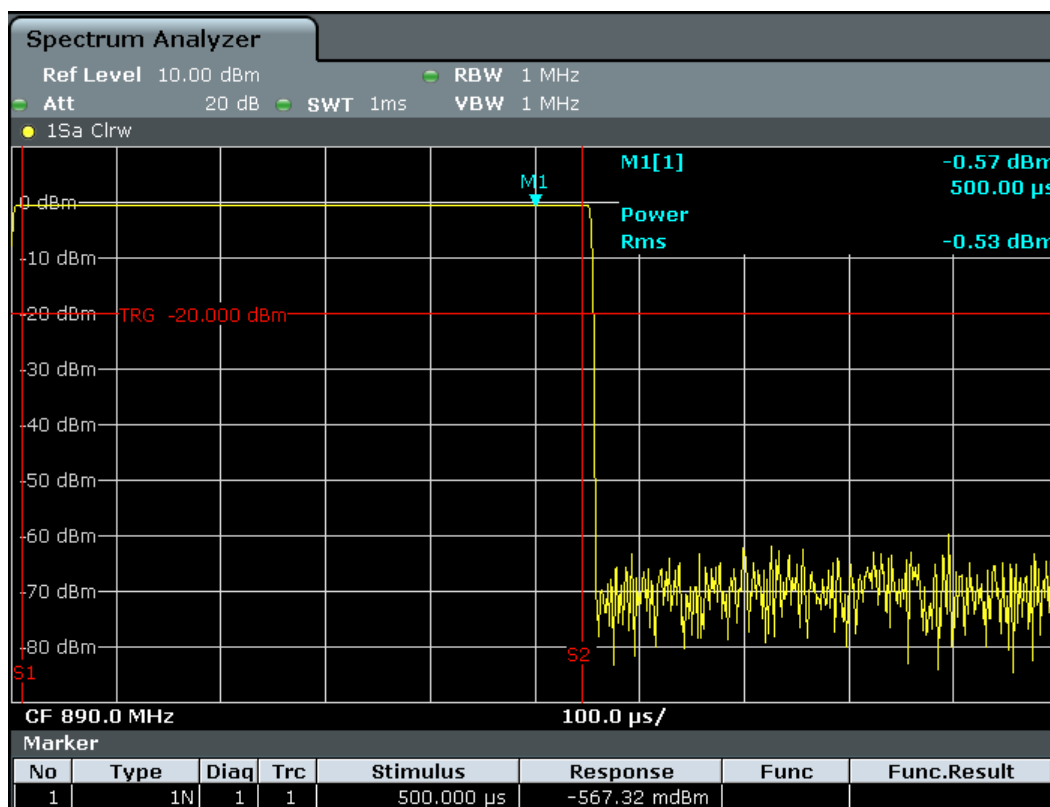


Figure 2-14: Measurement of the average power during the burst of a GSM signal

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.

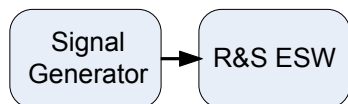


Figure 2-15: Test setup

Table 2-7: 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.

- Switch off the power measurement.
 - Press the MEAS key.
 - Select "All Functions Off".
- Increase the time resolution to $100 \mu\text{s}$ (SWEEP > "Sweeptime Manual").
- Shift the rising edge of the GSM burst to the center of the display by defining a trigger offset.
 - Press the TRIG key.
 - Select "Trigger Offset".
 - 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.

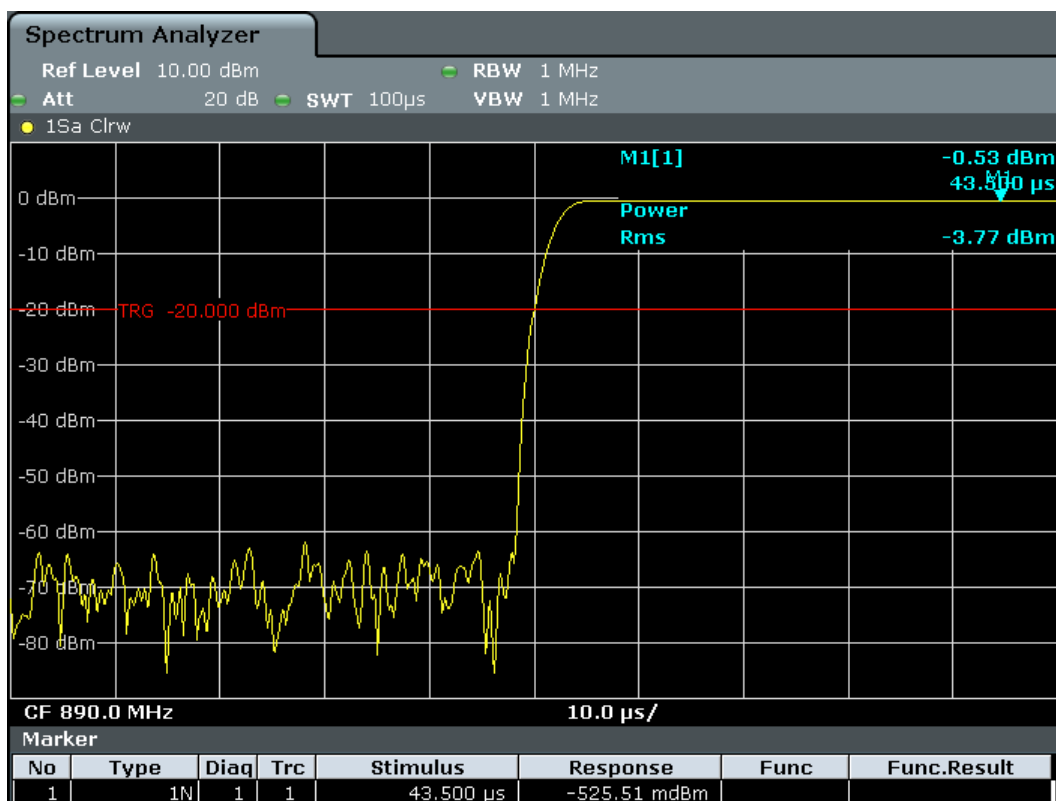


Figure 2-16: Rising edge of the GSM burst displayed with high time resolution

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.

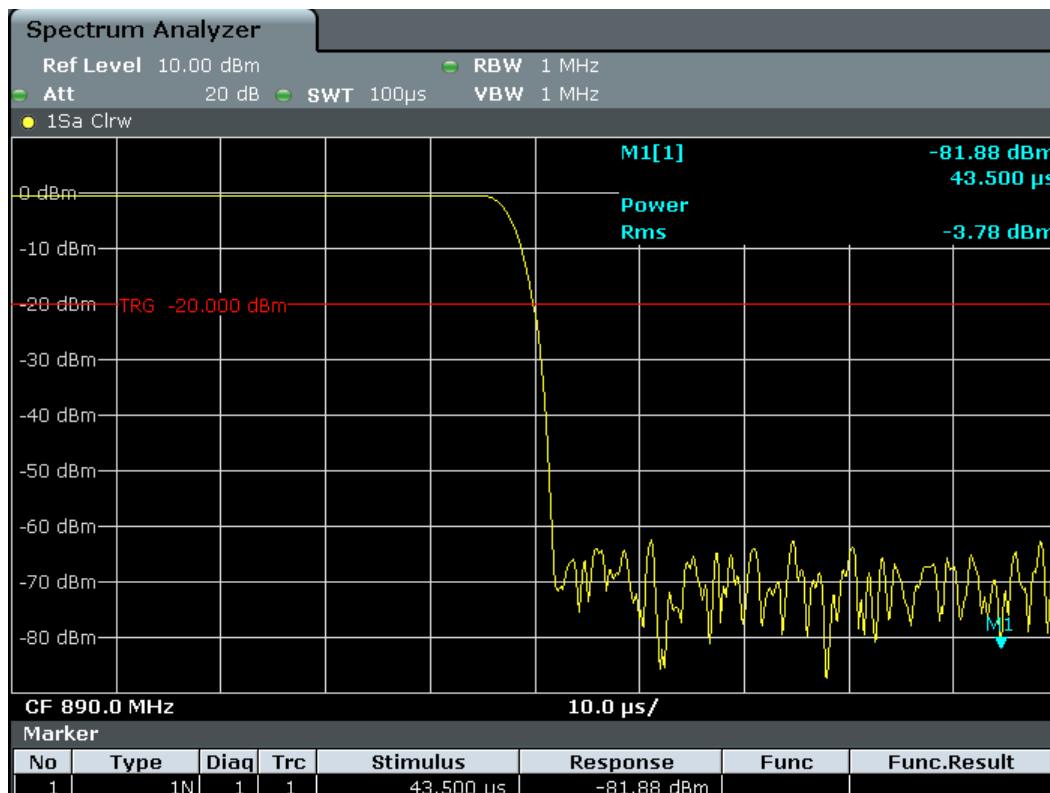


Figure 2-17: Falling edge of the GSM burst displayed with high time resolution

2.2.5.2 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

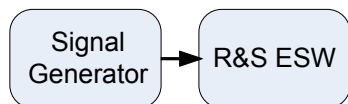


Figure 2-18: Test setup

Table 2-8: 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 the MODE key.
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 > "Sweeptime 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 the MEAS key.
 - 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.
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.

Channel Power and Adjacent-Channel Power (ACLR) Measurement

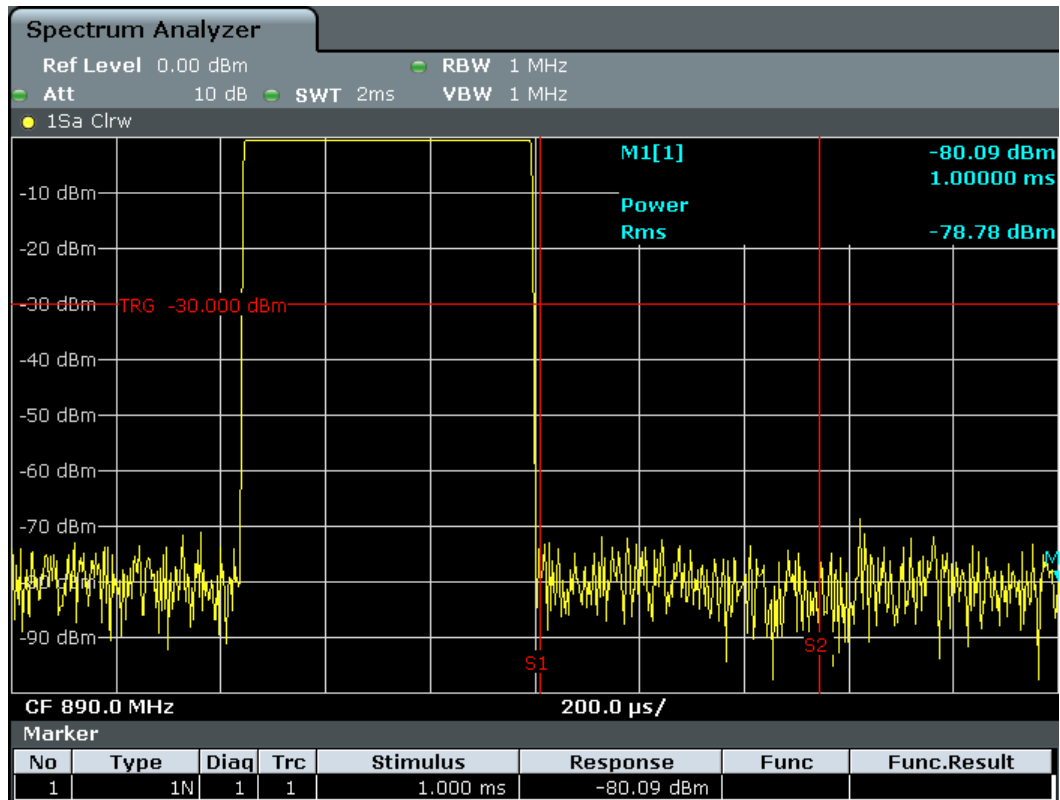


Figure 2-19: Measurement of the signal-to-noise ratio of a GSM burst signal in zero span

2.3 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.

- [About Channel Power Measurements](#)..... 41
- [Channel Power Results](#).....41
- [Channel Power Basics](#).....43
- [Channel Power Configuration](#)..... 54
- [MSR ACLR Configuration](#)..... 64
- [How to Perform Channel Power Measurements](#).....80
- [Measurement Examples](#)..... 84
- [Optimizing and Troubleshooting the Measurement](#)..... 87
- [Reference: Predefined CP/ACLR Standards](#)..... 88

2.3.1 About Channel Power Measurements

Measuring channel power and adjacent channel power is one of the most important tasks for a signal analyzer with the necessary test routines in the field of digital transmission. 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 the 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.

The R&S ESW 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 2.3.7, "Measurement Examples"](#), on page 84.

2.3.2 Channel Power Results

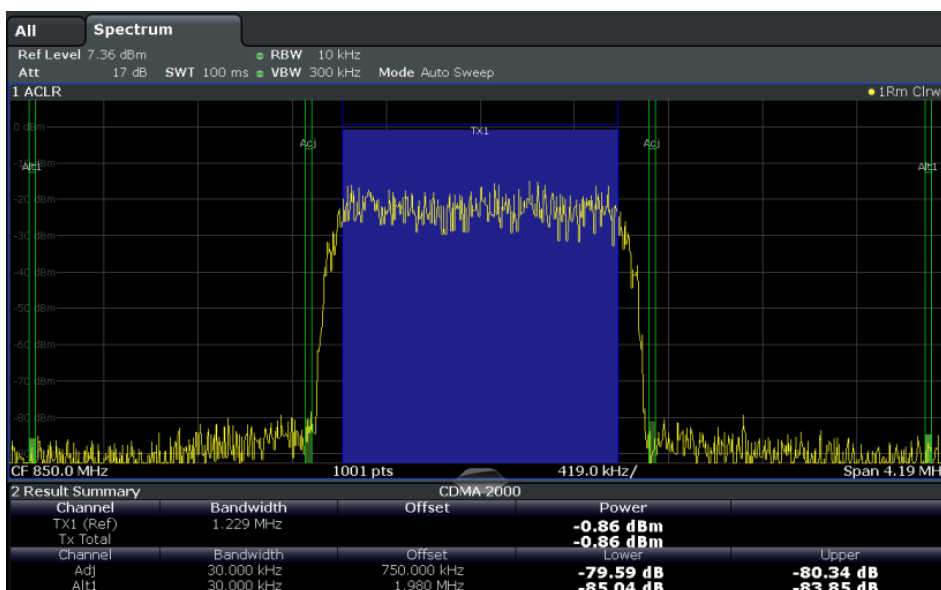
For channel or adjacent-channel power measurements, the individual channels are indicated by different colored bars in the diagram. The height of each bar corresponds to the measured power of that channel. In addition, the name of the channel ("Adj", "Alt1", "TX1", etc., or a user-defined name) is indicated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



Multi-standard radio (MSR) channel power results

The channel power results for MSR signals are described in [Chapter 2.3.3.4, "Measurement on Multi-Standard Radio \(MSR\) Signals"](#), on page 50.

Channel Power and Adjacent-Channel Power (ACLR) Measurement



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.

Table 2-9: 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"> Channel powers Power of the upper and lower adjacent channel
2	<ul style="list-style-type: none"> Channel powers Power of the upper and lower adjacent channel Power of the next higher and lower channel (alternate channel 1)
3	<ul style="list-style-type: none"> Channel powers Power of the upper and lower adjacent channel Power of the next higher and lower channel (alternate channel 1) Power of the second next higher and lower adjacent channel (alternate channel 2)
...	...
12	<ul style="list-style-type: none"> Channel powers Power of the upper and lower adjacent channel Power of all the higher and lower channels (alternate channels 1 to 11)



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 "Channel Names" on page 64).
Bandwidth	Configured channel bandwidth (see "Channel Bandwidths" on page 62)
Offset	Offset of the channel to the TX channel (configured channel spacing, see "Channel Bandwidths" on page 62)
Power (Lower/Upper)	The measured power values for the TX and lower and upper adjacent channels. The powers of the transmission channels are output in dBm or dBm/Hz, or in dBc, relative to the specified reference TX channel.

Retrieving Results via Remote Control

All or specific channel power measurement results can be retrieved using the `CALC:MARK:FUNC:POW:RES?` command from a remote computer (see `CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>:RESult?` on page 411). 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 617). In this case, the measured power value for each sweep point (by default 1001) is returned.

2.3.3 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

2.3.3.1 Measurement Methods

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

The **Adjacent Channel Leakage Power Ratio (ACLR)** is also known as the **Adjacent Channel Power Ratio (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.

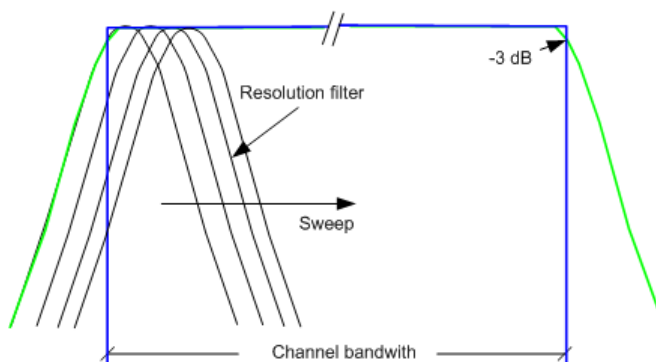


Figure 2-20: Approximating the channel filter by sweeping with a small resolution bandwidth

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**and**W**idth method).

Fast ACLR

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

To decrease the measurement times, the R&S 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

Channel Power and Adjacent-Channel Power (ACLR) Measurement

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.



Figure 2-21: Measuring the channel power and adjacent channel power ratio for CDMA2000 signals with zero span (Fast ACLR)

2.3.3.2 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:

$$\langle \text{sweep time in channel} \rangle * \langle \text{selected resolution bandwidth} \rangle$$

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.

Channel Power and Adjacent-Channel Power (ACLR) Measurement

For the same repeatability, the integration method requires a sweep time of 8.5 s. The [Figure 2-22](#) shows the standard deviation of the results as a function of the sweep time.

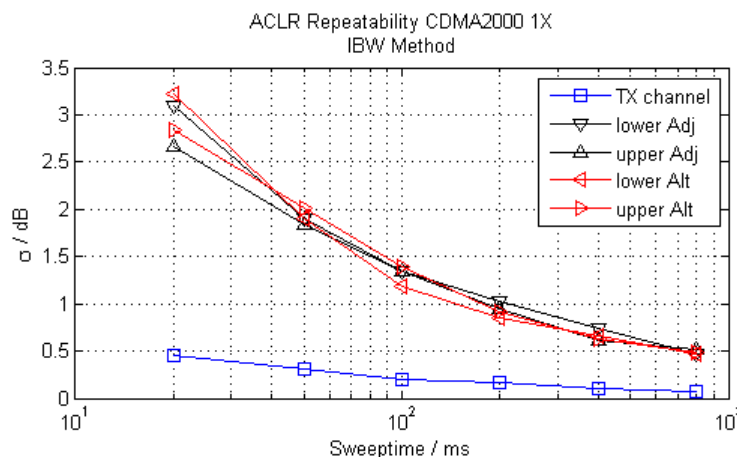


Figure 2-22: Repeatability of adjacent channel power measurement on CDMA2000 standard signals if the integration bandwidth method is used

The [Figure 2-23](#) 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.

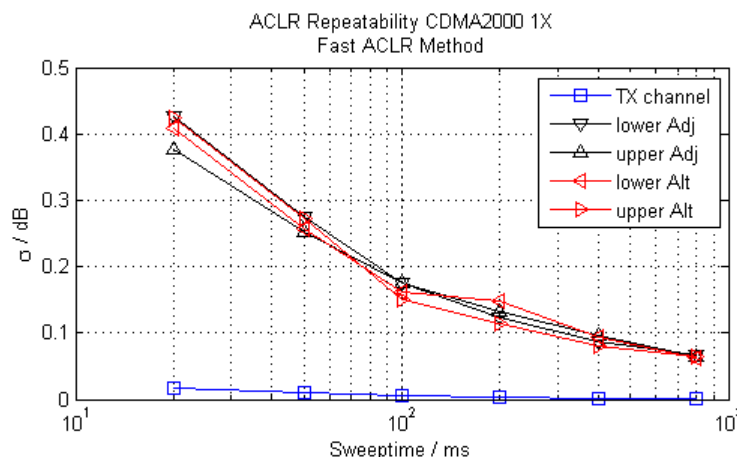


Figure 2-23: Repeatability of adjacent channel power measurements on CDMA2000 signals in the fast ACLR mode

2.3.3.3 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 3.2, "Configuration Overview"](#), on page 216.

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_{decorr} means uncorrelated samples)

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

The "Sweep Time" can be defined using the softkey in the "Ch Power" menu or in the "Sweep" configuration dialog box (see "[Sweep Time](#)" on page 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 Power and Adjacent-Channel Power (ACLR) Measurement

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 3.4.3, "How To Define the Frequency Range"](#), on page 260.

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 in the neighborhood of the adjacent channels normally has a constant level.

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 207.

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

" $RBW \leq 1/40$ of channel bandwidth"

The maximum resolution bandwidth (concerning the requirement $RBW \leq 1/40$) 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:

$$"VBW \geq * RBW"$$

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 277.

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

Detector

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

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

Where:

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

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

P_{RMS} = power represented by a measurement point

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

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

The RMS detector can be set for the defined channel settings automatically. 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 332.

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 333.

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.

2.3.3.4 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

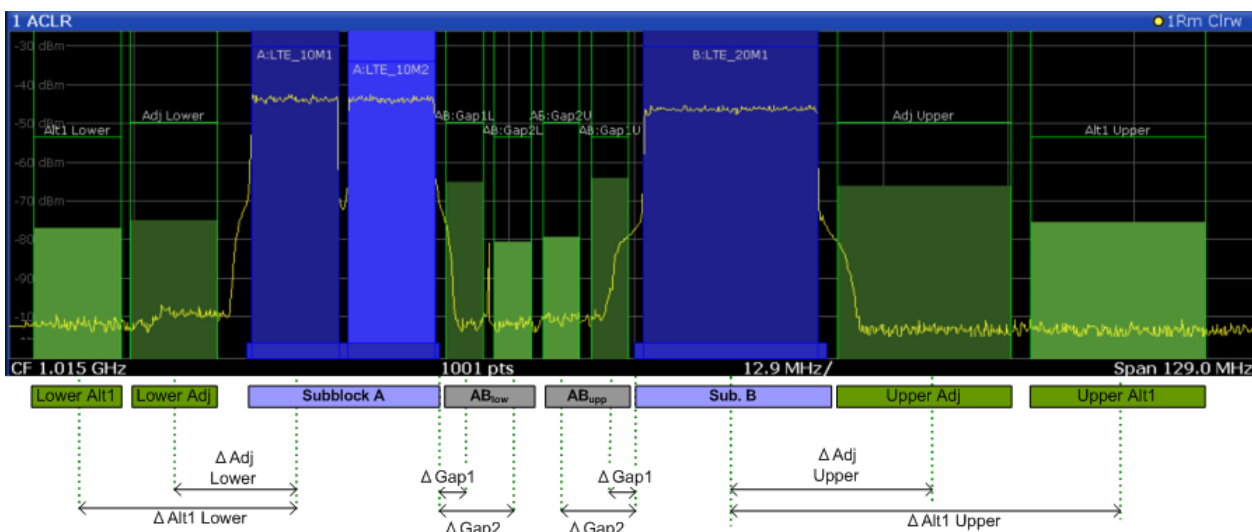


Figure 2-24: MSR signal structure

Sub block and channel definition

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

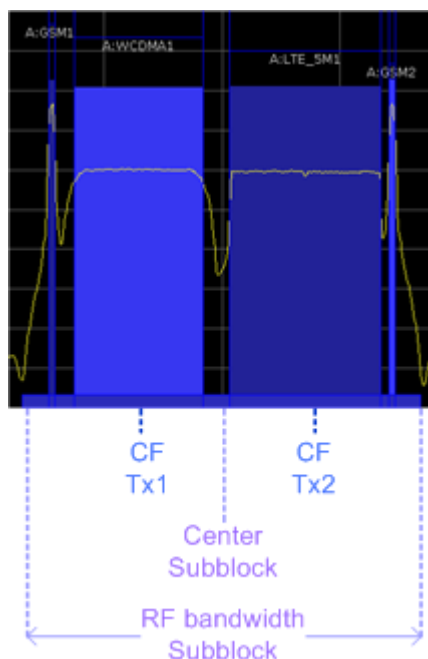


Figure 2-25: Sub block definition

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 pre-define 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. Since 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):

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

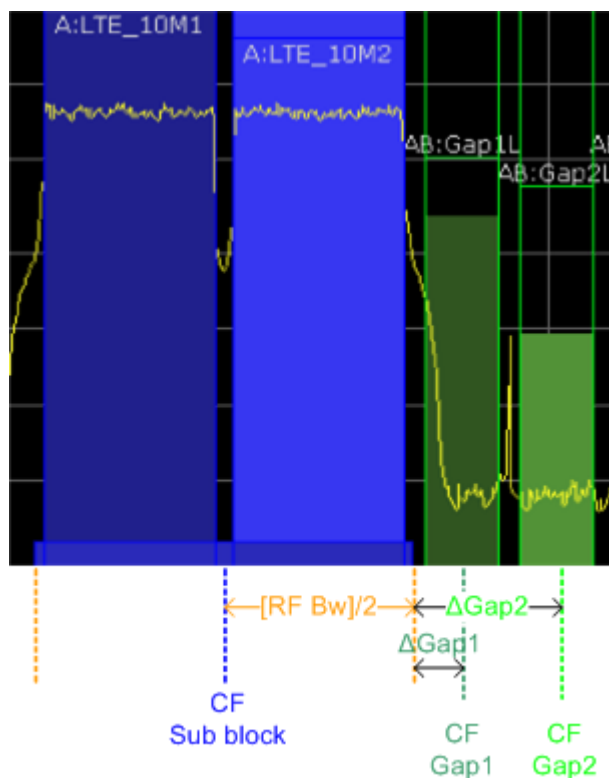


Figure 2-26: Gap channel definition for lower gap

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 2-24](#)):

- 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.



The upper and lower adjacent channels can also be defined asymmetrically (see "[Symmetrical Adjacent Setup](#)" on page 70). 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.



The gap channels can be hidden if they do not reach a minimum size, or deactivated entirely. 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 now user-definable.

Channel Power and Adjacent-Channel Power (ACLR) Measurement

Channel power results

The Result Summary for MSR signal measurements is similar to the table for common signals (see [Chapter 2.3.2, "Channel Power Results"](#), on page 41). However, the Tx channel results are grouped by sub blocks, and sub block totals are provided instead of a total Tx channel power. Instead of the individual channel frequency offsets, the absolute center frequencies are indicated for the transmit channels.

The CACLR 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		Multi-Standard Radio		
Channel	Bandwidth	Frequency	Power	
A:LTE_10M1	9.015 MHz	980.000 MHz	-19.11 dBm	
A:LTE_10M2	9.015 MHz	990.000 MHz	-19.21 dBm	
Sub Block A Total			-16.15 dBm	
Channel	Bandwidth	Frequency	Power	
B:LTE_20M1 (Ref)	18.015 MHz	1.025 GHz	-18.72 dBm	
Sub Block B Total			-18.72 dBm	
Adj Channels	Bandwidth	Offset	ACLR Power	
Adj Lower	9.015 MHz	12.500 MHz	-56.31 dB	
Adj Upper	18.015 MHz	20.000 MHz	-47.50 dB	
Alt1 Lower	9.015 MHz	22.500 MHz	-58.46 dB	
Alt1 Upper	18.015 MHz	40.000 MHz	-56.97 dB	
Gap Channels	Bandwidth	Offset	ACLR Power	CACLR Power
AB:Gap1L	3.840 MHz	2.500 MHz	-45.85 dB	-49.11 dB
AB:Gap1U	3.840 MHz	2.500 MHz	-45.30 dB	-48.07 dB
AB:Gap2L	3.840 MHz	7.500 MHz	-61.51 dB	-64.78 dB
AB:Gap2U	3.840 MHz	7.500 MHz	-60.62 dB	-63.39 dB

Figure 2-27: 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 411

Restrictions and dependencies

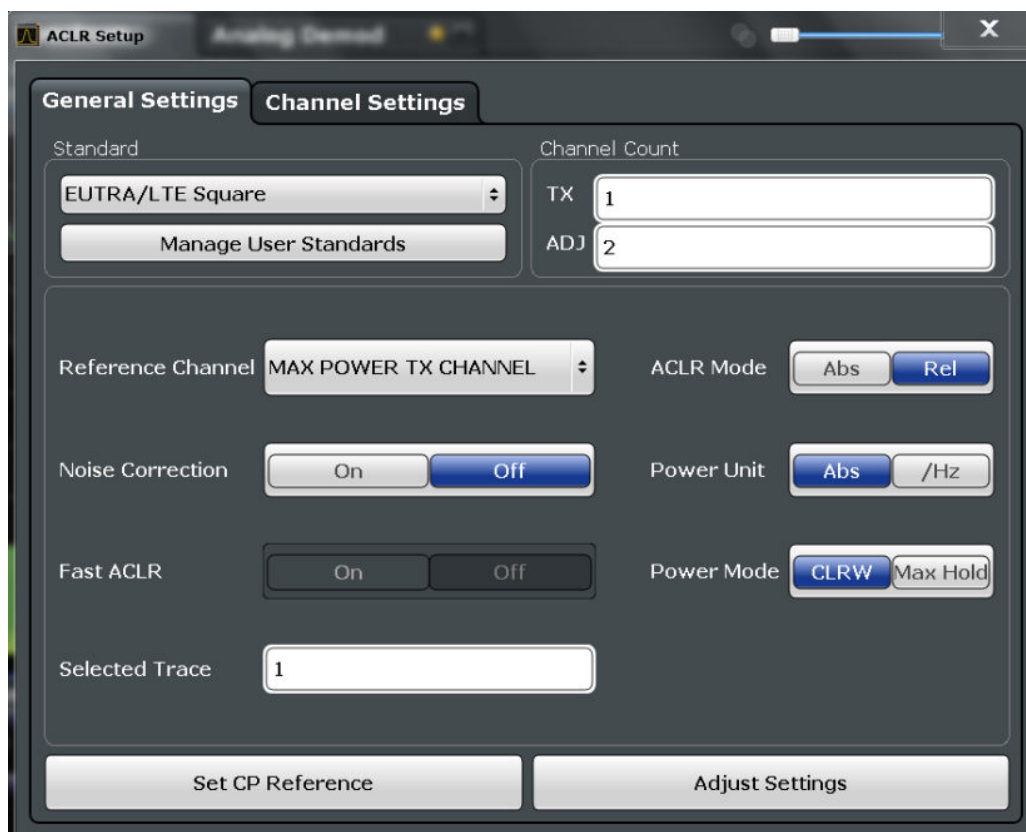
As the signal structure in multi-standard radio signals can vary considerably, you can define the channels very flexibly for the ACLR measurement with the R&S ESW. No checks or limitations are implemented concerning the channel definitions, apart from the maximum number of channels to be defined. Thus, 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.

2.3.4 Channel Power Configuration

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



If the "Multi-Standard Radio" standard is selected (see ["Standard"](#) on page 56), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box. See [Chapter 2.3.5, "MSR ACLR Configuration"](#), on page 64 for a description of these settings.



The easiest way to configure a measurement is using the configuration "Overview", see [Chapter 3.2, "Configuration Overview"](#), on page 216.

The remote commands required to perform these tasks are described in [Chapter 5.3.3, "Measuring the Channel Power and ACLR"](#), on page 415.

- [General CP/ACLR Measurement Settings](#).....55
- [Channel Setup](#)..... 61

2.3.4.1 General CP/ACLR Measurement Settings

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

Standard.....	56
L Predefined Standards	56
L User-Defined Standards	56
Number of Channels (Tx, ADJ).....	58
Reference Channel.....	58
Noise Cancellation.....	58
Fast ACLR.....	59
Selected Trace.....	59
Absolute and Relative Values (ACLR Mode).....	59
Channel Power Levels and Density (Power Unit).....	59

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 2.3.5, "MSR ACLR Configuration"](#), on page 64).

If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see [Chapter 2.3.4, "Channel Power Configuration"](#), on page 54).

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, the settings can be changed.

The predefined standards contain the following settings:

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

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

For details on the available standards, see [Chapter 2.3.9, "Reference: Predefined CP/ACLR Standards"](#), on page 88.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER:PRESet` on page 415

User-Defined Standards ← Standard

Access: "CP/ACLR Setup" > "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:\R_S\Instr\acp_std` directory.

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

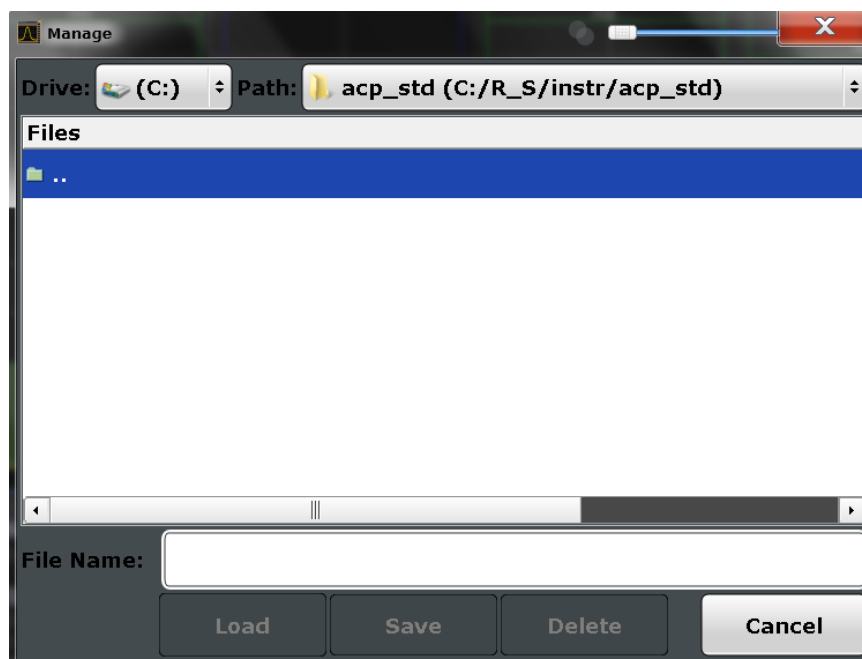
Channel Power and Adjacent-Channel Power (ACLR) Measurement

Note that ACLR user standards are not supported for Fast ACLR and multicarrier 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 2.3.6.4, "How to Manage User-Defined Configurations"](#), on page 83.

Remote command:

To query all available standards:

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

on page 416

To load a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER:PRESet` on page 415

To save a standard:

[CALCulate<n>:MARKer<m>:FUNCTION:POWER:STANDARD:SAVE](#) on page 417

To delete a standard:

[CALCulate<n>:MARKer<m>:FUNCTION:POWER:STANDARD:DELETE](#) on page 416

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 58).

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 2.3.2, "Channel Power Results"](#), on page 41.

Remote command:

Number of Tx channels:

[\[SENSe:\]POWER:ACHannel:TXChannel:COUNT](#) on page 421

Number of Adjacent channels:

[\[SENSe:\]POWER:ACHannel:ACPairs](#) on page 417

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. (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 424

[\[SENSe:\]POWER:ACHannel:REFERENCE:TXChannel:AUTO](#) on page 424

Noise Cancelation

The R&S ESW can correct the results by removing the inherent noise of the analyzer, which increases the dynamic range.

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

Channel Power and Adjacent-Channel Power (ACLR) Measurement

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

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors:

- RMS
- Average
- Sample
- Positive Peak

Remote command:

[\[SENSe:\]POWER:NCORrection](#) on page 587

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:HSPeed](#) on page 431

Selected Trace

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

Remote command:

[\[SENSe:\]POWER:TRACe](#) on page 415

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 446

Channel Power Levels and Density (Power Unit)

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

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

"channel power density = channel power – log₁₀(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:RESult:PHZ` on page 445

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:MODE` on page 410

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 58), thus, this function is not available.

Remote command:

`[SENSe:]POWER:ACHannel:REFERENCE:AUTO ONCE` on page 424

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 47
- "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 414

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 601

2.3.4.2 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 2.3.6.2, "How to Set up the Channels"](#), on page 80.

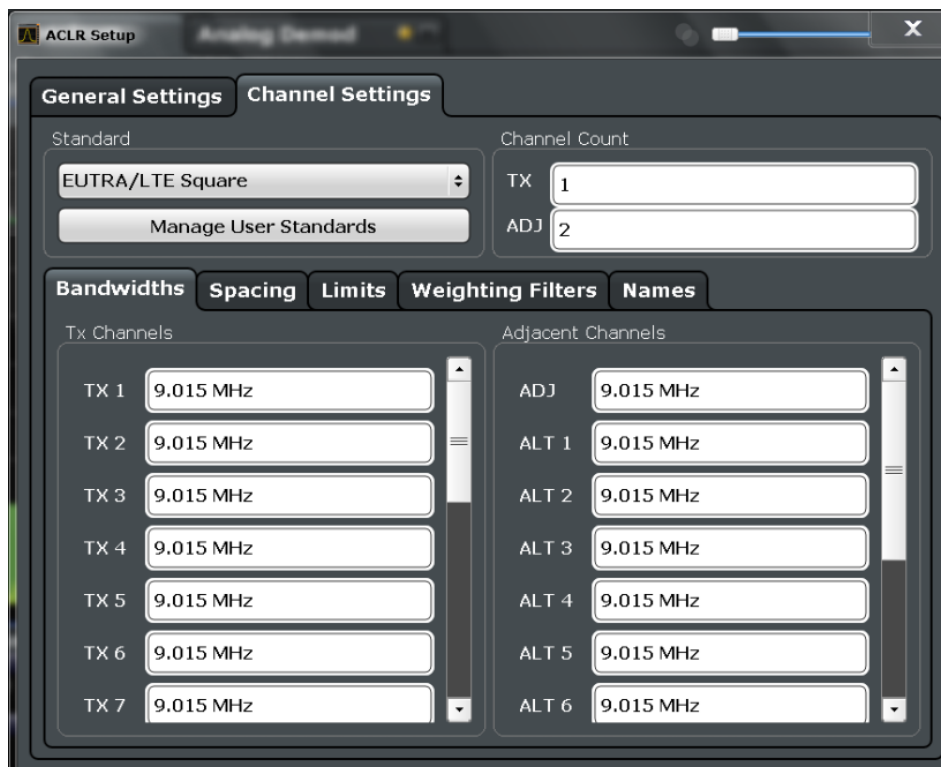


In addition to the specific channel settings, the general settings ["Standard"](#) on page 56 and ["Number of Channels \(Tx, ADJ\)"](#) on page 58 are also available in this tab.

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

Channel Bandwidths	62
Channel Spacings	62
Limit Checking	63
Weighting Filters	64
Channel Names	64

Channel Bandwidths



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

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

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

The value entered for any Tx channel is automatically also defined for all subsequent Tx channels. Thus, only 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|BWIDth\[:CHANnel<ch>\]](#) on page 418

[\[SENSe:\] POWER:ACHannel:BANDwidth|BWIDth:ACHannel](#) on page 417

[\[SENSe:\] POWER:ACHannel:BANDwidth|BWIDth:ALternate<ch>](#) on page 418

Channel Spacings

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

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

Channel Power and Adjacent-Channel Power (ACLR) Measurement

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 2.3.6.2, "How to Set up the Channels"](#), on page 80

Remote command:

[\[SENSe:\] POWER:ACHannel:SPACing:CHANnel<ch>](#) on page 420

[\[SENSe:\] POWER:ACHannel:SPACing\[:ACHannel\]](#) on page 420

[\[SENSe:\] POWER:ACHannel:SPACing:ALternate<ch>](#) on page 420

Limit Checking

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

2 Result Summary		Tx Power 30.54 dBm		Tx Bandwidth 3.840 MHz		W-CDMA 3GPP DL	
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit	
-12.750 MHz	-8.000 MHz	1.000 MHz	2.09053 GHz	-40.68 dBm	-71.22 dB	-17.18 dB	
-8.000 MHz	-4.000 MHz	1.000 MHz	2.09268 GHz	-40.13 dBm	-70.67 dB	-20.63 dB	
-4.000 MHz	-3.515 MHz	30.000 kHz	2.09647 GHz	-52.60 dBm	-83.14 dB	-20.10 dB	
-3.515 MHz	-2.715 MHz	30.000 kHz	2.09652 GHz	-54.30 dBm	-84.84 dB	-22.38 dB	
-2.715 MHz	-2.515 MHz	30.000 kHz	2.09728 GHz	-51.51 dBm	-82.05 dB	-31.01 dB	
-2.515 MHz	2.715 MHz	30.000 kHz	2.10270 GHz	-54.13 dBm	-84.67 dB	-33.63 dB	
2.715 MHz	3.515 MHz	30.000 kHz	2.10299 GHz*	-17.29 dBm*	-47.83 dB*	7.27 dB*	
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.46 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<k>:ACPower\[:STATE\]](#) on page 430

[CALCulate<n>:LIMIT<k>:ACPower:ACHannel:ABSolute:STATE](#) on page 425

[CALCulate<n>:LIMIT<k>:ACPower:ACHannel:ABSolute](#) on page 425

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

on page 426

[CALCulate<n>:LIMit<k>:ACPoweR:ACHannel\[:RELative\]](#) on page 426

[CALCulate<n>:LIMit<k>:ACPoweR:ALternate<ch>:ABSolute:STATe](#)
on page 428

[CALCulate<n>:LIMit<k>:ACPoweR:ALternate<ch>:ABSolute](#) on page 427

[CALCulate<n>:LIMit<k>:ACPoweR:ALternate<ch>\[:RELative\]:STATe](#)
on page 429

[CALCulate<n>:LIMit<k>:ACPoweR:ALternate<ch>\[:RELative\]](#) on page 428

[CALCulate<n>:LIMit<k>:ACPoweR:ACHannel:RESult?](#) on page 427

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 423

[\[SENSe:\] POWer:ACHannel:FILTer\[:STATe\]:ACHannel](#) on page 422

[\[SENSe:\] POWer:ACHannel:FILTer\[:STATe\]:ALternate<ch>](#) on page 423

Alpha value:

[\[SENSe:\] POWer:ACHannel:FILTer:ALPHa:CHANnel<ch>](#) on page 422

[\[SENSe:\] POWer:ACHannel:FILTer:ALPHa:ACHannel](#) on page 421

[\[SENSe:\] POWer:ACHannel:FILTer:ALPHa:ALternate<ch>](#) on page 422

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 419

[\[SENSe:\] POWer:ACHannel:NAME:ALternate<ch>](#) on page 419

[\[SENSe:\] POWer:ACHannel:NAME:CHANnel<ch>](#) on page 419

2.3.5 MSR ACLR Configuration

ACLR measurements can also be performed on input containing multiple signals for different communication standards. A new measurement standard is provided that allows you to define multiple discontinuous transmit channels at specified frequencies, independent from the selected center frequency. If the "Multi-Standard Radio" standard is selected (see ["Standard"](#) on page 56), the "ACLR Setup" dialog box is replaced by the "MSR ACLR Setup" dialog box.

For more information, see [Chapter 2.3.3.4, "Measurement on Multi-Standard Radio \(MSR\) Signals"](#), on page 50.

The remote commands required to perform these tasks are described in [Chapter 5.3.3, "Measuring the Channel Power and ACLR"](#), on page 415.

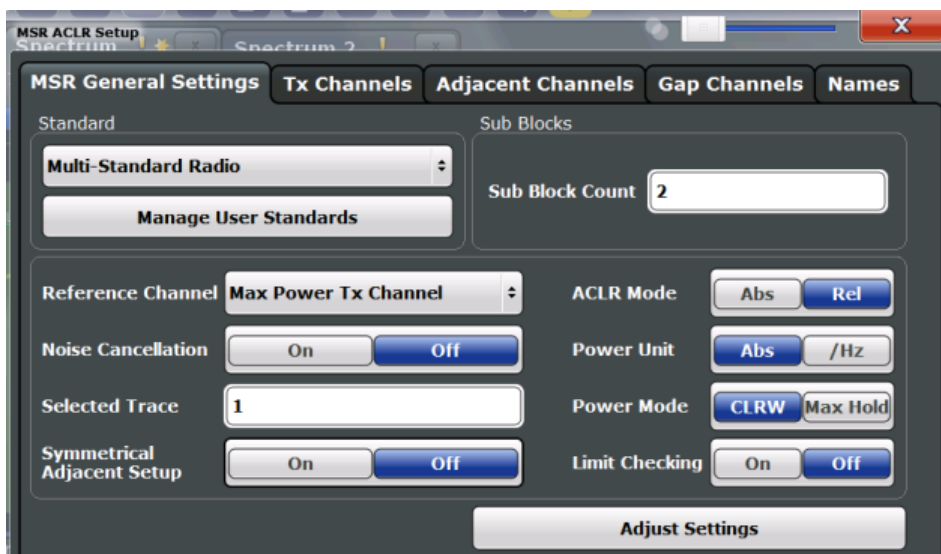
- [General MSR ACLR Measurement Settings](#).....65
- [MSR Sub Block and Tx Channel Definition](#).....70
- [MSR Adjacent Channel Setup](#).....73
- [MSR Gap Channel Setup](#).....76
- [MSR Channel Names](#).....79

2.3.5.1 General MSR ACLR Measurement Settings

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

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

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



- Standard.....66
 - [Predefined Standards](#).....66
 - [User-Defined Standards](#).....66
- Number of Sub Blocks.....68
- Reference Channel.....68
- Noise Cancellation.....68
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- Absolute and Relative Values (ACLR Mode).....69
- Channel Power Levels and Density (Power Unit).....69
- Power Mode.....69

Optimized Settings (Adjust Settings).....	69
Symmetrical Adjacent Setup.....	70
Limit Checking.....	70

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 2.3.5, "MSR ACLR Configuration"](#), on page 64).

If any other predefined standard (or "NONE") is selected, the "ACLR Setup" dialog box is restored (see [Chapter 2.3.4, "Channel Power Configuration"](#), on page 54).

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, the settings can be changed.

The predefined standards contain the following settings:

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

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

For details on the available standards, see [Chapter 2.3.9, "Reference: Predefined CP/ACLR Standards"](#), on page 88.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER:PRESet` on page 415

User-Defined Standards ← Standard

Access: "CP/ACLR Setup" > "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:\R_S\instr\acp_std` directory.

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

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

Channel Power and Adjacent-Channel Power (ACLR) Measurement

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 2.3.6.4, "How to Manage User-Defined Configurations"](#), on page 83.

Remote command:

To query all available standards:

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

on page 416

To load a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER:PRESet` on page 415

To save a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER:STANDARD:SAVE` on page 417

Channel Power and Adjacent-Channel Power (ACLR) Measurement

To delete a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER:STANDARD:DELETE` on page 416

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 2.3.3.4, "Measurement on Multi-Standard Radio \(MSR\) Signals"](#), on page 50.

Remote command:

`[SENSe:]POWER:ACHannel:SBCount` on page 440

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. (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 424

`[SENSe:]POWER:ACHannel:REFERENCE:TXChannel:AUTO` on page 424

Noise Cancelation

The R&S ESW can correct the results by removing the inherent noise of the analyzer, which increases the dynamic range.

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

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

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors:

- RMS
- Average
- Sample
- Positive Peak

Channel Power and Adjacent-Channel Power (ACLR) Measurement

Remote command:

[\[SENSe:\] POWER:NCORrection](#) on page 587

Selected Trace

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

Remote command:

[\[SENSe:\] POWER:TRACe](#) on page 415

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 446

Channel Power Levels and Density (Power Unit)

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

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

"channel power density = channel power – log₁₀(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:RESULT:PHZ](#) on page 445

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:MODE](#) on page 410

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 47
- "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 414

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 444

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.

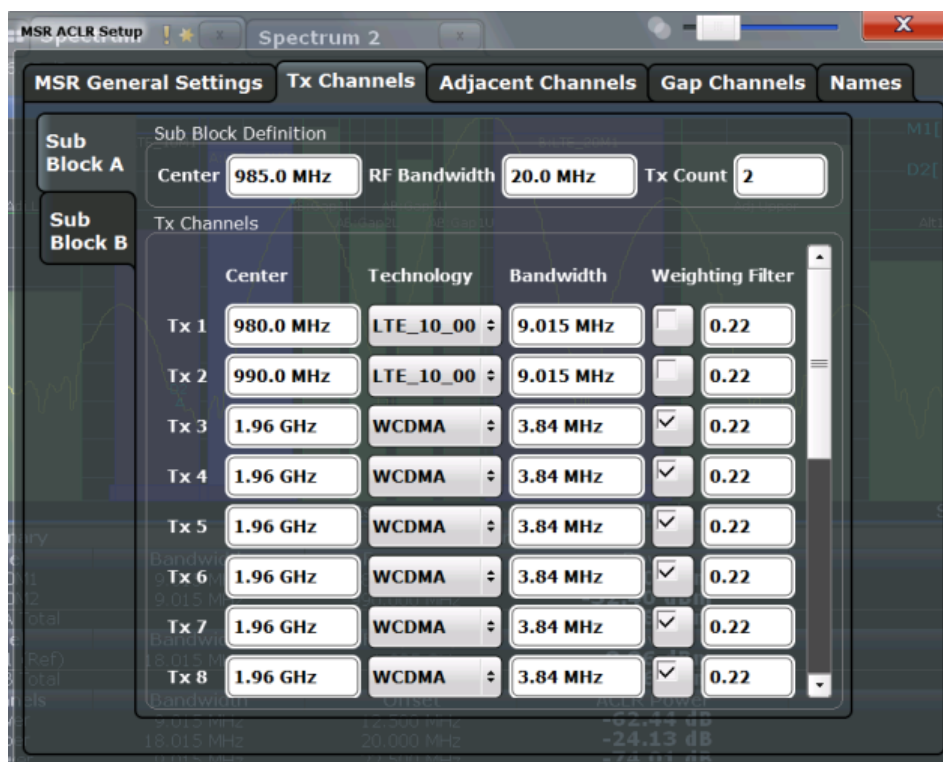
Remote command:

`CALCulate<n>:LIMit<k>:ACPower[:STATe]` on page 430

2.3.5.2 MSR Sub Block and Tx Channel Definition

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

Channel Power and Adjacent-Channel Power (ACLR) Measurement



For details on MSR signals, see [Chapter 2.3.3.4, "Measurement on Multi-Standard Radio \(MSR\) Signals"](#), on page 50.

For details on setting up channels, see [Chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement"](#), on page 82.

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

- Sub Block Definition..... 71
 - └ Sub Block Center Frequency..... 72
 - └ RF Bandwidth..... 72
 - └ Number of Tx Channels (Tx Count)..... 72
- Tx Channel Definition..... 72
 - └ Tx Center Frequency..... 72
 - └ Technology Used for Transmission..... 72
 - └ Tx Channel Bandwidth..... 73
 - └ Weighting Filters..... 73

Sub Block Definition

Sub blocks are groups of transmit channels in an MSR signal. Up to five 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.

Sub Block Center Frequency ← 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 441

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 442

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 443

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 2.3.6.3, "How to Configure an MSR ACLR Measurement"](#), on page 82.

Remote command:

[SENSe:] POWER:ACHannel:SBLOCK<sb>:NAME[:CHANNEL<ch>] on page 441

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 441

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

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"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 442

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|BWIDth[:CHANnel<ch>]`
on page 440

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 438

Alpha value:

`[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLOCK<sb>:CHANnel<ch>`
on page 437

2.3.5.3 MSR Adjacent Channel Setup

The "Adjacent Channel" tab in the "MSR ACLR Setup" dialog box 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 70), the dialog box is reduced as the upper and lower channels are identical.

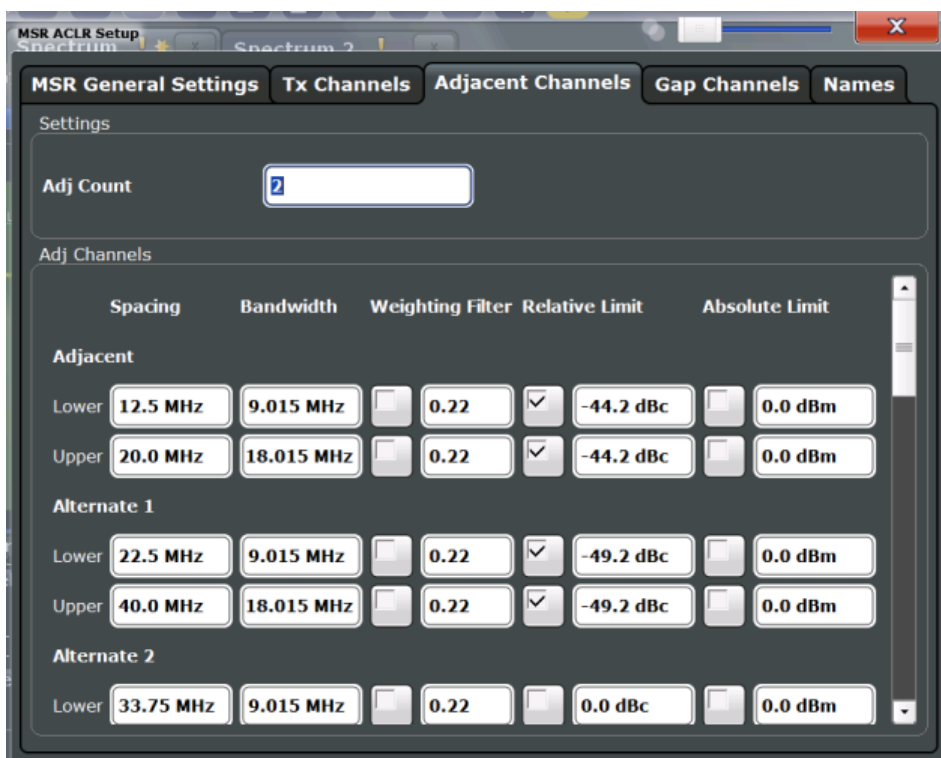


Figure 2-28: Asymmetrical adjacent channel definition

For details on setting up channels, see [Chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement"](#), on page 82.

Number of Adjacent Channels (ADJ Count)..... 74

Adjacent Channel Definition..... 74

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- └ Limit Checking..... 76

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 58).

Remote command:

[\[SENSe:\] POWER:ACHannel:ACPairs](#) on page 417

Adjacent Channel Definition

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

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

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

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- 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 2.3.5.5, "MSR Channel Names"](#), on page 79).

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 2.3.6.3, "How to Configure an MSR ACLR Measurement"](#), on page 82

Remote command:

`[SENSe:] POWER:ACHannel:SPACing[:ACHannel]` on page 420

`[SENSe:] POWER:ACHannel:SPACing:ALternate<ch>` on page 420

`[SENSe:] POWER:ACHannel:SPACing:UACHannel` on page 444

`[SENSe:] POWER:ACHannel:SPACing:UALternate<ch>` on page 444

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|BWIDth:ACHannel` on page 417

`[SENSe:] POWER:ACHannel:BANDwidth|BWIDth:ALternate<ch>` on page 418

`[SENSe:] POWER:ACHannel:BANDwidth|BWIDth:UACHannel` on page 436

`[SENSe:] POWER:ACHannel:BANDwidth|BWIDth:UALternate<ch>` on page 436

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 422

`[SENSe:] POWER:ACHannel:FILTer[:STATe]:ALternate<ch>` on page 423

`[SENSe:] POWER:ACHannel:FILTer[:STATe]:UACHannel` on page 438

`[SENSe:] POWER:ACHannel:FILTer[:STATe]:UALternate<ch>` on page 439

Alpha value:

`[SENSe:] POWER:ACHannel:FILTer:ALPHa:ACHannel` on page 421

`[SENSe:] POWER:ACHannel:FILTer:ALPHa:ALternate<ch>` on page 422

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[SENSe:] POWer:ACHannel:FILTer:ALPHa:UACHannel on page 437

[SENSe:] POWer:ACHannel:FILTer:ALPHa:UALTernate<ch> on page 437

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 70).

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

Remote command:

CALCulate<n>:LIMit<k>:ACPowEr[:STATe] on page 430

CALCulate<n>:LIMit<k>:ACPowEr:ACHannel:ABSolute:STATe on page 425

CALCulate<n>:LIMit<k>:ACPowEr:ACHannel:ABSolute on page 425

CALCulate<n>:LIMit<k>:ACPowEr:ACHannel[:RELative]:STATe
on page 426

CALCulate<n>:LIMit<k>:ACPowEr:ACHannel[:RELative] on page 426

CALCulate<n>:LIMit<k>:ACPowEr:ALTernate<ch>:ABSolute:STATe

on page 428

CALCulate<n>:LIMit<k>:ACPowEr:ALTernate<ch>:ABSolute on page 427

CALCulate<n>:LIMit<k>:ACPowEr:ALTernate<ch>[:RELative]:STATe

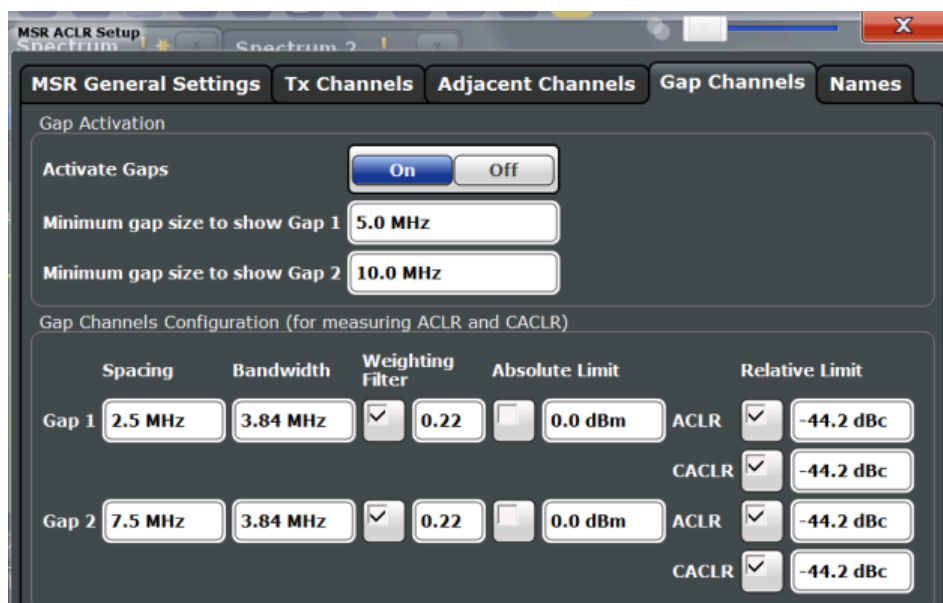
on page 429

CALCulate<n>:LIMit<k>:ACPowEr:ALTernate<ch>[:RELative] on page 428

CALCulate<n>:LIMit<k>:ACPowEr:ACHannel:RESult? on page 427

2.3.5.4 MSR Gap Channel Setup

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



For details on MSR signals, see [Chapter 2.3.3.4, "Measurement on Multi-Standard Radio \(MSR\) Signals"](#), on page 50.

For details on setting up channels, see [Chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement"](#), on page 82.

Activate Gaps.....77

Minimum gap size to show gap 1/2.....77

Gap Channel Definition.....77

- L Gap Channel Spacings.....78
- 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 435
```

Minimum gap size to show gap 1/2

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>:MSIZE on page 439
```

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 contains two channels, the *gap channels*. The channels in the upper gap are identical to those in the lower gap, but inverted. Thus, in the R&S ESW MSR ACLR measurement, only two gap channels are configured.

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)

Gap Channel Spacings ← 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. Since the upper and lower gap channels are identical, only two channels must be configured. The required spacing can be determined according to the following formula (indicated for lower channels):

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

(See also [Figure 2-25](#) and [Figure 2-26](#).)

For details, see [Chapter 2.3.6.3, "How to Configure an MSR ACLR Measurement"](#), on page 82.

Remote command:

`[SENSe:] POWER:ACHannel:SPACing:GAP<gap>` on page 443

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 53).

Remote command:

`[SENSe:] POWER:ACHannel:BANDwidth|BWIDth:GAP<gap>` on page 435

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>` on page 438

`[SENSe:] POWER:ACHannel:FILTer:ALPHa:GAP<gap>` on page 436

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.

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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 70).

Remote command:

`CALCulate<n>:LIMit<k>:ACPower[:STATE]` on page 430

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATE` on page 432

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative:]STATE`
on page 433

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLR][:RELative:]STATE`
on page 434

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute` on page 432

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR[:RELative]` on page 433

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>[:CACLR][:RELative]`
on page 434

on page 434

`CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?` on page 434

2.3.5.5 MSR Channel Names

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

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

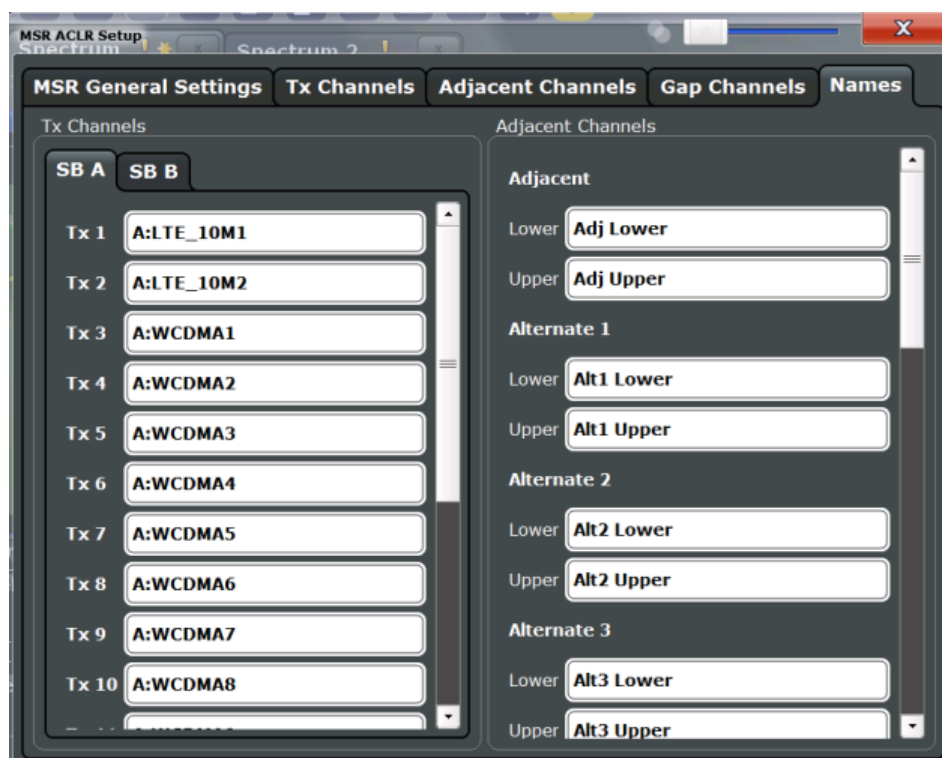


Figure 2-29: Channel name definition for asymmetric adjacent channels

Remote command:

[SENSe:] POWER:ACHannel:SBLOCK<sb>:NAME[:CHANnel<ch>] on page 441

[SENSe:] POWER:ACHannel:NAME:ACHannel on page 419

[SENSe:] POWER:ACHannel:NAME:ALternate<ch> on page 419

[SENSe:] POWER:ACHannel:NAME:UACHannel on page 440

[SENSe:] POWER:ACHannel:NAME:UALternate<ch> on page 440

2.3.6 How to Perform Channel Power Measurements

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

- [How to Perform a Standard Channel Power Measurement](#).....80
- [How to Set up the Channels](#)..... 80
- [How to Configure an MSR ACLR Measurement](#).....82
- [How to Manage User-Defined Configurations](#).....83
- [How to Compare the Tx Channel Power in Successive Measurements](#).....84

2.3.6.1 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 the MEAS key or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".
The measurement is started immediately with the default settings.
3. Select the "CP / ACLR Standard" softkey and select a standard from the list.
The measurement is restarted with the predefined settings for the selected standard.
4. If necessary, edit the settings for your specific measurement as described in [Chapter 2.3.6.2, "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).

2.3.6.2 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 stan-

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 2.3.6.4, "How to Manage User-Defined Configurations"](#), on page 83.

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



In the "Channel Setup" dialog box, you can define the channel settings for all channels, 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"), ...

2.3.6.3 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 the MEAS key or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".
The measurement is started immediately with the default settings.
3. Select the "CP / ACLR Standard" softkey and select the "Multi-Standard Radio" standard from the list.
4. Select the "CP / ACLR Config" softkey to configure general MSR settings, including the number of sub blocks (up to 5).
To configure asymmetric adjacent channels, deactivate the "Symmetrical" option in the general MSR settings.
5. 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 and select the technology used for transmission. If necessary, edit the bandwidth and define the use of a weighting filter for the channel.
6. Select the "Adjacent Channels" tab to configure the adjacent channels.
7. 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.
8. Select the "Gap Channels" tab to configure the gap channels.
9. Define the 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. The required spacing can be determined as follows:
Spacing = [CF of the gap channel] - [left sub block center] + ([RF bandwidth of left sub block] / 2)
 - The bandwidth

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- 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.
10. If power limits are defined and activated, activate global limit checking for the measurement on the "MSR General Settings" tab.
 11. 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.

2.3.6.4 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 the "CP / ACLR Config" softkey to display the "ACLR Setup" dialog box.
2. Configure the measurement as required (see also [Chapter 2.3.6.2, "How to Set up the Channels"](#), on page 80).
3. In the "General Settings" tab, select the "Manage User Standards" button to display the "Manage" dialog box.
4. Define a file name for the user standard and select its storage location.
By default, the XML file is stored in C:\R_S\Instr\acp_std\. However, you can define any other storage location.
5. Select "Save".

To load a user-defined configuration

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

3. Select "Load".

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

2.3.6.5 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 2.3.6.2, "How to Set up the Channels"](#), on page 80).
2. Select the "Set CP Reference" softkey in the "Ch Power" menu, or the "Set CP Reference" button in the "ACLR Setup" dialog box.

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

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

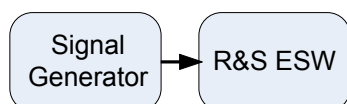
2.3.7 Measurement Examples

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.

- [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

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

The R&S 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.

7. Set the optimal reference level and RF attenuation for the applied signal level using the "Auto Level" function in the AUTO SET menu.
8. Activate "Fast ACLR" mode in the "ACLR Setup" dialog box to increase the repeatability of results.

The R&S ESW sets the optimal RF attenuation and the reference level based on the transmission channel power to obtain the maximum dynamic range. The [Figure 2-30](#) shows the result of the measurement.

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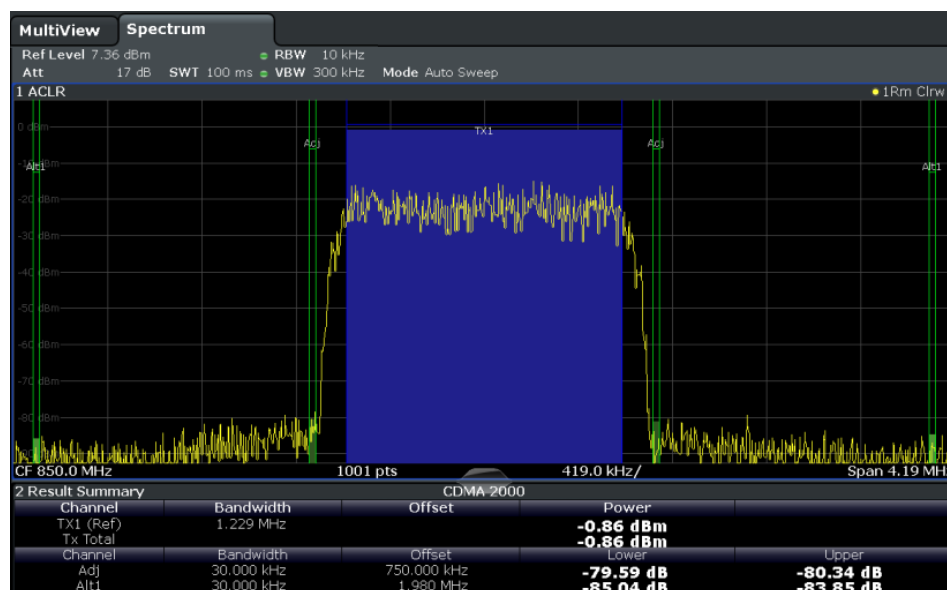


Figure 2-30: Adjacent channel power measurement on a CDMA2000 1x signal

2.3.7.2 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.
4. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.

Channel Power and Adjacent-Channel Power (ACLR) Measurement

5. In the "ACLR Setup" dialog box, set up a single Tx channel with the channel bandwidth 1.23 MHz.
6. Select the "Adjust Settings" softkey.
The settings for the frequency span, the bandwidth (RBW and VBW) and the detector are automatically set to the optimum values required for the measurement.
7. Stabilize the measurement result by increasing the sweep time.
Set the sweep time to 1 s.

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

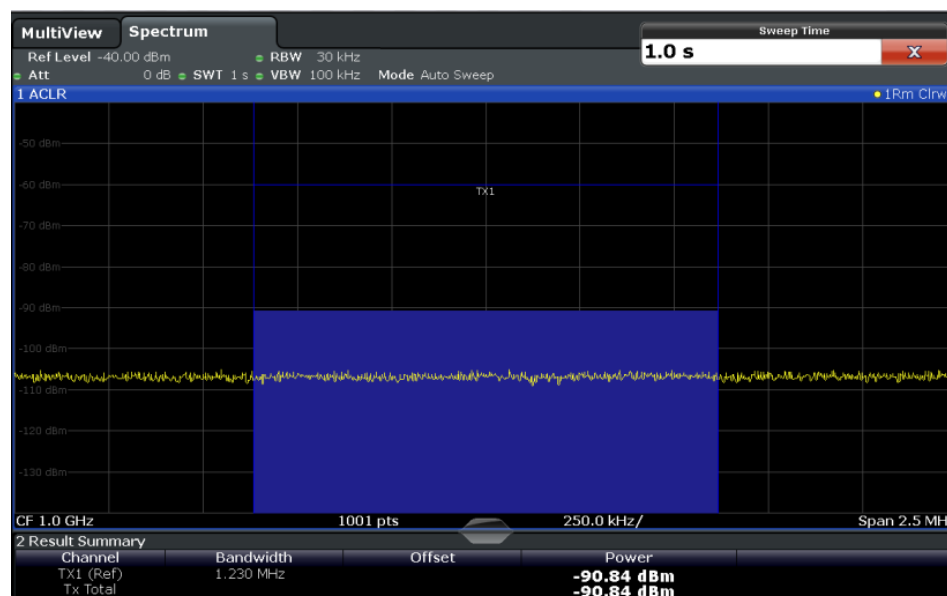


Figure 2-31: Measurement of the R&S ESW's intrinsic noise power in a 1.23 MHz channel bandwidth.

2.3.8 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 280).
- Reduce the **sweep time** and thus the amount of data to be captured and calculated; however, consider the requirements regarding the standard deviation.

Channel Power and Adjacent-Channel Power (ACLR) Measurement

- 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.

2.3.9 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 the "CP / ACLR Standard" softkey in the "Ch Power" menu or the selection list in the "General Settings" tab of the "ACLR Setup" dialog box (see ["Standard"](#) on page 56).

Table 2-10: Predefined CP / ACLR standards with remote command parameters

Standard	Remote parameter
None	NONE
Multi-Standard Radio	MSR
EUTRA/LTE Square	EUTRa
EUTRA/LTE Square/RRC	REUTra
W-CDMA 3GPP FWD	FW3Gppcdma
W-CDMA 3GPP REV	RW3Gppcdma
CDMA IS95A FWD	F8CDma
CDMA IS95A REV	R8CDma
CDMA IS95C Class 0 FWD*)	FIS95c0
CDMA IS95C Class 0 REV*)	RIS95c0
CDMA J-STD008 FWD	F19Cdma
CDMA J-STD008 REV	R19Cdma
CDMA IS95C Class 1 FWD*)	FIS95c1
CDMA IS95C Class 1 REV*)	RIS95c1
CDMA2000	S2CDma
TD-SCDMA FWD	FTCDma
TD-SCDMA REV	TRCDma

Standard	Remote parameter
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 *).

2.4 Carrier-to-Noise Measurements

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

- [About the Measurement](#).....89
- [Carrier-to-Noise Results](#).....90
- [Carrier-to-Noise Configuration](#)..... 91
- [How to Determine the Carrier-to-Noise Ratio](#)..... 93

2.4.1 About the Measurement

The largest signal in the frequency span is the carrier. It is searched when the C/N or C/N₀ function is activated and is marked using a fixed reference marker ("FXD").

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

The noise power of the channel is subtracted from the maximum carrier signal level, and in the case of a C/N_0 measurement, it is referred to a 1 Hz bandwidth.



For this measurement, the RMS detector is activated.

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

Measurement process

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

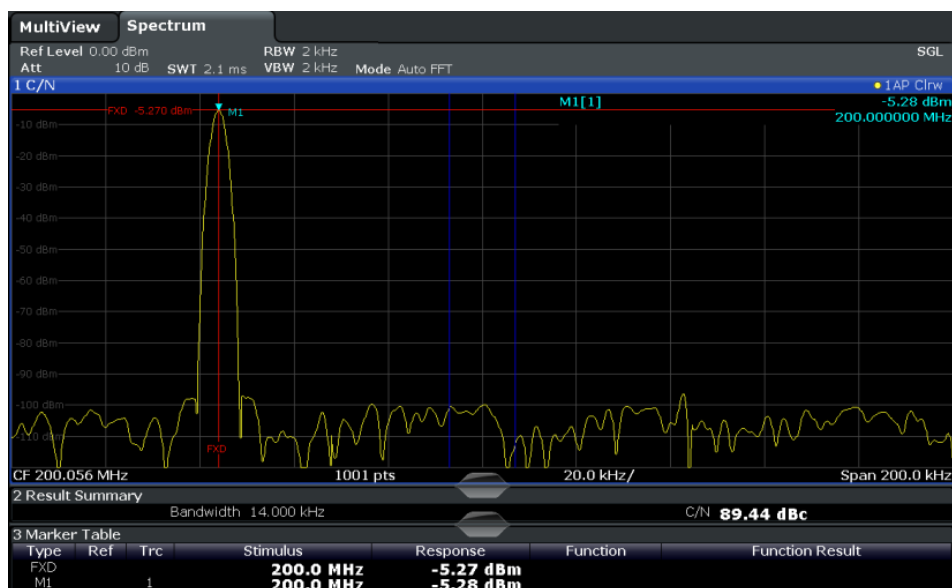
- The carrier is outside the analyzed channel: In this case, it is sufficient to switch on the desired measurement function and to set the channel bandwidth. The carrier/noise ratio is displayed on the screen.
- The carrier is inside the analyzed channel: In this case, the measurement must be performed in two steps:
 - First, perform the reference measurement by switching on either the C/N or the C/N_0 measurement and waiting for the end of the next measurement run. The fixed reference marker is set to the maximum of the measured carrier signal.
 - Then, switch off the carrier so that only the noise of the test setup is active in the channel. The carrier-to-noise ratio is displayed after the subsequent measurement has been completed.

Frequency Span

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

2.4.2 Carrier-to-Noise Results

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



Remote command:

You can also query the determined carrier-to-noise ratio via the remote command `CALC:MARK:FUNC:POW:RES? CN` or `CALC:MARK:FUNC:POW:RES? CN0`, see [CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?](#) on page 411.

2.4.3 Carrier-to-Noise Configuration

The Carrier-to-noise ratio (C/N) and the Carrier-to-noise ratio in relation to the bandwidth (C/N_0) measurements are selected via the corresponding button in the "Select Measurement" dialog box. The measurement is started immediately with the default settings. It can be configured via the MEAS CONFIG key or in the "Carrier Noise" configuration dialog box, which is displayed as a tab in the "Analysis" dialog box or when you select the "Carrier Noise Config" softkey from the "Carrier Noise" menu.



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



The easiest way to configure a measurement is using the configuration "Overview", see [Chapter 3.2, "Configuration Overview"](#), on page 216.

The remote commands required to perform these tasks are described in [Chapter 5.3.4, "Measuring the Carrier-to-Noise Ratio"](#), on page 451.

C/N	92
C/N₀	92
Channel Bandwidth	92
Adjust Settings	92

C/N

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

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use the "Marker to Trace" softkey in the "Marker" menu (see ["Assigning the Marker to a Trace"](#) on page 205).

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:POWer:SElect` on page 413

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?` on page 411

`CALCulate<n>:MARKer<m>:FUNction:POWer[:STATe]` on page 414

C/N₀

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

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use the "Marker to Trace" softkey in the "Marker" menu (see ["Assigning the Marker to a Trace"](#) on page 205).

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:POWer:SElect` on page 413

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?` on page 411

`CALCulate<n>:MARKer<m>:FUNction:POWer[:STATe]` on page 414

Channel Bandwidth

Defines the measurement channel bandwidth.

The default setting is 14 kHz.

Remote command:

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]` on page 418

Adjust Settings

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

"4 x channel bandwidth + measurement margin"

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

Remote command:

`[SENSe:]POWer:ACHannel:PRESet` on page 414

2.4.4 How to Determine the Carrier-to-Noise Ratio

1. Press the "C/N, C/N₀" softkey to configure the carrier-to-noise ratio measurement.
2. To change the channel bandwidth to be analyzed, press the "Channel Bandwidth" softkey.
3. To optimize the settings for the selected channel configuration, press the "Adjust Settings" softkey.
4. To activate the measurements without reference to the bandwidth, press the "C/N" softkey.
To activate the measurements with reference to the bandwidth, press the "C/N₀" softkey .
5. If the carrier signal is located within the analyzed channel bandwidth, switch off the carrier signal so that only the noise is displayed in the channel and perform a second measurement.

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

2.5 Occupied Bandwidth Measurement (OBW)

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

• About the Measurement	93
• OBW Results	95
• OBW Configuration	96
• How to Determine the Occupied Bandwidth	98
• Measurement Example	98

2.5.1 About the Measurement

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

Measurement principle

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



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 re-calculated for the new range.



For step-by-step instructions see ["How to determine the OBW for a multicarrier signal using search limits"](#) on page 98.

Prerequisites

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

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

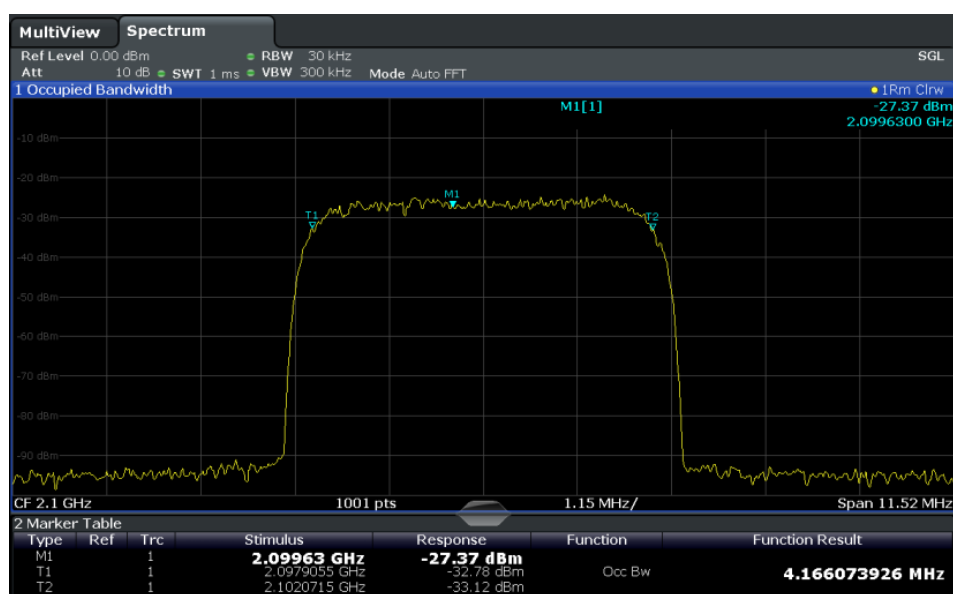
2.5.2 OBW Results

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.



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.

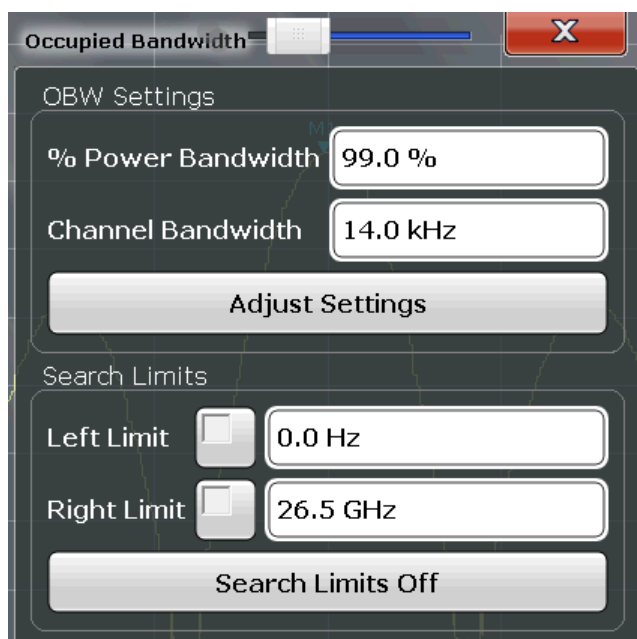
`CALC:MARK:FUNC:POW:SEL OBW`, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer:SElect](#) on page 413

[CALCulate<n>:MARKer<m>:FUNCTION:POWer\[:STATE\]](#) on page 414

`CALC:MARK:FUNC:POW:RES? OBW`, see [CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult?](#) on page 411

2.5.3 OBW Configuration

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



This measurement is not available in zero span.



Configuring search limits for OBW measurement

The OBW measurement uses the same search limits as defined for marker search (see [search limits](#)). However, only the left and right limits are considered.

The remote commands required to perform these tasks are described in [Chapter 5.3.5, "Measuring the Occupied Bandwidth"](#), on page 451.

% Power Bandwidth	96
Channel Bandwidth	97
Adjust Settings	97
Search Limits (Left / Right)	97
Deactivating All Search Limits	97

% 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| BWIDth` on page 452

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 97). 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|BWIDth[:CHANnel<ch>]` on page 418

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 it should be selected such that the signal maximum is close to the reference level (see "[Setting the Reference Level Automatically \(Auto Level\)](#)" on page 303).

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

Remote command:

`[SENSe:] POWER:ACHannel:PRESet` on page 414

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 354.

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 646

`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 645

`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 645

Deactivating All Search Limits

Deactivates the search range limits.

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 646

`CALCulate<n>:THReshold:STATe` on page 647

2.5.4 How to Determine the Occupied Bandwidth

How to determine the OBW for a single signal

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

The result is displayed as OBW in the marker results.

How to determine the OBW for a multicarrier signal using search limits

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

The result for the first carrier is displayed as OBW in the marker results.

6. Change the search limits so the search area contains the next carrier signal as described in [step 4](#).

The OBW is re-calculated and the result for the next carrier is displayed. A new sweep is not necessary!

7. Continue in this way until all carriers have been measured.

2.5.5 Measurement Example

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

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

The result is displayed as OBW in the marker results.

2.6 Spectrum Emission Mask (SEM) Measurement

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

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• Typical Applications	100
• SEM Results	100
• SEM Basics	103
• SEM Configuration	114
• How to Perform a Spectrum Emission Mask Measurement	130
• Measurement Example: Multi-SEM Measurement	135
• Reference: SEM File Descriptions	136

2.6.1 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.

2.6.2 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.

2.6.3 SEM Results

As a result of the Spectrum Emission Mask measurement, the following results are displayed in a diagram (see also [Chapter 2.6.4.2, "Limit Lines in SEM Measurements"](#), on page 106):

- The measured signal levels
- 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 2-32](#), " $31 < P < 39$ " is indicated as the used power class is defined from 31 to 39.

Spectrum Emission Mask (SEM) Measurement

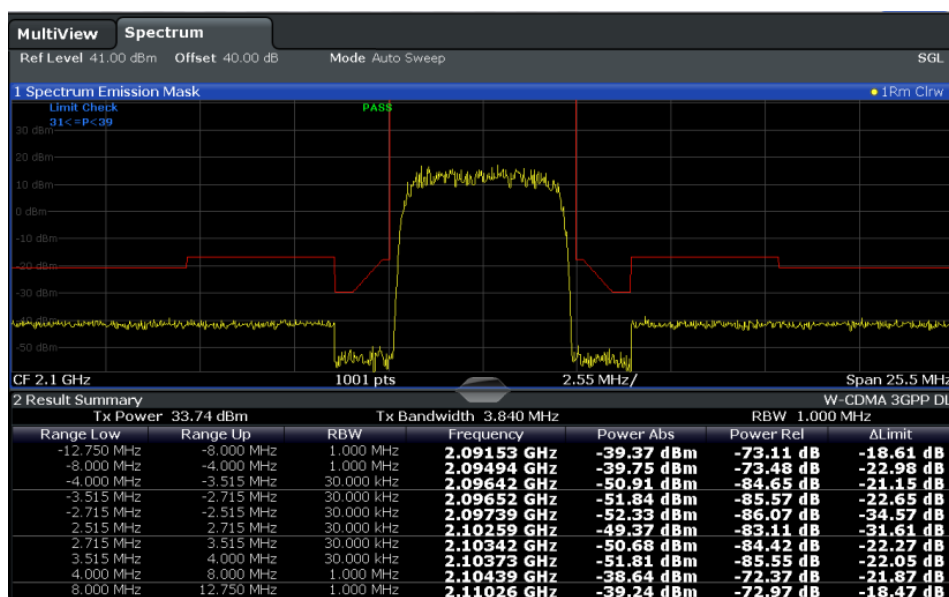


Figure 2-32: Spectrum Emission Mask result displays

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 2.6.4.2, "Limit Lines in SEM Measurements"](#), on page 106).

The following information is provided in the result summary:

Label	Description
General Information	
Standard	Loaded standard settings
Tx Power	Power of the reference range
Tx Bandwidth	Tx bandwidth used by the reference range
RBW	RBW used by the reference range
Range results	
Range Low	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 2.6.5.7, "List Evaluation \(Results Configuration\)"](#),

on page 129). 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 blue squares in the diagram (optionally, see [Show Peaks](#) in the "List Evaluation" settings).

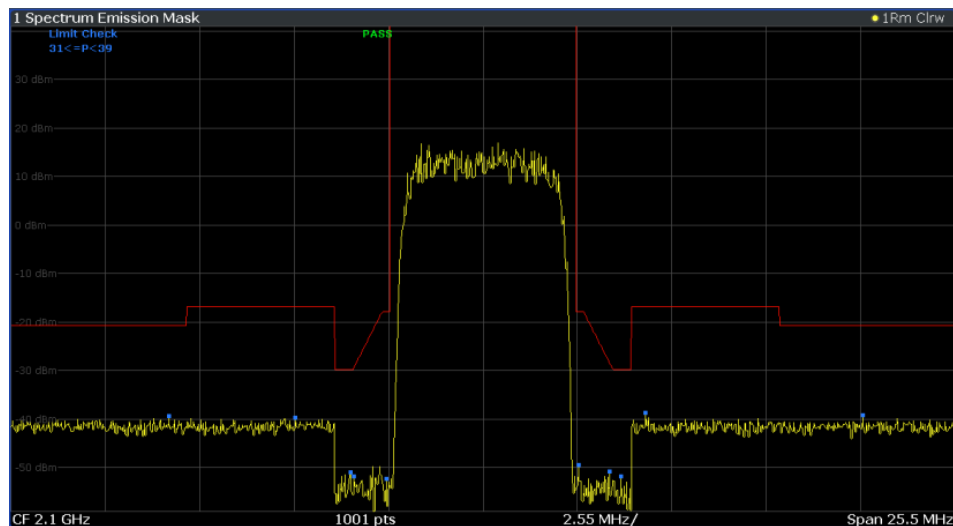


Figure 2-33: Detected peak display in SEM measurement

Furthermore, you can export the results of the result summary to a file which can be exported to another application for further analysis.

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 2.6.4.5, "SEM with Multiple Sub Blocks \("Multi-SEM"\)](#)", on page 110 for details). Up to three sub blocks (with two gaps) can be defined. For each sub block and each gap, the results described above are provided individually in the result summary.

Spectrum Emission Mask (SEM) Measurement

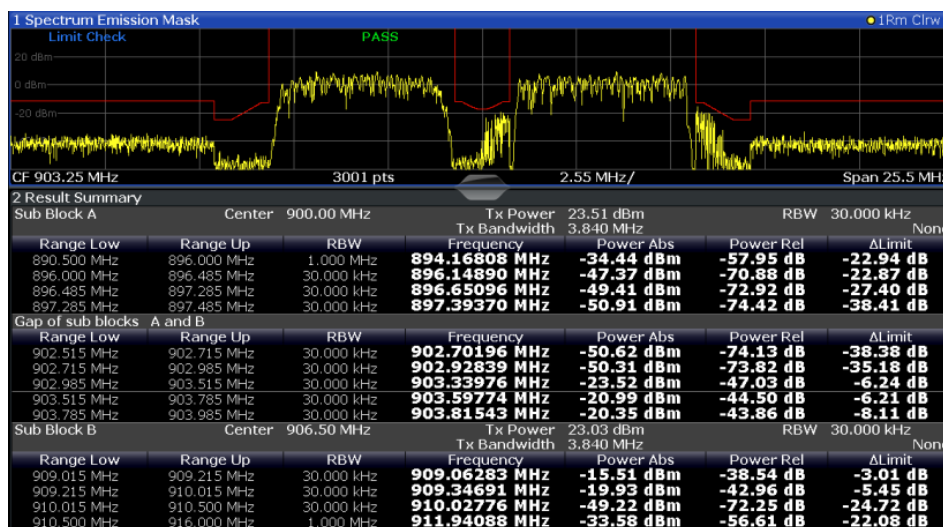


Figure 2-34: SEM results for multiple sub blocks

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<k>:FAIL?` on page 687 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 411.

The measured *power trace* can be queried using `TRAC:DATA?` and `TRAC:DATA:X?`, see `TRACe<n>[:DATA]` on page 617 and `TRACe<n>[:DATA]:X?` on page 618:

The measured *peak power list* can be queried using `TRAC:DATA? LIST`, see `TRACe<n>[:DATA]` on page 617.

2.6.4 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.

- [Ranges and Range Settings](#)..... 104
- [Limit Lines in SEM Measurements](#)..... 106
- [Fast SEM Measurements](#)..... 108
- [Multi-Standard Radio \(MSR\) SEM Measurements](#)..... 110
- [SEM with Multiple Sub Blocks \("Multi-SEM"\)](#)..... 110

2.6.4.1 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 2.6.5.1, "Sweep List"](#), on page 114.

For details on defining the limits (masks), see [Chapter 2.6.4.2, "Limit Lines in SEM Measurements"](#), on page 106.

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

Range definition

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

The changes of the sweep list are only kept until you load another parameter set (by pressing PRESET or by loading an XML file). If you want a parameter set to be available permanently, create an XML file for this configuration (for details refer to ["How to save a user-defined SEM settings file"](#) on page 134).

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 122).
- Define frequency values for each range relative to the center frequency.

To change the start frequency of the first range or the stop frequency of the last range, select the appropriate span with the SPAN key. You can define a span that is smaller than the combined span of all 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.

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 2.6.4.3, "Fast SEM Measurements"](#), on page 108).

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

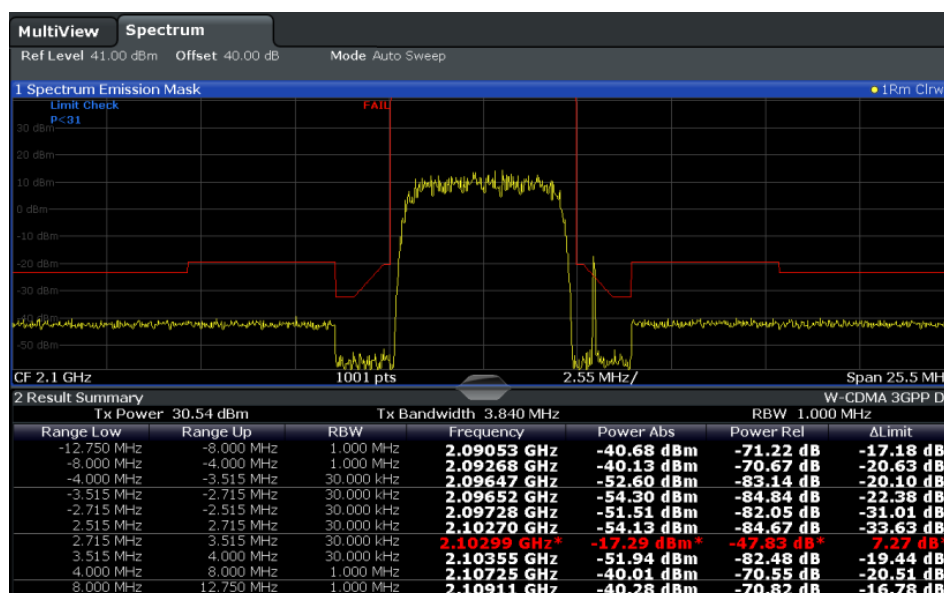
instance, for higher input levels a transmission standard can allow for higher power levels in adjacent channels, whereas for lower input levels the allowed deviation can be stricter. Up to four different power classes can be defined.

2.6.4.2 Limit Lines in SEM Measurements

On 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 key. For SEM measurements, however, special limit lines are available via the "Sweep List", and it is strongly recommended that you use only these limit line definitions.

In the "Sweep List", you can define a limit line for each power class that varies its level according to the specified frequency ranges. 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 measurement 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 2-11: 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 both the absolute and the relative limits, the check fails (see Relative limit line functions 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 both the absolute and the relative limits, the check fails.	The less strict (higher) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: the power must exceed the absolute limit, as well as the absolute and relative function values.
Abs or Rel	If the power exceeds either the absolute or the relative limits, the check fails.	The stricter (lower) limit line is displayed for each range. If you use a function to define the relative limit start or stop value, the signal is checked against an additional condition: if the power exceeds the absolute limit, or the higher of the absolute and relative function values, the check fails.

Relative limit line functions

A new function allows you to define limit lines whose start or end points (or both) are variable, depending on the carrier power. Thus, the resulting limit line 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 2-11](#)).

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 failed for the range, 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 2.6.5.7, "List Evaluation \(Results Configuration\)"](#), on page 129).

2.6.4.3 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 or transducer factors, can nevertheless be defined individually for each range.

Prerequisites

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

- The frequency ranges are consecutive, without frequency gaps
- The following sweep settings are identical (for details see [Chapter 2.6.5.1, "Sweep List"](#), on page 114):
 - Filter Type
 - RBW
 - VBW
 - Sweep Time Mode
 - Reference Level
 - Rf Attenuation Mode
 - RF Attenuation
 - Preamplification

Activating Fast SEM mode

"Fast SEM" mode is activated in the sweep list (see [Chapter 2.6.5.1, "Sweep List"](#), on page 114) 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>:HighSpeed on page 457



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 2.6.4.5, "SEM with Multiple Sub Blocks \("Multi-SEM"\)"](#), on page 110.

Consequences

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



If "Symmetrical Setup" mode is active when "Fast SEM" mode is activated, not all sweep list settings can be configured symmetrically automatically (see also ["Symmetric Setup"](#) on page 120).

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

Sweep List	Reference Range	Power Classes	Standard Files		
	Range 1	Range 2	Range 3	Range 4	Range 5
Range Start	-13.25 GHz	-12.75 MHz	-2.515 MHz	2.515 MHz	12.75 MHz
Range Stop	-12.75 MHz	-2.515 MHz	2.515 MHz	12.75 MHz	13.25 GHz
Fast SEM	On	On	On	On	On
Filter Type	Normal(3...	---	Channel	---	---
Res BW	3 MHz	---	30 kHz	---	---
Video BW	3 MHz	---	3 MHz	---	---
Sweep Time Mode	---	---	---	---	---
Sweep Time	27.5 ms	---	37.5 ms	---	---
Ref. Level	0 dBm	---	0 dBm	---	---
RF Att. Mode	Auto	---	Auto	---	---
RF Attenuator	10 dB	---	10 dB	---	---
Transducer	None	None	None	None	None
Limit Check 1	Relative	Relative	Relative	Relative	Relative
Abs Limit Start 1	-13 dBm	-13 dBm	-13 dBm	-13 dBm	-13 dBm
Abs Limit Stop 1	-13 dBm	-13 dBm	-13 dBm	-13 dBm	-13 dBm
Rel Limit Start 1	-50 dBc	-50 dBc	300 dBc	-50 dBc	-50 dBc
Rel Limit Stop 1	-50 dBc	-50 dBc	300 dBc	-50 dBc	-50 dBc

Figure 2-35: Sweep list using Fast SEM mode

In [Figure 2-35](#), a sweep list is shown for which Fast SEM is activated. The formerly five separately defined ranges are combined to two sweep ranges internally.

2.6.4.4 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.

2.6.4.5 SEM with Multiple Sub Blocks ("Multi-SEM")

In the Spectrum 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 three sub blocks (with two gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines and MSR 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.

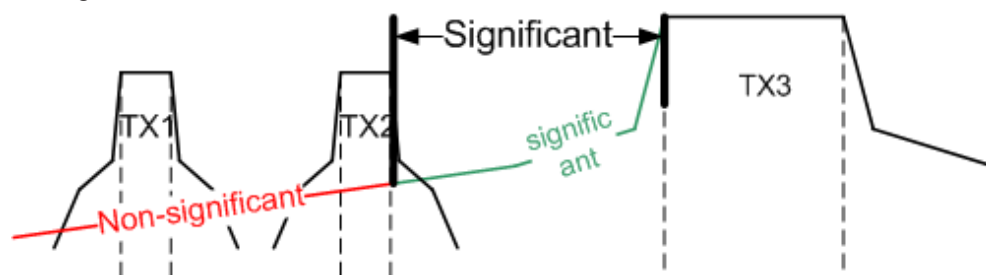


Figure 2-36: Behavior for overlapping masks

- 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 2-12: Limit lines in overlapping ranges crossing the mid-frequency

<p>The diagram shows two sub blocks, Sub block 1 and Sub block 2, separated by a mid-frequency region. Two transmitters, TX1 and TX2, are shown. Range 3 (blue diagonal lines) is in Sub block 1, and Range 6 (orange diagonal lines) is in Sub block 2. Range 4 (blue diagonal lines) and Range 5 (orange diagonal lines) overlap in the mid-frequency region. Range 4 is labeled "None" and Range 5 is labeled "None".</p>	<p>The diagram shows the same setup as the initial situation, but the overlapping region is now divided into two subranges: Subrange 4a (blue diagonal lines) and Subrange 5a (orange diagonal lines). Subrange 4a is labeled "Range 3 applies" and Subrange 5a is labeled "Range 6 applies".</p>
<p>Initial situation: overlapping ranges Range 4 ("None") + Range 5 ("None") overlap and cross the mid-frequency between sub blocks 1 and 2</p>	<p>Result: Subranges 4a and 5a are created left and right of the mid-frequency; For subrange 4a: limit line and parameters of range 4 apply 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".

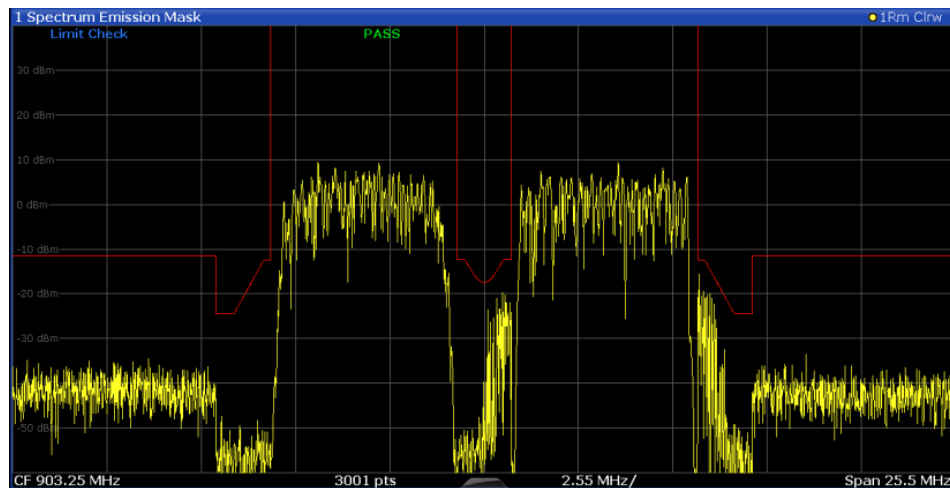


Figure 2-37: Summarized limit line for multiple sub blocks

2.6.5 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 5.3.6, "Measuring with Spectrum Emission Masks"](#), on page 453.



Global span settings

The span of the signal to be monitored is configured in the general span settings (see [Chapter 3.4.2, "Frequency and Span Settings"](#), on page 255). Only ranges within this global span are considered for the SEM measurement.



Multi-SEM configuration

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see [Chapter 2.6.4.5, "SEM with Multiple Sub Blocks \("Multi-SEM"\)"](#), on page 110). Up to three sub blocks (with two gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines and MSR can be defined in individual tabs. In addition, settings on the sub blocks themselves must be configured in the "Sub Blocks" tab of the "Spectrum Emission Mask" configuration dialog box (see [Chapter 2.6.5.2, "Multi-SEM \(Sub Block\) Settings"](#), on page 120).

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

- [Sweep List](#)..... 114
- [Multi-SEM \(Sub Block\) Settings](#) 120
- [Reference Range](#)..... 121
- [Power Classes](#)..... 122
- [MSR Settings](#)..... 124
- [Standard Files](#)..... 127
- [List Evaluation \(Results Configuration\)](#)..... 129

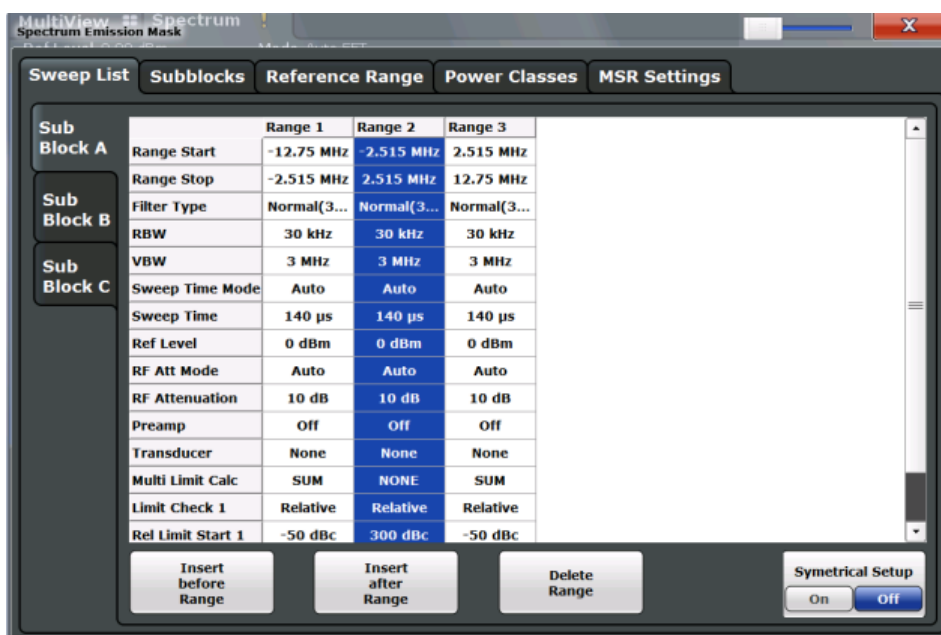
2.6.5.1 Sweep List

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 2.6.4.1, "Ranges and Range Settings"](#), on page 104.



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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 with the SPAN key. 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 122).

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>[:FREQuency]:START on page 460

[SENSe:]ESpectrum<sb>:RANGe<range>[:FREQuency]:STOP on page 461

Fast SEM

Activates "Fast SEM" mode for all ranges in the sweep list. For details, see [Chapter 2.6.4.3, "Fast SEM Measurements"](#), on page 108.

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>:HighSPeed on page 457

Filter Type

Sets the filter type for this range.

For details on filter types, see [Chapter 3.6.1.6, "Which Data May Pass: Filter Types"](#), on page 273.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:FILTer:TYPE on page 459

RBW

Sets the resolution bandwidth for this range.

For details on the RBW, see [Chapter 3.6.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth"](#), on page 270.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:BANDwidth[:RESolution]

on page 458

VBW

Sets the video bandwidth for this range.

For details on the VBW, see [Chapter 3.6.1.2, "Smoothing the Trace Using the Video Bandwidth"](#), on page 271.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:BANDwidth:VIDeo on page 458

Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode, see [Chapter 3.6.1.7, "How Long the Data is Measured: Sweep Time"](#), on page 274

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:SWEep:TIME:AUTO on page 471

Sweep Time

Sets the sweep time value for the range.

For details on the sweep time, see [Chapter 3.6.1.7, "How Long the Data is Measured: Sweep Time"](#), on page 274

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<range>:SWEep:TIME` on page 470

Ref. Level

Sets the reference level for the range.

For details on the reference level, see [Chapter 3.5.1.1, "Reference Level"](#), on page 262.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<range>:RLEVel` on page 470

RF Att. Mode

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation, see ["Using the RF Attenuator"](#) on page 219.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO`
on page 462

RF Attenuator

Sets the attenuation value for the range.

For details on attenuation, see [Chapter 3.5.1.2, "Scaling"](#), on page 263.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:ATTenuation` on page 461

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 266.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:GAIN:STATe` on page 462

`[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:GAIN:LNA:STATe`

on page 462

Transd. Factor

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

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

For details on transducers, see the User Manual of the R&S ESW.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:TRANsducer on page 471

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 2.6.4.2, "Limit Lines in SEM Measurements"](#), on page 106.

The limit state affects the availability of all limit settings.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:STATe on page 468
CALCulate<n>:LIMit<k>:FAIL? on page 687

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:

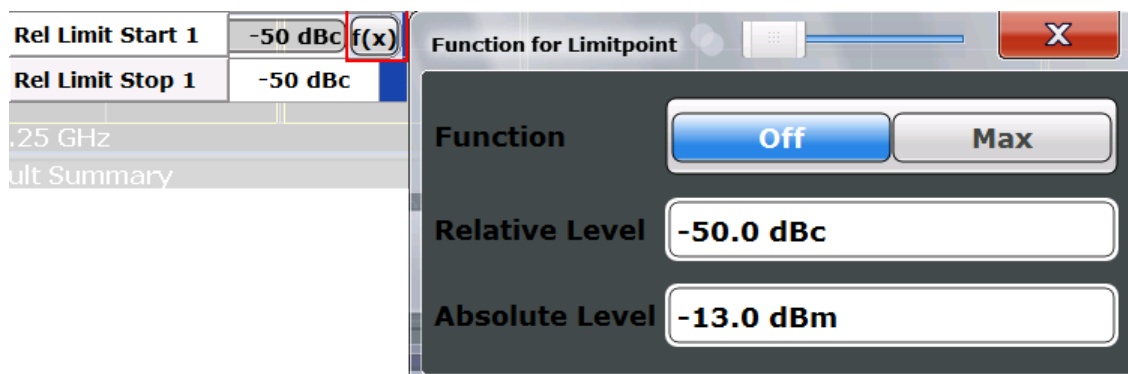
[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:START on page 463

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP on page 464

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.



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 107.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START on page 464

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP on page 466

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START:FUNCTION on page 466

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCTION on page 468

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START:ABS on page 465

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute on page 467

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 111.

"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<range>:MLCalc on page 455

Minimum 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 105

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<range>:POINTs:MIN[:VALue] on page 469

Insert before/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<range>:INSert on page 463

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<range>:DELete on page 459

Symmetric Setup

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

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

Note: If "Fast SEM" mode is deactivated while "Symmetric Setup" mode is on, "Sym Setup" mode is automatically also deactivated.

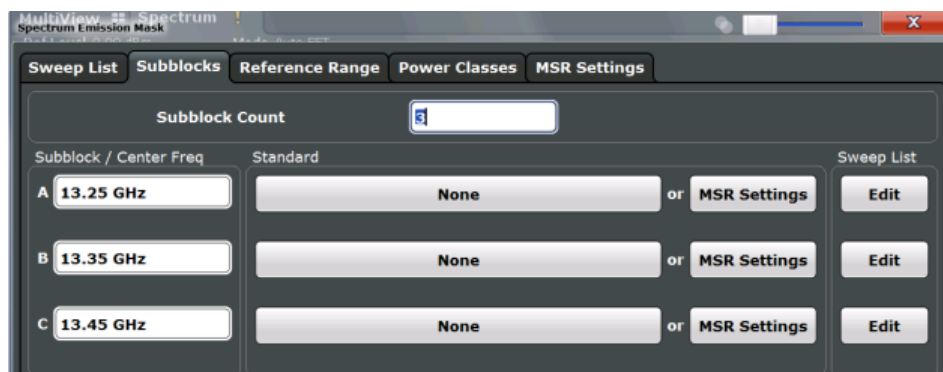
If "Fast SEM" mode is activated while "Symmetric Setup" mode is on, not all range settings can be set automatically.

2.6.5.2 Multi-SEM (Sub Block) Settings

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Sub Blocks"

In the Spectrum application only, spectrum emissions can be measured for multiple sub blocks of channels (see Chapter 2.6.4.5, "SEM with Multiple Sub Blocks ("Multi-SEM")", on page 110). 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..... 120
 Sub Block Center Frequency..... 121
 Standard / MSR Settings..... 121
 Edit sweep list..... 121

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>:SBCOUNT on page 456

Sub Block Center Frequency

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>:SBCENTER on page 456

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 2.6.5.6, "Standard Files"](#), on page 127 and [Chapter 2.6.5.5, "MSR Settings"](#), on page 124.

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 454
[Chapter 5.3.6.3, "Configuring Multi SEM Measurements"](#), on page 455

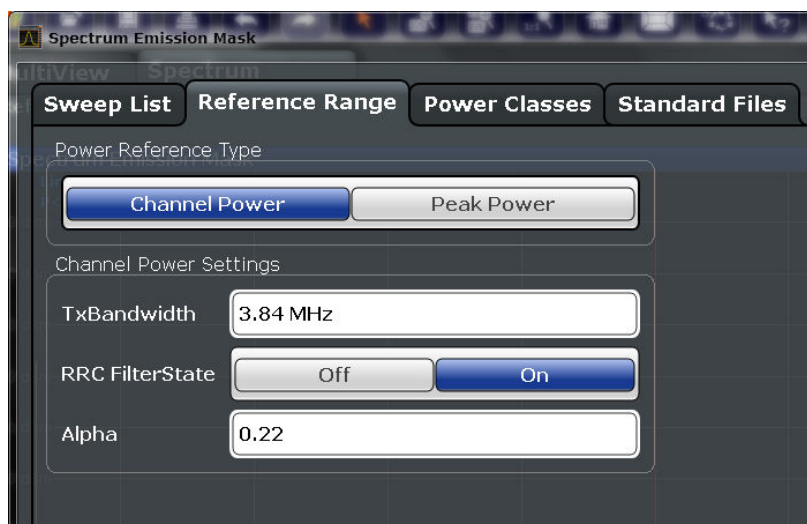
Edit sweep list

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 2.6.5.1, "Sweep List"](#), on page 114.

2.6.5.3 Reference Range

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Reference Range"

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



[Power Reference Type](#)..... 122
[Channel Power Settings](#)..... 122

L Tx Bandwidth.....	122
L RRC Filter State.....	122
L Alpha.....	122

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 (see also "[IBW method](#)" on page 44). Additional settings can be configured for this method.

"Peak Power"

Determines the peak power within the reference range.

Remote command:

`[SENSe:]ESpectrum<sb>:RTYPe` on page 473

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 ≤ Bandwidth ≤ of reference range

Remote command:

`[SENSe:]ESpectrum<sb>:BWID` on page 472

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 472

Alpha ← Channel Power Settings

Sets the alpha value of the RRC filter (if activated).

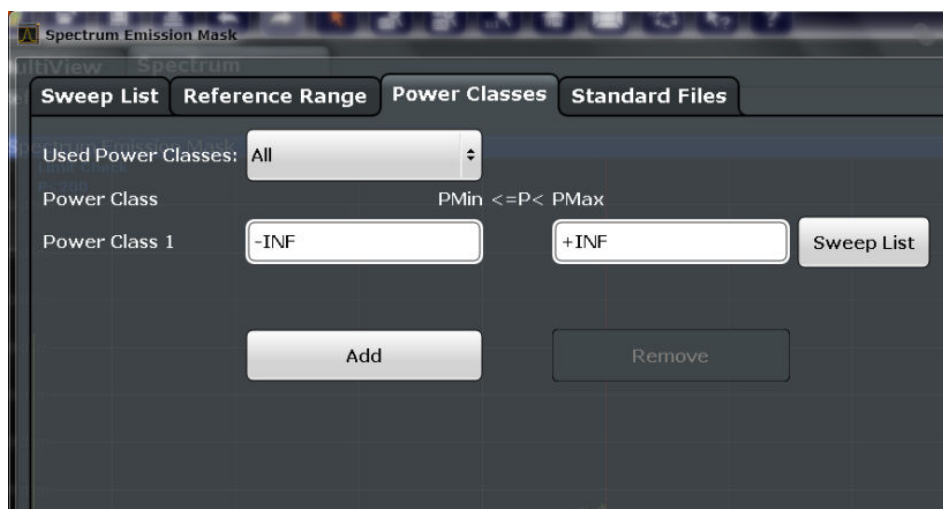
Remote command:

`[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHa` on page 472

2.6.5.4 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 105.



Used Power Classes..... 123
 PMin/PMax..... 123
 Sweep List..... 124
 Adding or Removing a Power Class..... 124

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 118 and "Rel Limit Start/Stop <n>" on page 118).

Remote command:

```
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>[:EXCLusive]
on page 477
```

To define all limits in one step:

```
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:LIMit[:STATe]
on page 475
```

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<k>:ESpectrum<sb>:PCLass<PClass>:MINimum`
on page 476

`CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:MAXimum`
on page 476

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 118).

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:

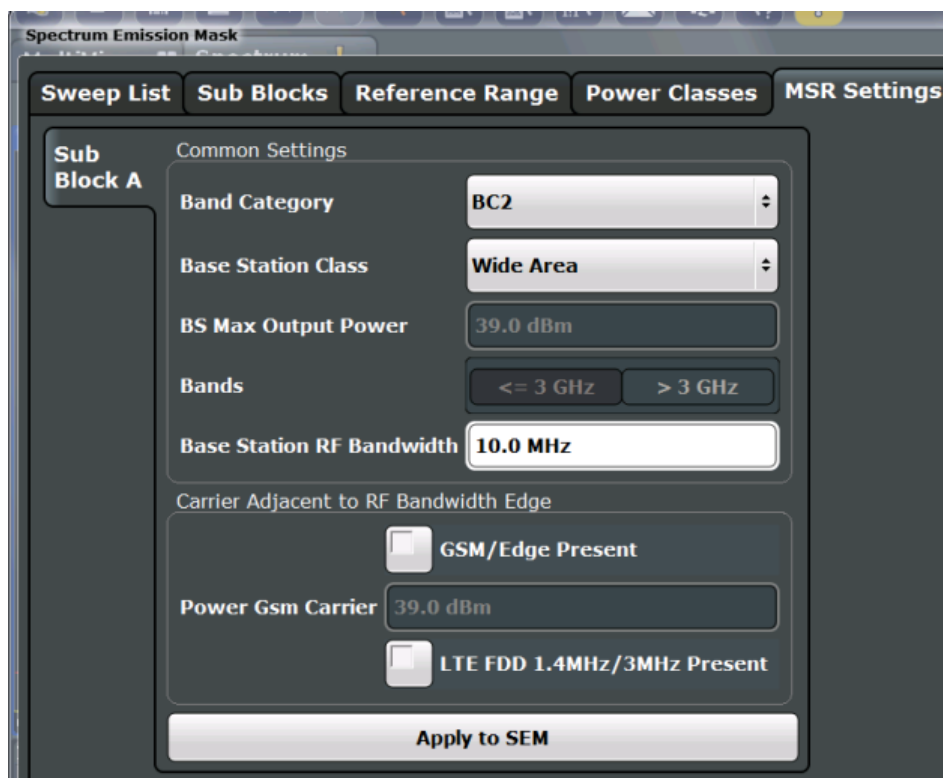
`CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass:COUNT` on page 475

2.6.5.5 MSR Settings

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "MSR Settings"

Multi-standard radio (MSR) measurements allow you to perform SEM tests on multiple carriers using different digital standards.

For details, see [Chapter 2.6.4.4, "Multi-Standard Radio \(MSR\) SEM Measurements"](#), on page 110.



Band Category..... 125
 Base Station Class..... 125
 Base Station Maximum Output Power..... 126
 Bands..... 126
 Base Station RF Bandwidth..... 126
 Carrier Adjacent to RF Bandwidth Edge..... 126
 Power GSM Carrier..... 126
 Apply to SEM..... 127

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 479

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:CLAS on page 480

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 483

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 479

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 483

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 126).

"LTE FDD 1.4 MHz / 3 MHz present"

An LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the RF band.

Remote command:

[\[SENSe:\]ESpectrum<sb>:MSR:GSM:CPResent](#) on page 482

[\[SENSe:\]ESpectrum<sb>:MSR:LTE:CPResent](#) on page 482

Power GSM Carrier

Defines the power of the GSM carrier (if available, see ["Carrier Adjacent to RF Bandwidth Edge"](#) on page 126). Possible values are from 0 dBm to 100 dBm in 1 dB steps.

This setting is only available for [Band Category](#) 2.

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:CARR on page 481

Apply to SEM

Configures the SEM sweep list according to the specified MSR settings.

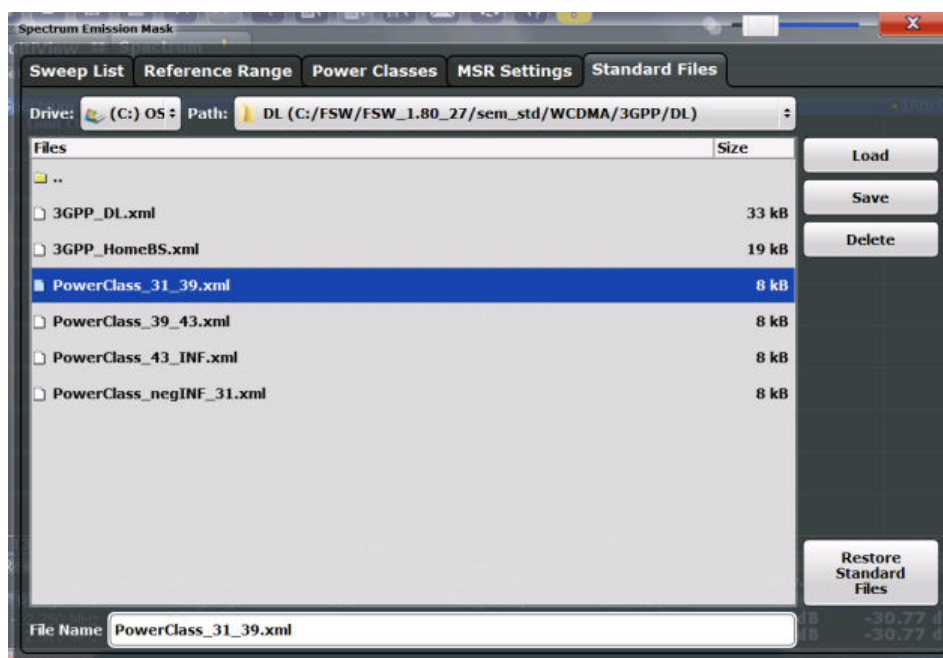
Remote command:

[SENSe:] ESpectrum<sb>:MSR:APPLY on page 478

2.6.5.6 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 2.6.6.1, "How to Manage SEM Settings Files"](#), on page 133.



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.

[Selecting the Storage Location - Drive/ Path/ Files](#)..... 128

[File Name](#)..... 128

[Load Standard](#)..... 128

Save Standard.....	129
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Selecting the Storage Location - Drive/ Path/ Files

Select the storage location of the settings file on the <instrument> or an external drive.

The "Drive" indicates the internal (C:) or any connected external drives (e.g. a USB storage device).

The "Path" contains the drive and the complete file path to the currently selected folder.

The "Files" list contains all subfolders and files of the currently selected path.

The default storage location for the SEM settings files is: C:\R_S\instr\sem_std.

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 full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S 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 settings file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g. limit_lines_005.

For details on the file name and location, see the R&S ESW User Manual.

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 full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S ESW User Manual.

Load Standard

Loads the selected measurement settings file.

Remote command:

[SENSe:]ESpectrum<sb>:PRESet[:STANdard] on page 454

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 454

Delete Standard

Deletes the selected standard. Standards predefined by Rohde & Schwarz can also be deleted. A confirmation query is displayed to avoid unintentional deletion of the standard.

Note: Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standards" function (see "Restore Standard Files" on page 129).

Restore Standard Files

Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

The XML files from the C:\R_S\instr\sem_backup folder are copied to the C:\R_S\instr\sem_std folder.

Note that this function will overwrite customized standards that have the same name as predefined standards.

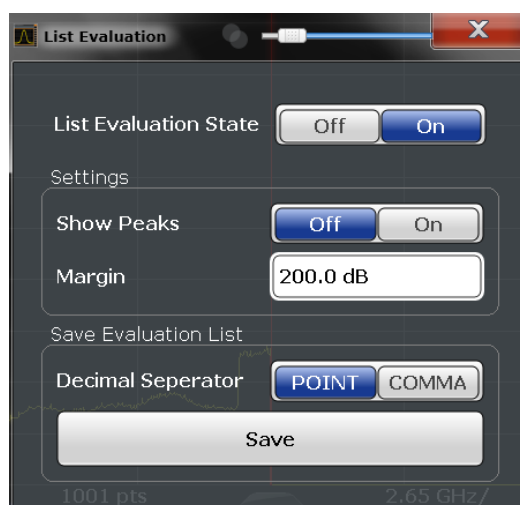
Remote command:

[SENSe:]ESpectrum<sb>:PRESet:RESTore on page 454

2.6.5.7 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.



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Show Peaks.....	130
Margin.....	130
Saving the Result Summary (Evaluation List) to a File.....	130

List Evaluation (Result Summary) State

Activates or deactivates the Result Summary.

Remote command:

`CALCulate<n>:ESpectrum:PEAKsearch:AUTO` on page 484

`TRACe<n>[:DATA]` on page 617

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 485

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 485

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 file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

For details, see [Chapter 2.6.8.2, "ASCII File Export Format \(Spectrum Emission Mask\)"](#), on page 142.

Remote command:

`MMEMemory:STORe<n>:LIST` on page 485

`FORMat:DEXPort:DSEParator` on page 626

2.6.6 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 multi-standard radio SEM measurements, configuration for specified scenarios can be done automatically.

For signals with multiple carriers, also in non-contiguous ranges, an SEM measurement with multiple sub blocks can be configured.

The following tasks are described:

- ["To select an SEM measurement"](#) on page 131
- ["To perform an SEM measurement according to a standard"](#) on page 131
- ["To configure a user-defined SEM measurement"](#) on page 131
- ["To perform an MSR SEM measurement"](#) on page 132
- ["To perform a Multi-SEM measurement"](#) on page 133

To select an SEM measurement

- ▶ Press the MEAS key, then select the "Spectrum Emission Mask" measurement.

To perform an SEM measurement according to a standard

- ▶ Load the settings file as described in ["How to load an SEM settings file"](#) on page 134 and start a measurement.

To configure a user-defined SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
Starting from the center frequency, determine which sections of the signal to the left and right can be swept and monitored using the same parameters. Criteria for such a range definition may be, for example:
 - The signal power level
 - The required resolution bandwidth or sweep time
 - Transducer factors
 - Permitted deviation from the defined signal level, i.e. the required limit values for monitoringIf 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 the "Overview" softkey, then select the "SEM Setup" button and switch to the "Power Classes" tab.
 - b) Add a power class by selecting the "Add" button.
 - c) Enter the start and stop power levels to define the class.
 - d) Select the power classes to be used for the current measurement: either a specific class, or all classes, to have the required class selected automatically according to the input level measured in the reference range.
4. Select the "Sweep List" tab of the "Spectrum Emission Mask" dialog box.
5. Insert the required ranges using the "Insert before Range" and "Insert after Range" buttons, which refer to the currently selected range (the reference range by default).

If the signal trace is symmetric to the center frequency, activate the "Sym Setup" option to make setup easier and quicker.

6. Define the measurement parameters for each range as required. If symmetrical setup is activated, you only have to configure the ranges to one side of the center range.
In particular, define the limits for each range of the signal, i.e. the area in which the signal level 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 134.
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 2.6.6.2, "How to Save SEM Result Files"](#), on page 134.

To perform an MSR SEM measurement

1. Select the "MSR Config" softkey.
2. Select the band category that determines the digital standards used in the measurement setup (see ["Band Category"](#) on page 125).
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 the "Apply to SEM" button.
The sweep list is configured according to the MSR specification, with the required number of ranges and defined limits.

6. Start a sweep.
The determined powers and limit deviations for each range are indicated in the 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 2.6.6.2, "How to Save SEM Result Files"](#), on page 134.

To perform a Multi-SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Select the "Multi-SEM Config" softkey.
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:
 - a) Select a standard settings file to be used.
 - b) Select the "MSR Settings" button and define the MSR configuration as described in ["To perform an MSR SEM measurement"](#) on page 132.
 - c) Select the "Edit" button and configure the sweep list manually as defined in ["To configure a user-defined SEM measurement"](#) on page 131. 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 2.6.6.2, "How to Save SEM Result Files"](#), on page 134.

2.6.6.1 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:\r_s\instr\sem_std`.

For details on the file format of the SEM settings file, see [Chapter 2.6.8.1, "Format Description of SEM XML Files"](#), on page 136.

SEM settings or standard files are managed in the "Standards" tab of the "Spectrum Emission Mask" dialog box. To display this dialog box, select the "Overview" softkey and then the "SEM Setup" button.

How to load an SEM settings file

1. From the file selection dialog box, select the settings file (with a .xml extension).
2. Select the "Load" button.

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 2.6.6, "How to Perform a Spectrum Emission Mask Measurement"](#), on page 130).
2. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, define a file name and storage location for the settings file.
3. Select the "Save" button.

The settings are stored to a file with the extension ".xml" as specified.

How to delete an SEM settings file

1. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select the file you want to delete.
2. Select the "Delete" button.
3. Confirm the message.

The settings file is removed from the R&S 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 the "Restore Standard Files" button.

The original predefined settings files are available for selection on the R&S ESW.

2.6.6.2 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 2.6.8.2, "ASCII File Export Format \(Spectrum Emission Mask\)"](#), on page 142.

1. Configure and perform an SEM measurement as described in [Chapter 2.6.6, "How to Perform a Spectrum Emission Mask Measurement"](#), on page 130.
2. In the "Overview", select the "Analysis" button.

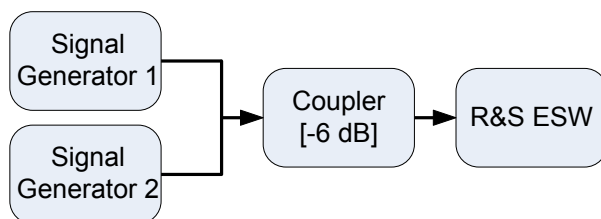
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select the "Save" button.
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select the "Save" button.

The file with the specified name and the extension `.dat` is stored in the defined storage location.

2.6.7 Measurement Example: Multi-SEM Measurement

The following measurement example demonstrates an SEM measurement for a signal with multiple sub blocks.

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	EUTRALTE	906.5 MHz	0 dBm	1_1_5MHz

Setting up the measurement

1. Preset the R&S ESW.
2. Set the center frequency to *903.25 MHz*.
3. Set the reference level to *10 dBm* with an offset of to *30 dB*.
4. Press the MEAS key and select the "SEM" measurement function from the "Select Measurement" dialog box.
5. Select the "Sub Blocks" softkey and define a sub block count of 2.
6. For sub block A, define the settings for the 3GPP/FDD signal:
 - a) Set the center frequency to *900 MHz*
 - b) Select "MSR Settings".
 - c) Set the "Base Station RF Bandwidth" to *5 MHz*.
 - d) Select "Apply to SEM".

7. For sub block B, define the settings for the EUTRA/LTE signal:
 - a) Set the center frequency to 906.5 MHz
 - b) Select "MSR Settings".
 - c) Set the "Base Station RF Bandwidth" to 5 MHz.
 - d) Select "Apply to SEM".
8. 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.

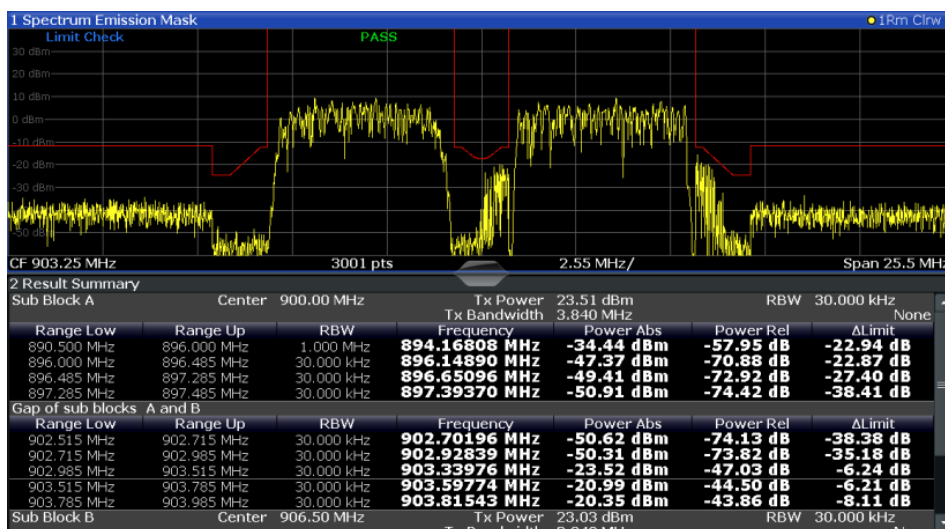


Figure 2-38: Multi-SEM measurement: results of the measurement for each sub block

2.6.8 Reference: SEM File Descriptions

This reference provides details on the format of the SEM settings and result files.

- [Format Description of SEM XML Files](#)..... 136
- [ASCII File Export Format \(Spectrum Emission Mask\)](#)..... 142

2.6.8.1 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:\r_s\instr\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 134). All XML files are stored under `C:\r_s\instr\sem_std`.

The files for importing range settings obey the rules of the XML standard. The child nodes, attributes, and structure defined for the data import are described here.



Be sure to follow the structure exactly as shown below or else the R&S 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 2-13](#).

Example:

In the sample file `PowerClass_39_43.xml` under `C:\r_s\instr\sem_std\WCDMA\3GPP`, these attributes are defined as follows:

- `Standard="W-CDMA 3GPP"`
- `LinkDirection="DL"`
- `PowerClass="(39,43)dBm"`

The "PowerClass" element

It is embedded in the `BaseFormat` element and contains settings information about the power classes. Up to four different power classes can be defined. For details, refer to [Chapter 2.6.5.4, "Power Classes"](#), on page 122. The child nodes and attributes of this element are shown in [Table 2-14](#).

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 2.6.5.1, "Sweep List"](#), on page 114. The child nodes and attributes of this element are shown in [Table 2-15](#).

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:\r_s\instr\sem_std" directory, or check the structure as shown below.

Below, a basic example of the structure of the file is shown, containing all mandatory attributes and child nodes. Note that the `PowerClass` element and the `Range` element are themselves elements of the `BaseFormat` element. 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 2-14 -->`
`<!-- 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 2-15 -->`
`<!-- 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 2-13: Attributes and child nodes of the BaseFormat element

Child Node	Attribute	Value	Parameter Description	Mand.
	FileFormatVersion	1.0.0.0		Yes
	Date	YYYY-MM-DD HH:MM:SS	Date in ISO 8601 format	No
Name		<string>	Name of the standard	Yes
Instrument	Type	FSL	Name of the instrument	No
	Application	SA K72 K82	Name of the application	No
LinkDirection	Name	Downlink Uplink None		Yes
	ShortName	DL UL		No
Reference-Power				Yes

Spectrum Emission Mask (SEM) Measurement

Child Node	Attribute	Value	Parameter Description	Mand.
Method	TX Channel Power TX Channel Peak Power			Yes
Reference-Channel	<string>			No

Table 2-14: 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 Absolute and Relative Absolute or Relative		Yes

Table 2-15: 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 116	Yes
	Type	NORM PULS CFIL RRC		No
VBW	Bandwidth	<bandwidth in Hz>	"VBW" on page 116	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 116	Yes
	Time	<time in sec>	"Sweep Time" on page 117	No
Amplitude				No
ReferenceLevel	Value	<power in dBm>	"Ref. Level" on page 117	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 117	Yes, if the ReferenceLevel child node is used

2.6.8.2 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 11;	Storage date of data set
Mode;ANALYZER;SEM;	Operating mode and measurement function
Center Freq;13250000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;255000000.000000;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	

File contents	Explanation
Margin;200;	Peak List margin
Reference range settings	
RefType; CPOWER;	Reference power type
TxBandwidth;3840000;;Hz	Channel power settings
Filter State; ON;	
Alpha;0.22;	
PeaksPerRange;1;	Max. number of peaks per range to be detected
Values;2;	Number of detected peaks
File data section	
0;-12750000;-2515000;30000;13242367500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <relative power in dBc of peak>; (related to the channel power) <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;
2;2515000;12750000;30000;13257632500;-43.844722747802734;-0.33028793334960938;49.669712066650391;FAIL;	

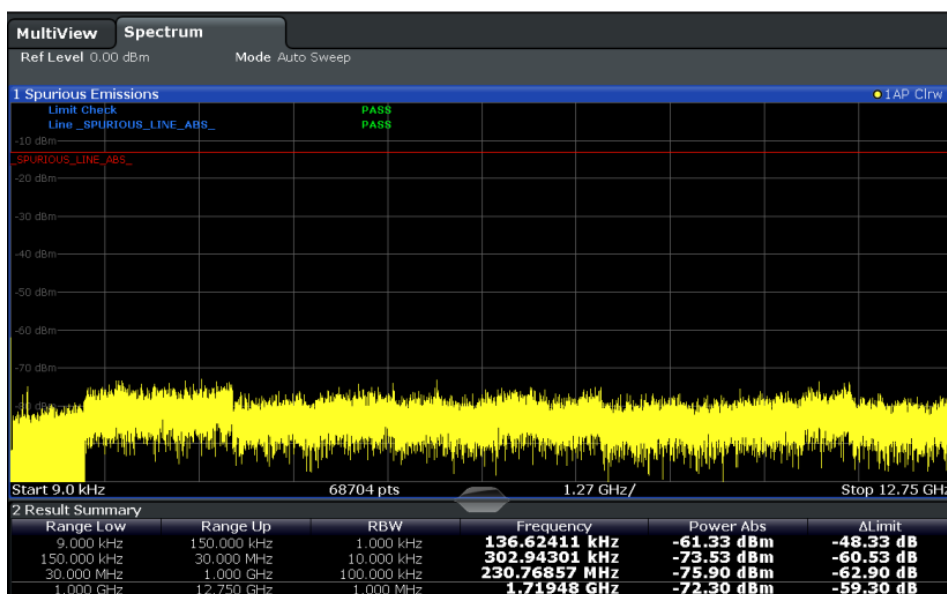
2.7 Spurious Emissions Measurement

The R&S ESW supports Spurious Emissions measurements.

- [About the Measurement](#)..... 143
- [Spurious Emissions Measurement Results](#)..... 144
- [Spurious Emissions Basics](#)..... 145
- [Spurious Emissions Measurement Configuration](#)..... 147
- [How to Perform a Spurious Emissions Measurement](#)..... 153
- [Reference: ASCII Export File Format \(Spurious\)](#)..... 154

2.7.1 About the Measurement

The Spurious Emissions measurement monitors unwanted RF products outside the assigned frequency band generated by an amplifier. The spurious emissions are usually measured across a wide frequency range. The Spurious Emissions measurement allows a flexible definition of all parameters. A result table indicates the largest deviations of the absolute power from the limit line for each range, and the results can be checked against defined limits automatically.



2.7.2 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 2.7.3.2, "Limit Lines in Spurious Measurements"](#), on page 146). The details of the evaluation list can be configured.

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	136.62411 kHz	-61.33 dBm	-48.33 dB
150.000 kHz	30.000 MHz	10.000 kHz	302.94301 kHz	-73.53 dBm	-60.53 dB
30.000 MHz	1.000 GHz	100.000 kHz	230.76857 MHz	-75.90 dBm	-62.90 dB
1.000 GHz	12.750 GHz	1.000 MHz	1.71948 GHz	-72.30 dBm	-59.30 dB

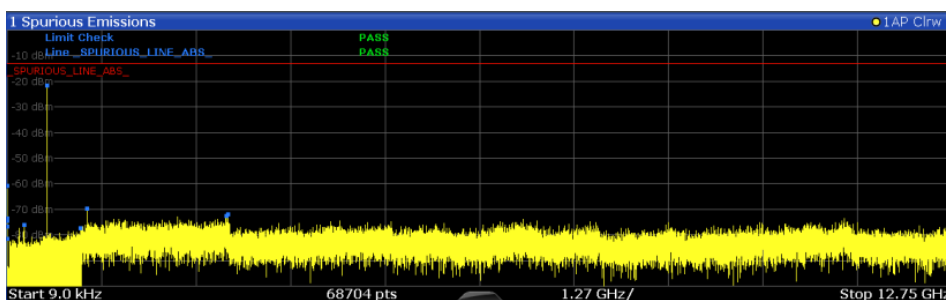
The following information is provided in the evaluation list for each range:

Column	Description
Range Low	Frequency range start for the range the peak value belongs to
Range Up	Frequency range end for the range the peak value belongs to
RBW	RBW of the range
Frequency	Frequency at the peak value
Power Abs	Absolute power level at the peak value
ΔLimit	Deviation of the absolute power level from the defined limit for the peak value

By default, one peak per range is displayed. However, you can change the settings to:

- Display all peaks
- Display a certain number of peaks per range

- Display only peaks that exceed a threshold ("Margin")
- 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 617).

2.7.3 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](#)..... 145
- [Limit Lines in Spurious Measurements](#)..... 146

2.7.3.1 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.

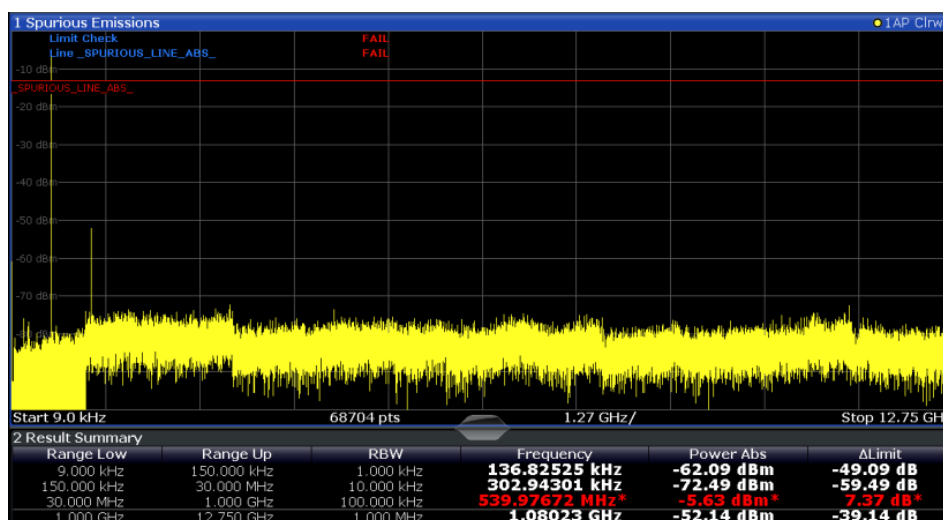
A remote command example for defining parameters and ranges in Spurious Emissions measurements is described in [Chapter 5.3.7.6, "Programming Example: Spurious Emissions Measurement"](#), on page 501.

2.7.3.2 Limit Lines in Spurious Measurements

Limit lines allow you to check the measured data against specified limit values. Generally, it is possible to define limit lines for any measurement in the Spectrum application using the LINES key. For Spurious measurements, however, a special limit line is available via the "Sweep List", and it is strongly recommended that you use only this limit line definition.

In the "Sweep List", you can define a limit line that varies its level according to the specified frequency ranges. A distinguished limit line 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 measurement channels.

If a limit check is activated in the "Sweep List", the "_SPURIOUS_LINE_ABS" limit line is indicated by a red line in the display. The result of the limit check is indicated at the top of the diagram. Note that only "Pass" or "Fail" is indicated; a margin function as for general limit lines is not available. Also, only absolute limits can be checked, not relative ones.



As for general limit lines, the results of each limit line check are displayed (here: "_SPURIOUS_LINE_ABS"), as well as the combined result for all defined limit lines ("Limit Check").

The limit check is considered to be "failed" if any signal level outside the absolute limits is measured.

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 2.7.4.3, "List Evaluation"](#), on page 151.

2.7.4 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 5.3.7, "Measuring Spurious Emissions"](#), on page 490.

- [Sweep List](#).....147
- [Adjusting the X-Axis to the Range Definitions](#).....151
- [List Evaluation](#).....151

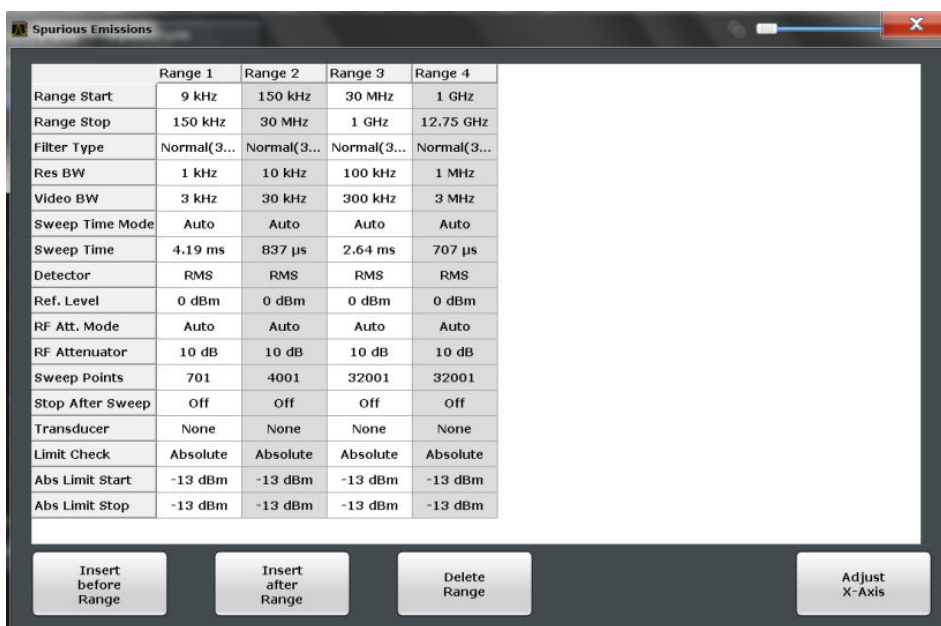
2.7.4.1 Sweep List

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 2.7.3.1, "Ranges and Range Settings"](#), on page 145.



Range Start / Range Stop..... 148

Filter Type..... 148

RBW..... 149

VBW..... 149

Sweep Time Mode..... 149

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RF Att. Mode..... 150

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Preamp..... 150

Sweep Points..... 150

Stop After Sweep..... 150

Transducer..... 150

Limit Check..... 151

Abs Limit Start/Stop..... 151

Insert before/after Range..... 151

Delete Range..... 151

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<range>[:FREQuency]:START on page 493

[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP on page 494

Filter Type

Sets the filter type for this range.

For details on filter types, see [Chapter 3.6.1.6, "Which Data May Pass: Filter Types"](#), on page 273.

Remote command:

[\[SENSe:\]LIST:RANGe<range>:FILTer:TYPE](#) on page 492

RBW

Sets the RBW value for this range.

For details on the RBW, see [Chapter 3.6.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth"](#), on page 270.

Remote command:

[\[SENSe:\]LIST:RANGe<range>:BANDwidth\[:RESolution\]](#) on page 491

VBW

Sets the VBW value for this range.

For details on the VBW, see [Chapter 3.6.1.2, "Smoothing the Trace Using the Video Bandwidth"](#), on page 271.

Remote command:

[\[SENSe:\]LIST:RANGe<range>:BANDwidth:VIDeo](#) on page 491

Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode, see [Chapter 3.6.1.7, "How Long the Data is Measured: Sweep Time"](#), on page 274

Remote command:

[\[SENSe:\]LIST:RANGe<range>:SWEep:TIME:AUTO](#) on page 497

Sweep Time

Sets the sweep time value for the range.

For details on the sweep time, see [Chapter 3.6.1.7, "How Long the Data is Measured: Sweep Time"](#), on page 274

Remote command:

[\[SENSe:\]LIST:RANGe<range>:SWEep:TIME](#) on page 497

Detector

Sets the detector for the range.

For details, refer to [Chapter 4.3.1.1, "Mapping Samples to sweep Points with the Trace Detector"](#), on page 317.

Remote command:

[\[SENSe:\]LIST:RANGe<range>:DETector](#) on page 492

Ref. Level

Sets the reference level for the range.

For details on the reference level, see [Chapter 3.5.1.1, "Reference Level"](#), on page 262.

Remote command:

[SENSe:] LIST:RANGe<range>:RLEVel on page 497

RF Att. Mode

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation, see [Chapter 3.3.1.1, "Increasing Measurement Sensitivity \(or Avoiding an Input Mixer Overload\)"](#), on page 218.

Remote command:

[SENSe:] LIST:RANGe<range>:INPut:ATTenuation:AUTO on page 494

RF Attenuator

Sets the attenuation value for that range.

For details on attenuation, see [Chapter 3.3.1.1, "Increasing Measurement Sensitivity \(or Avoiding an Input Mixer Overload\)"](#), on page 218.

Remote command:

[SENSe:] LIST:RANGe<range>:INPut:ATTenuation on page 494

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 266.

Remote command:

[SENSe:] LIST:RANGe<range>:INPut:GAIN:STATe on page 495

[SENSe:] LIST:RANGe<range>:INPut:GAIN:LNA:STATe on page 495

Sweep Points

Sets the number of sweep points for the specified range.

For details on sweep points, see [Chapter 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274.

Remote command:

[SENSe:] LIST:RANGe<range>:POINTs[:VALue] on page 496

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<range>:BREak on page 491

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<range>:TRANsducer` on page 497

Limit Check

Activates or deactivates the limit check for all ranges.

For details on limit checks, see [Chapter 2.7.3.2, "Limit Lines in Spurious Measurements"](#), on page 146.

"Absolute" Signal is checked against absolute limit values

"None" No limit check is performed.

Remote command:

`[SENSe:]LIST:RANGe<range>:LIMit:STATe` on page 496

`CALCulate<n>:LIMit<k>:FAIL?` on page 687

Abs Limit Start/Stop

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

Remote command:

`[SENSe:]LIST:RANGe<range>:LIMit:START` on page 495

`[SENSe:]LIST:RANGe<range>:LIMit:STOP` on page 496

Insert before/after Range

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

Delete Range

Deletes the currently focused range. The range numbers are updated accordingly.

2.7.4.2 Adjusting the X-Axis to the Range Definitions

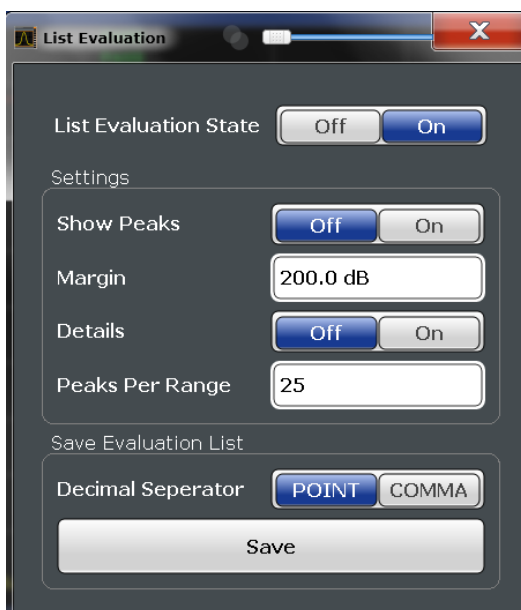
Access: "Overview" > "Select Measurement" > "Spurious Emissions" > "Adjust x-Axis"

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.

2.7.4.3 List Evaluation

Access: "Overview" > "Select Measurement" > "Spurious Emissions" > "List Evaluation"

Configure the contents and display of the result list.



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 Saving the Evaluation List..... 153

List Evaluation State

Activates or deactivates the list evaluation.

Remote command:

[CALCulate<n>:ESpectrum:PEAKsearch:AUTO](#) on page 484

[TRACe<n>\[:DATA\]](#) on page 617

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>:ESpectrum:PEAKsearch:PSHow](#) on page 485

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>:ESpectrum:PEAKsearch:MARGIN](#) on page 485

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 498

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 500

Saving the Evaluation List

Exports the evaluation list of the Spurious Emissions measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

Define the file name and storage location in the file selection dialog box that is displayed when you select the "Save" function.

For details, see ["How to Save the Spurious Emissions Evaluation List"](#) on page 154.

Remote command:

[MMEMory:STORe<n>:LIST](#) on page 485

[FORMat:DEXPort:DSEPARATOR](#) on page 626

2.7.5 How to Perform a Spurious Emissions Measurement

1. Press the MEAS key, then select the "Spurious Emissions" measurement.
2. Define the span of the signal to be monitored in the general span settings.
3. Select the "Overview" softkey, then select the "Spurious Setup" button.
The "Spurious Emissions" dialog box is displayed.
4. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.
Define the required ranges in the "Sweep List" using the "Insert before Range" and "Insert after Range" buttons, which refer to the currently selected range.
5. Define the measurement parameters for each range as required.
6. Optionally, define a limit check.
 - a) Activate the limit check by setting "Limit Check" to "Absolute". The limit check is always activated or deactivated for all ranges simultaneously.
 - b) Define the limit line's start and stop values for each range of the signal. If a signal level higher than the defined limit is measured, the limit check fails, which may indicate a spurious emission.

7. Configure the peak detection during a Spurious Emissions measurement: select the "Evaluations" button in the "Overview".
 - To indicate the determined peaks in the display, activate the "Show Peaks" option.
 - To restrict peak detection, define a "Margin". Only peaks that exceed this value are detected.
 - To allow for more peaks per range to be detected than the default 1, increase the "Peaks Per Range" value and set "Details" to "On".
8. Start a sweep.

The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
9. To save the evaluation list, export the results to a file as described in ["How to Save the Spurious Emissions Evaluation List"](#) on page 154.

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 2.7.5, "How to Perform a Spurious Emissions Measurement"](#), on page 153.
2. Select the "Evaluations" button in the "Overview".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select the "Save" button.
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select the "Save" button.

The file with the specified name and the extension `.dat` is stored in the defined storage location.

2.7.6 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;1325000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;26499982000.000000;Hz	
x-Axis;LIN;	
Start;9000.000000;Hz Stop;8000000000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Sweep Count;1;	
TRACE 1:	
Trace Mode;CLR/WRITE;	
x-Unit;Hz;	
y-Unit;dBm;	
List evaluation settings	
Margin;6.000000;s	Peak List margin
PeaksPerRange;25;	Max. number of peaks per range to be detected
Values;3;	Number of detected peaks

File contents	Explanation
File data section	
0;9000;150000;1000;79500;-25.006643295288086;-12.006643295288086;PASS;	Measured peak values: <range number>; <start frequency>; <stop frequency>; <resolution bandwidth of range>; <frequency of peak>; <absolute power in dBm of peak>; <distance to the limit line in dB>; (positive value means above the limit) <limit fail (pass = 0, fail =1)>;
0;9000;150000;1000;101022.11126961483;-47.075111389160156;-34.075111389160156;PASS;	
0;9000;150000;1000;58380.171184022824;-47.079341888427734;-34.079341888427734;PASS;	

2.8 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](#)..... 156
- [Typical Applications](#)..... 157
- [APD and CCDF Results](#)..... 157
- [APD and CCDF Basics - Gated Triggering](#)..... 160
- [APD and CCDF Configuration](#)..... 161
- [How to Perform an APD or CCDF Measurement](#)..... 167
- [Examples](#)..... 168
- [Optimizing and Troubleshooting the Measurement](#)..... 170

2.8.1 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 2.8.4, "APD and CCDF Basics - Gated Triggering"](#), on page 160.

2.8.2 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.

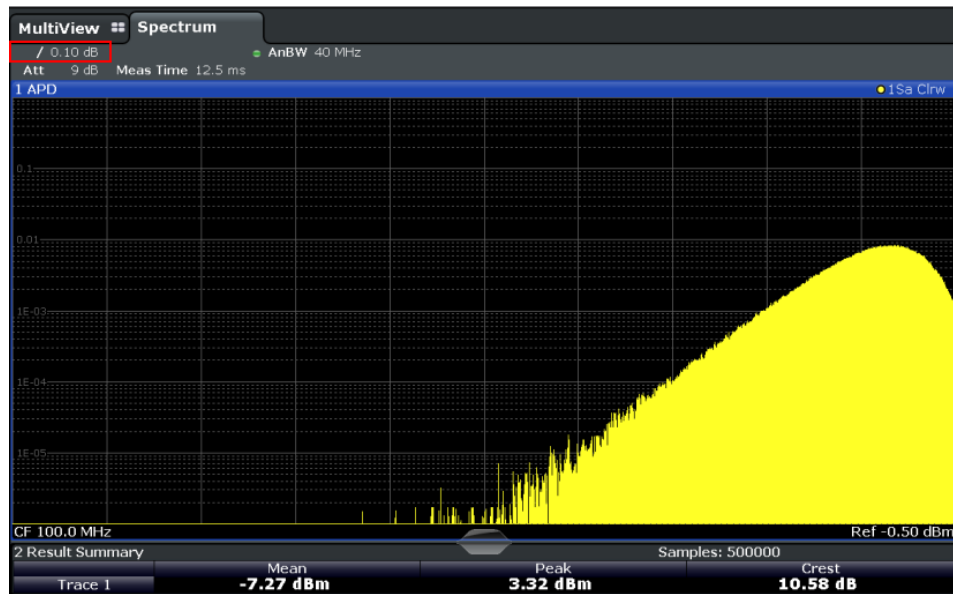
2.8.3 APD and CCDF Results

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 mean signal power amplitude will be exceeded in percent. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.



A red line indicates the ideal Gaussian distribution for the measured amplitude range.

The displayed amplitude range is indicated as "Mean Pwr + <x dB>"

In addition to the histogram, a result table is displayed containing the following information:

- Number of samples used for calculation
- For each displayed trace:

Mean	Mean power
Peak	Peak power
Crest	Crest factor (peak power – mean power)
10 %	Level values over 10 % above mean power
1 %	Level values over 1 % above mean power
0,1 %	Level values over 0,1 % above mean power
0,01 %	Level values over 0,01 % above mean power

Percent marker

In addition to the results for specific percentages in the table, a percent marker can be activated for a freely selectable percentage. This marker indicates how many level values are over <x> % above the mean power.

**Percent marker**

As all markers, the percent marker can be moved simply by selecting it with a finger or mouse cursor and dragging it to the desired position.

Diagram Scaling

The scaling for both the x-axis and y-axis of the statistics diagram can be configured. In particular, you can restrict the range of amplitudes to be evaluated and the probabilities to be displayed.

Remote commands:

`CALCulate<n>:STATistics:CCDF:X<t>?` on page 509

`CALCulate<n>:STATistics:RESult<t>?` on page 510

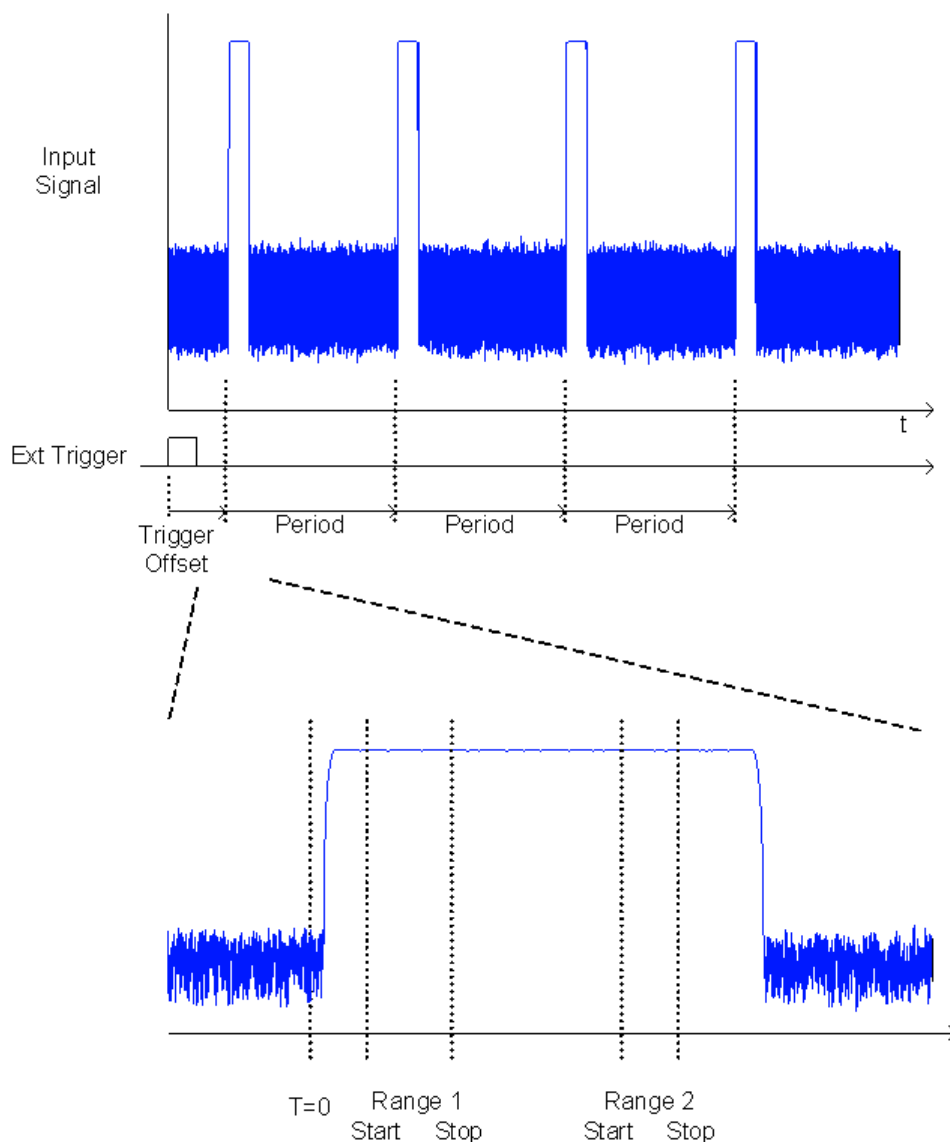
2.8.4 APD and CCDF Basics - Gated Triggering

Statistic measurements on pulsed signals can be performed using a gated trigger. An external frame trigger is required as a time (frame) reference.

The gate ranges define the part of the measured data taken into account for the statistics calculation. These ranges are defined relative to a reference point $T=0$. The gate interval is repeated for each period until the end of the capture buffer.

The reference point $T=0$ is defined by the external trigger event and the instrument's trigger offset.

For each trace you can define up to 3 separate ranges of a single period to be traced.



2.8.5 APD and CCDF Configuration

Configuration consists of the following settings:

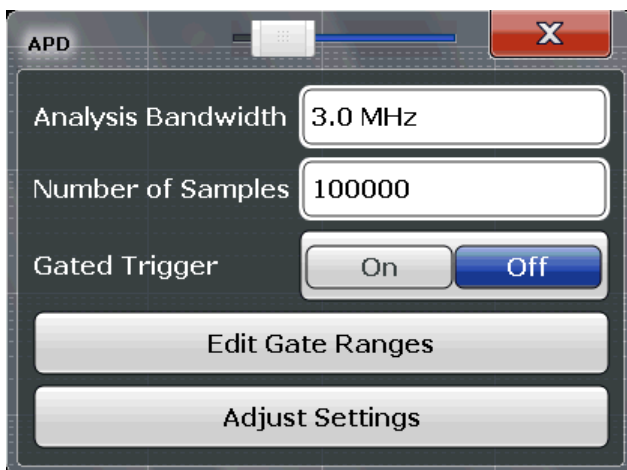
- [Basic Settings](#)..... 161
- [Gate Range Definition for APD and CCDF](#) 163
- [Scaling for Statistics Diagrams](#)..... 165

2.8.5.1 Basic Settings

APD measurements are selected via the "APD" button in the "Select Measurement" dialog box. CCDF measurements are selected via the "CCDF" button in the "Select Measurement" dialog box. The measurements are started immediately with the default settings. They can be configured via the MEAS CONFIG key or in the "APD/CCDF"

dialog boxes, which are displayed as a tab in the "Analysis" dialog box or when you select the "APD Config" softkey from the "APD" menu or the "CCDF Config" softkey from the "CCDF" menu.

The remote commands required to perform these tasks are described in [Chapter 5.3.8, "Analyzing Statistics"](#), on page 503.



Both dialog boxes are identical except for the "Percent Marker" setting, which is only available for CCDF measurements.

Percent Marker (CCDF only)	162
Analysis Bandwidth	162
Number of Samples	163
Gated Trigger	163
Edit Gate Ranges	163
Adjust Settings	163

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 504

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 594

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:

$$\text{Meas Time} = N_{\text{Samples}}/\text{RBW}$$

Remote command:

`CALCulate<n>:STATistics:NSAMples` on page 504

Gated Trigger

Activates and deactivates gating for statistics functions for the ACP and the CCDF measurements. If activated, the trigger source is changed to "External Trigger 1". The gate ranges are defined using the [Edit Gate Ranges](#) function.

Remote command:

`[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<range>]` on page 506

Edit Gate Ranges

Opens a dialog box to configure up to 3 gate ranges for each trace. For details see [Chapter 2.8.5.2, "Gate Range Definition for APD and CCDF"](#), on page 163.

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 507

2.8.5.2 Gate Range Definition for APD and CCDF

Gate ranges for gated triggering in statistical measurements can be configured in the "Gate Ranges" dialog box, which is displayed when you select the "Edit Gate Ranges" button in the "APD" or "CCDF" configuration dialog boxes.

For background information on defining gate ranges see [Chapter 2.8.4, "APD and CCDF Basics - Gated Triggering"](#), on page 160.

The remote commands required to perform these tasks are described in [Chapter 5.3.8.3, "Using Gate Ranges for Statistical Measurements"](#), on page 504.

	Trace 1	Trace 2	Trace 3	Trace 4	Trace 5	Trace 6
Comment						
Period	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 1 Use	On	Off	Off	Off	Off	Off
Range 1 Start	0 s	0 s	0 s	0 s	0 s	0 s
Range 1 Stop	1 ms	1 ms	1 ms	1 ms	1 ms	1 ms
Range 2 Use	Off	Off	Off	Off	Off	Off
Range 2 Start	2 ms	2 ms	2 ms	2 ms	2 ms	2 ms
Range 2 Stop	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms
Range 3 Use	Off	Off	Off	Off	Off	Off
Range 3 Start	4 ms	4 ms	4 ms	4 ms	4 ms	4 ms
Range 3 Stop	5 ms	5 ms	5 ms	5 ms	5 ms	5 ms

Up to three ranges can be defined for each of the six available traces.

[Comment](#)..... 164
[Period](#)..... 164
[Range <x> Use](#)..... 164
[Range <x> Start/Stop](#)..... 164

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 505

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 163). The current measurement time is indicated as "Meas Time" in the channel bar.

Remote command:

[SENSe:] SWEep:EGATe:TRACe:PERIoD on page 505

Range <x> Use

Activates tracing of the defined range during a gated measurement.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>[:STATe<range>] on page 506

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:

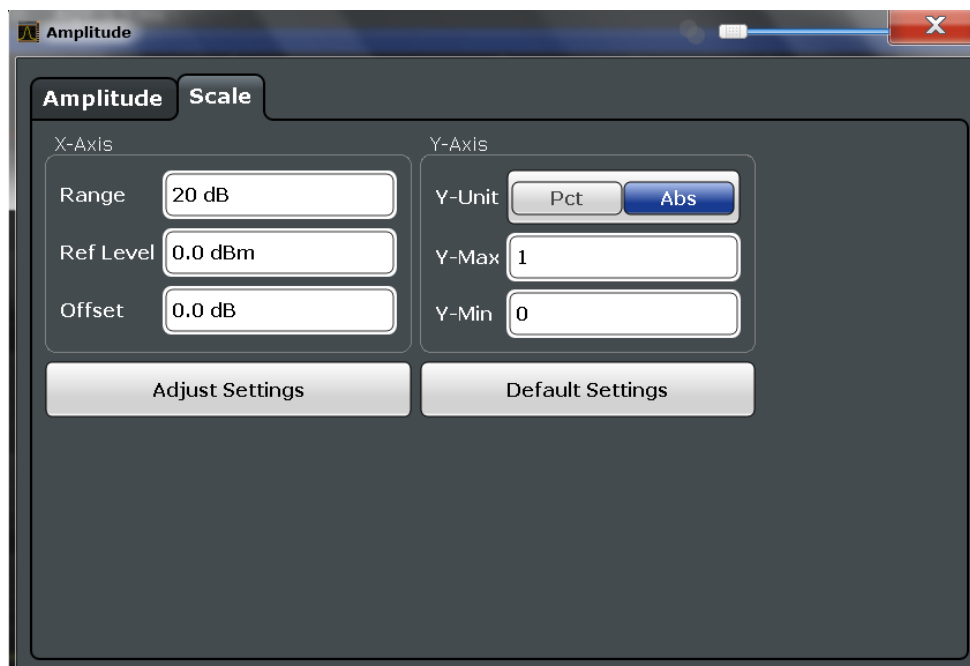
[SENSe:] SWEep:EGATe:TRACe<t>:STARt<range> on page 505

[SENSe:] SWEep:EGATe:TRACe<t>:STOP<range> on page 506

2.8.5.3 Scaling for Statistics Diagrams

The diagram scaling for statistical measurements can be configured in the "Scaling" dialog box, which is displayed when you select the AMPT key and then the "Scale Config" softkey.

The remote commands required to perform these tasks are described in [Chapter 5.3.8.4, "Scaling the Diagram"](#), on page 506.



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.....	165
L Range.....	166
L Ref Level.....	166
L Shifting the Display (Offset).....	166
Y-Axis.....	166
L Y-Unit.....	166
L Y-Max / Y-Min.....	166
Default Settings.....	166
Adjust Settings.....	167

X-Axis

Defines the scaling settings for signal level values.

Range ← X-Axis

Defines the level range in dB to be evaluated by the statistics measurement.

Remote command:

[CALCulate<n>:STATistics:SCALE:X:RANGE](#) on page 508

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 508

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\[:WINDow<n>\]:TRACe<t>:Y\[:SCALE\]:RLEVEL:OFFSET](#) on page 589

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 509

Y-Max / Y-Min ← Y-Axis

Defines the upper (max) and lower (min) limit of the displayed probability range. Values on the y-axis are normalized which means that the maximum value is 1.0. The minimum value must be in the range:

$$1E-9 < Y\text{-Min} < 0.1$$

The distance between Y-max and Y-min must be at least one decade.

Remote command:

[CALCulate<n>:STATistics:SCALE:Y:UPPER](#) on page 509

[CALCulate<n>:STATistics:SCALE:Y:LOWER](#) on page 508

Default Settings

Resets the x- and y-axis scalings to their preset values.

x-axis ref level:	-10 dBm
x-axis range APD:	100 dB
x-axis range CCDF:	20 dB

y-axis upper limit:	1.0
y-axis lower limit:	1E-6

Remote command:

[CALCulate<n>:STATistics:PRESet](#) on page 507

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 507

2.8.6 How to Perform an APD or CCDF Measurement

To start a basic statistic measurement

1. Press the MEAS key, then select the "APD" or "CCDF" measurement.
2. Start a sweep.

As soon as the defined number of samples have been measured, the statistical evaluation is displayed.

To perform a statistic measurement using gate ranges

For pulsed signals, the transmission intervals should not be included in the statistical evaluation. Thus, you must define gate ranges to be included in the measurement.

1. Press the MEAS CONFIG key, then select the "APD Config" or "CCDF Config" softkey.
The "APD" or "CCDF" dialog box is displayed.
2. Select the "Edit Gate Ranges" button.
3. Define the time period for which the input signal is to be analyzed, for example the duration of 3 signal pulses.
4. For each active trace, define up to three ranges within the time period to be measured. In the example covering 3 pulses, you could define one range for each pulse.
 - a) Assuming the external trigger determines T=0 as the start of the first pulse, define the start time of range 1 at 0 s.
 - b) Define the stop time of range 1 at the duration of the first pulse.
 - c) Activate range 1 by setting "Range 1 Use" to *On*.
 - d) Define the start time of range 2 as (duration of pulse 1 + duration of interval)
 - e) Define the stop time of range 2 as (start time of range 2 + duration of pulse 2)

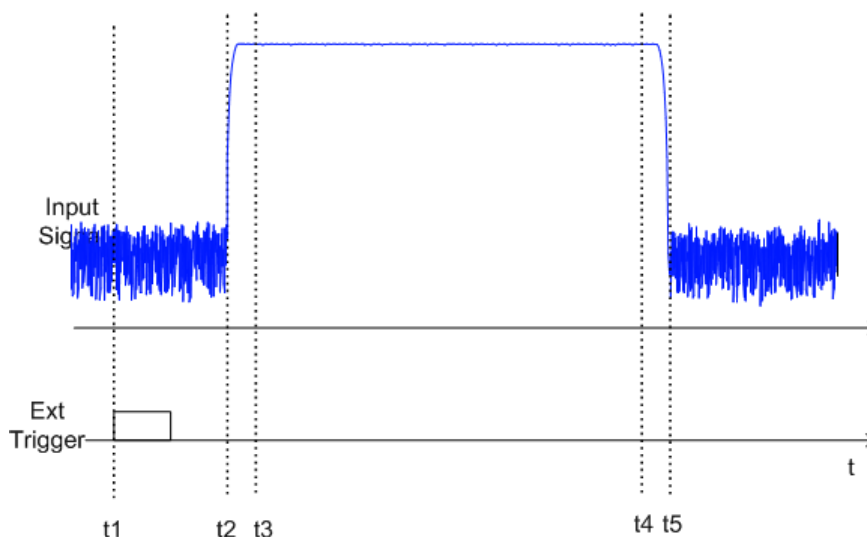
- f) Activate range 2 by setting "Range 2 Use" to *On*.
 - g) Define the third range in the same way.
5. Start a sweep.

As soon as the defined number of samples have been measured, the statistical evaluation is displayed. Only the signal levels within the pulse periods are considered.

2.8.7 Examples

2.8.7.1 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.



- t_1 : External positive trigger slope
- t_2 : Begin of burst (after 25 μs)
- t_3 : Begin of useful part, to be used for statistics (after 40 μs)
- t_4 : End of useful part, to be used for statistics (after 578 μs)
- t_5 : End of burst (after 602 μs)

The instrument has to be configured as follows:

Trigger Offset	$t_2 - t_1 = 25 \mu\text{s}$	now the gate ranges are relative to t_2
Range1 Start	$t_3 - t_2 = 15 \mu\text{s}$	start of range 1 relative to t_2
Range1 End	$t_4 - t_2 = 553 \mu\text{s}$	end of range 1 relative to t_2

2.8.7.2 Measurement Example – Measuring the APD and CCDF of White Noise Generated by the R&S ESW



Setting the RBW

When the amplitude distribution is measured, the analysis bandwidth must be set so that the complete spectrum of the signal to be measured falls within the bandwidth. This is the only way of ensuring that all the amplitudes will pass through the IF filter without being distorted. If the selected bandwidth is too small for a digitally modulated signal, the amplitude distribution at the output of the IF filter becomes a Gaussian distribution according to the central limit theorem and thus corresponds to a white noise signal. The true amplitude distribution of the signal therefore cannot be determined.

1. Preset the R&S ESW.
2. Set the reference level to -60 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.

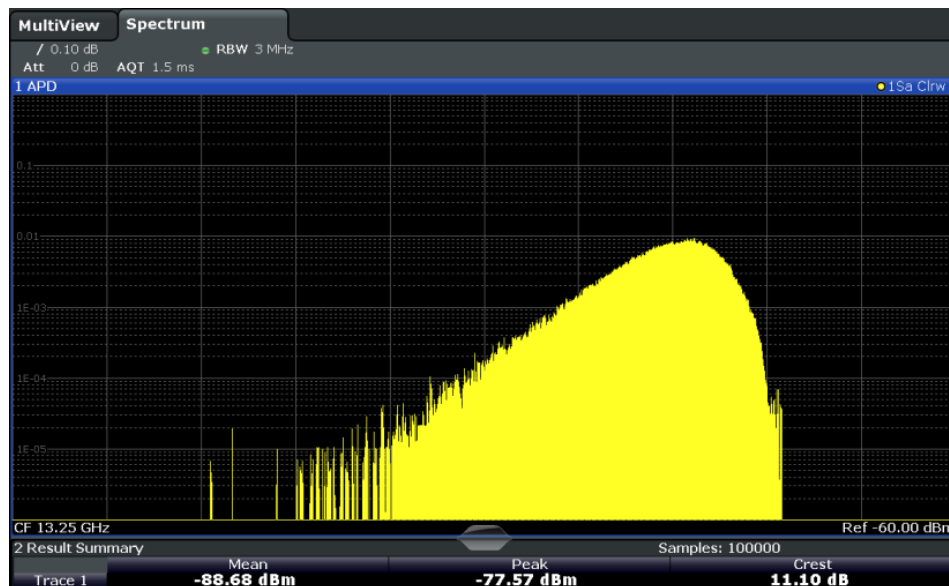


Figure 2-39: Amplitude probability distribution of white noise

4. Now select the "CCDF" measurement function from the "Select Measurement" dialog box.



Figure 2-40: 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.

2.8.8 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 162).
- 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.

2.9 Time Domain Power Measurement

The R&S ESW can determine the power of a signal in the time domain using the Time Domain Power measurement function.

- [About the Measurement](#)..... 171
- [Time Domain Power Results](#)..... 171
- [Time Domain Power Basics - Range Definition Using Limit Lines](#)..... 172
- [Time Domain Power Configuration](#)..... 172
- [How to Measure Powers in the Time Domain](#)..... 173
- [Measurement Example](#)..... 174

2.9.1 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.

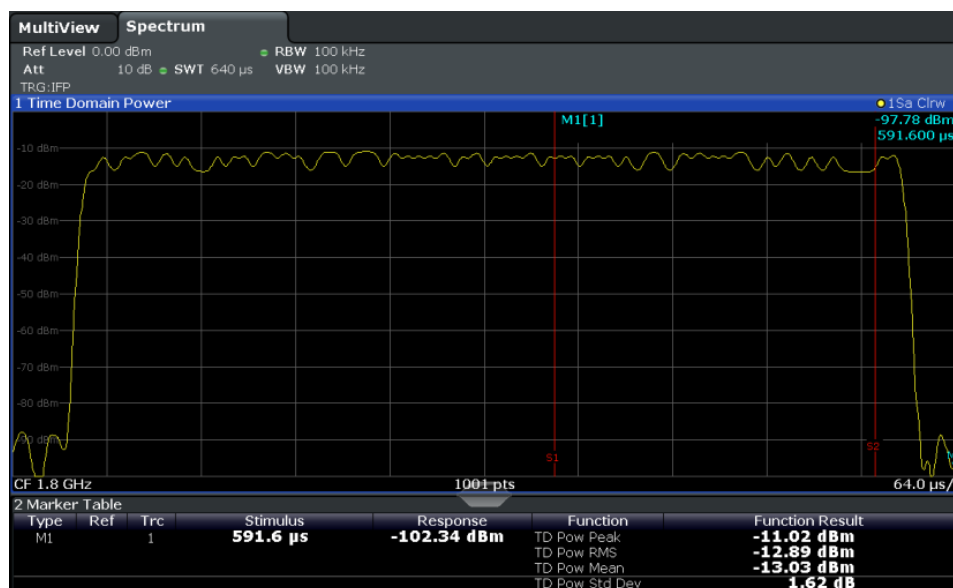
For this measurement, the sample detector is activated.

2.9.2 Time Domain Power Results

Several different power results can be determined simultaneously:

Mode	Description
Peak	Peak value from the points of the displayed trace or a segment thereof.
RMS	RMS value from the points of the displayed trace or a segment thereof.
Mean	Mean value from the points of the displayed trace or a segment thereof. The linear mean value of the equivalent voltages is calculated. For example to measure the mean power during a GSM burst
Std Dev	The standard deviation of the measurement points from the mean value.

The result is displayed in the marker results, indicated by "Power" and the selected power mode, e.g. "RMS". The measured values are updated after each sweep or averaged over a user-defined number of sweeps (trace averaging).



The results can also be queried using the remote commands described in [Chapter 5.3.9, "Measuring the Time Domain Power"](#), on page 512.

2.9.3 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.

2.9.4 Time Domain Power Configuration

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

The remote commands required to perform these tasks are described in [Chapter 5.3.9, "Measuring the Time Domain Power"](#), on page 512.

Results	172
Limit State	173
Left Limit / Right Limit	173

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 514

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:RESult?](#) on page 517

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS\[:STATe\]](#) on page 515

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:RESult?](#) on page 519

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN\[:STATe\]](#) on page 514

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:RESult?](#) on page 516

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 646

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 645

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 645

2.9.5 How to Measure Powers in the Time Domain

To measure the power in the time domain

1. Select the "Time Domain Power" measurement function from the "Select Measurement" dialog box.
2. Select the type of power measurement results to be determined by selecting the corresponding softkeys.
3. To restrict the power evaluation range, define limits:
 - a) Select the "Time Dom Power Config" softkey to display the "Time Domain Power" configuration dialog box.
 - b) Switch on the limits by setting the "Limit State" to "On".
The limit lines S1 and S2 are displayed.
 - c) Define the left limit (limit line S1), the right limit (S2), or both.

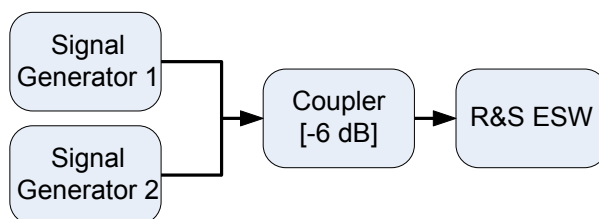
4. Start a sweep.

The measured powers are displayed in the marker results.

2.9.6 Measurement Example

This measurement example demonstrates the time domain power calculation for a GSM burst.

Test setup:



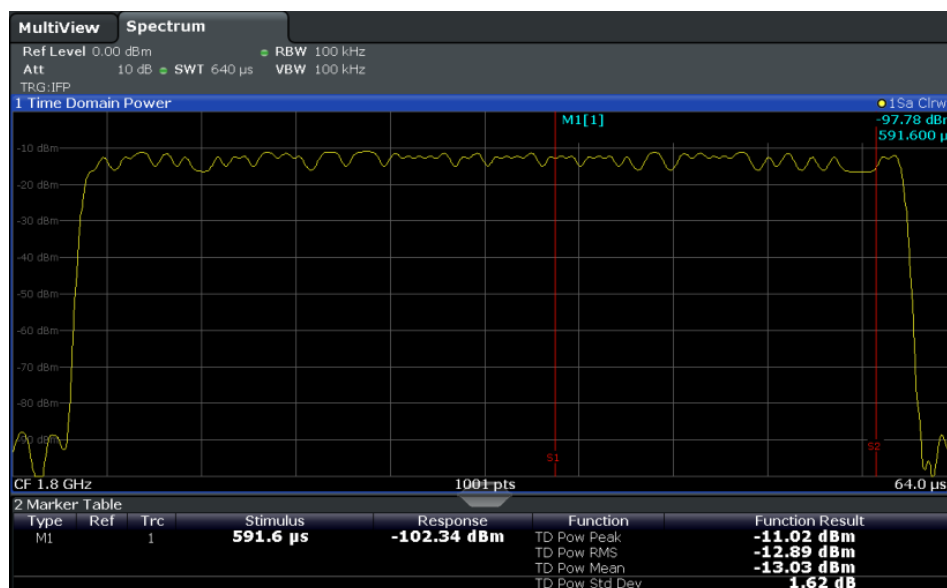
Signal generator settings (e.g. R&S ESW SMW):

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*.



2.10 Harmonic Distortion Measurement

The harmonics and their distortion can be measured using the "Harmonic Distortion" function.

- [About the Measurement](#)..... 175
- [Harmonic Distortion Basics](#)..... 176
- [Harmonic Distortion Results](#)..... 178
- [Harmonic Distortion Configuration](#)..... 179
- [How to Determine the Harmonic Distortion](#)..... 180

2.10.1 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).

2.10.2 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 2-41](#), the level of the 2nd harmonic drops by 20 dB if the level of the fundamental wave is reduced by 10 dB.

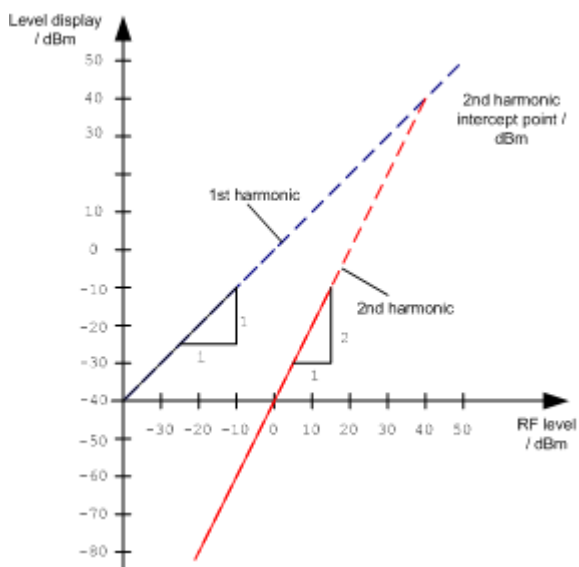


Figure 2-41: Extrapolation of the 1st and 2nd harmonics to the 2nd harmonic intercept at 40 dBm

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 2nd 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:

$$P_1 = \frac{P_{\text{noise}} / \text{dBm} + IP2}{2}$$

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

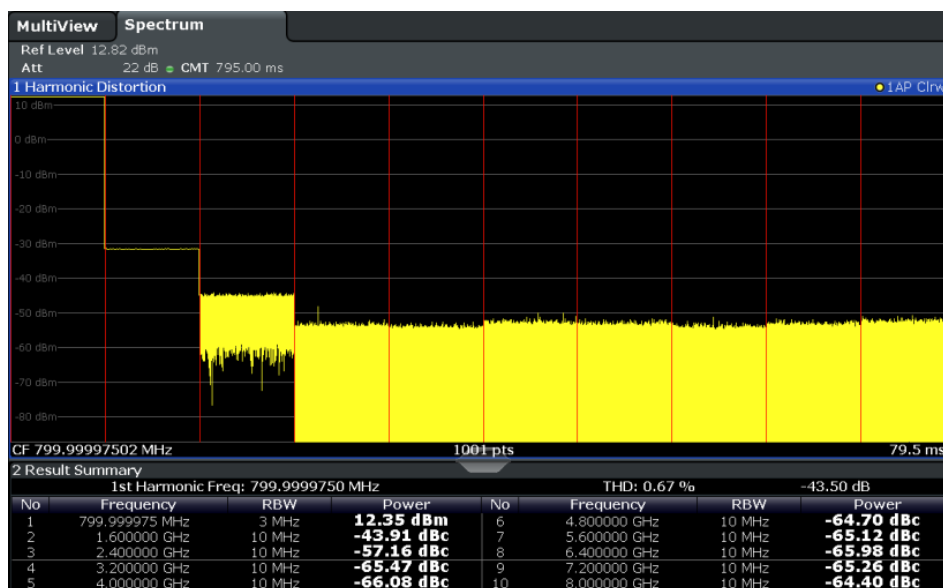
During the harmonics measurement, zero span sweeps are performed at the center frequency and at each harmonic. The duration of each sweep ("Harmonic Sweep Time", **SWT**) and the "Number of Harmonics" (n) are defined in the "Harmonic Distortion" configuration dialog box. Thus, the required measurement 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.

2.10.3 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.

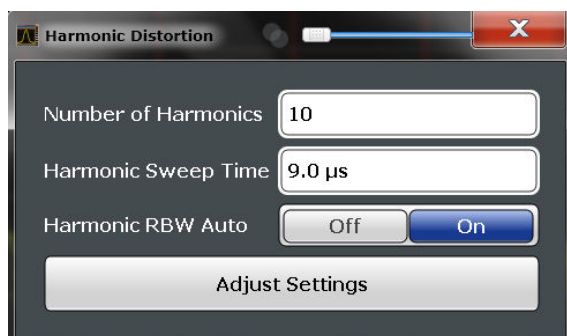
The first harmonic frequency can be read out via the general center frequency command `[SENSe:]FREQuency:CENTer` on page 582.

THD: `CALCulate<n>:MARKer<m>:FUNction:HARMonics:DISTortion?` on page 524

List of harmonics: `CALCulate<n>:MARKer<m>:FUNction:HARMonics:LIST?` on page 524

2.10.4 Harmonic Distortion Configuration

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



The remote commands required to perform these tasks are described in [Chapter 5.3.10, "Measuring the Harmonic Distortion"](#), on page 521.

No. of Harmonics	179
Harmonic Sweep Time	179
Harmonic RBW Auto	180
Adjust Settings	180

No. 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 523

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 278.

Remote command:

[SENSe:] SWEep:TIME:AUTO on page 602

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 522

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 523

2.10.5 How to Determine the Harmonic Distortion



In [Chapter 4.4.6, "Measurement Example: Measuring Harmonics Using Marker Functions"](#), on page 385, measuring harmonics was described using marker functions. This task can be performed much simpler using the Harmonic Distortion measurement, as described in the following procedure.

1. Select the "Harmonic Distortion" measurement function from the "Select Measurement" dialog box.
2. Define the number of harmonics to be determined using the "No. of Harmonics" softkey.
3. Perform a sweep.
The trace for the determined harmonics are displayed in the diagram, separated by red display lines. The measured power for each harmonic in relation to the fundamental is indicated in the result table.
4. If the signal changes significantly during or after the harmonics measurement, use the "Adjust Settings" function to adjust the settings automatically and restart the measurement.

2.11 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.

- [About the TOI Measurement](#)..... 181
- [TOI Basics](#)..... 181
- [TOI Results](#)..... 185
- [TOI Configuration](#)..... 186
- [How to Determine the Third Order Intercept](#)..... 187
- [Measurement Example – Measuring the R&S ESW's Intrinsic Intermodulation](#)... 188

2.11.1 About the TOI Measurement

If several signals are applied to a transmission two-port device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic. The intermodulation products of lower order have a special effect since their level is largest and they are near the useful signals. The intermodulation product of third order causes the highest interference. It is the intermodulation product generated from one of the useful signals and the 2nd harmonic of the second useful signal in case of two-tone modulation.

In order to measure the third order intercept point (TOI), a two-tone signal with equal carrier levels is expected at the R&S 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 field.

2.11.2 TOI Basics

If several signals are applied to a transmission two-port device with nonlinear characteristic, intermodulation products appear at its output at the sums and differences of the signals. The nonlinear characteristic produces harmonics of the useful signals which intermodulate at the characteristic.

The frequencies of the intermodulation products are above and below the useful signals. The [Figure 2-42](#) shows intermodulation products P_{S1} and P_{S2} generated by the two useful signals P_{U1} and P_{U2} .

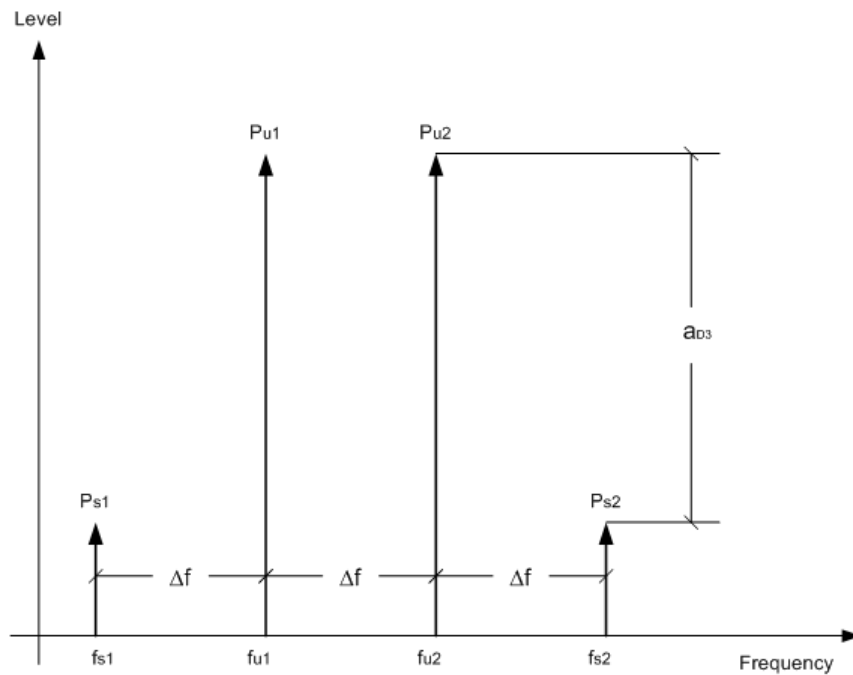


Figure 2-42: Intermodulation products P_{s1} and P_{s2}

The intermodulation product at f_{i2} is generated by mixing the 2nd harmonic of useful signal P_{U2} and signal P_{U1} .

The intermodulation product at f_{i1} is generated by mixing the 2nd harmonic of useful signal P_{U1} and signal P_{U2} .

$$f_{i1} = 2 \times f_{u1} - f_{u2} \quad (1)$$

$$f_{i2} = 2 \times f_{u2} - f_{u1} \quad (2)$$

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, which means that the spacing a_{D3} between intermodulation signals and useful signals is reduced by 2 dB. This is illustrated in [Figure 2-43](#).

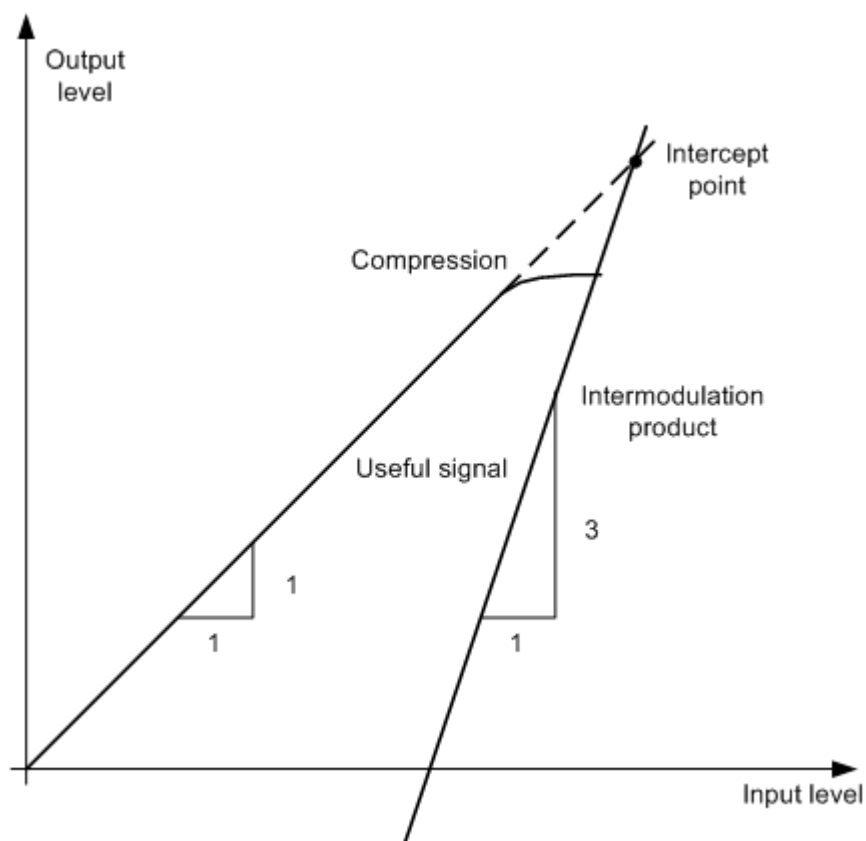


Figure 2-43: Dependency of intermodulation products on level of useful signals

The useful signals at the two-port output increase proportionally with the input level as long as the two-port is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. Beyond a certain input level, the two-port goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as quickly as the useful signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly since the useful level is previously limited by the maximum two-port output power.

Calculation method

However, the intercept point can be calculated from the known line slopes and the measured spacing a_{D3} at a given level according to the following formula:

$$IP3 = \frac{a_{D3}}{2} + P_N$$

The third order intercept point (TOI), for example, is calculated for an intermodulation of 60 dB and an input level P_U of -20 dBm according to the following formula:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm$$

Intermodulation-free dynamic range

The "Intermodulation-free dynamic range", i.e. the level range in which no internal intermodulation products are generated if two-tone signals are measured, is determined by the third order intercept point, the phase noise and the thermal noise of the signal analyzer. At high signal levels, the range is determined by intermodulation products. At low signal levels, intermodulation products disappear below the noise floor, i.e. the noise floor and the phase noise of the signal analyzer determine the range. The noise floor and the phase noise depend on the resolution bandwidth that has been selected. At the smallest resolution bandwidth, the noise floor and phase noise are at a minimum and so the maximum range is obtained. However, a large increase in sweep time is required for small resolution bandwidths. It is therefore best to select the largest resolution bandwidth possible to obtain the range that is required. Since phase noise decreases as the carrier-offset increases, its influence decreases with increasing frequency offset from the useful signals.

The following diagrams illustrate the intermodulation-free dynamic range as a function of the selected bandwidth and of the level at the input mixer (= signal level – set RF attenuation) at different useful signal offsets.

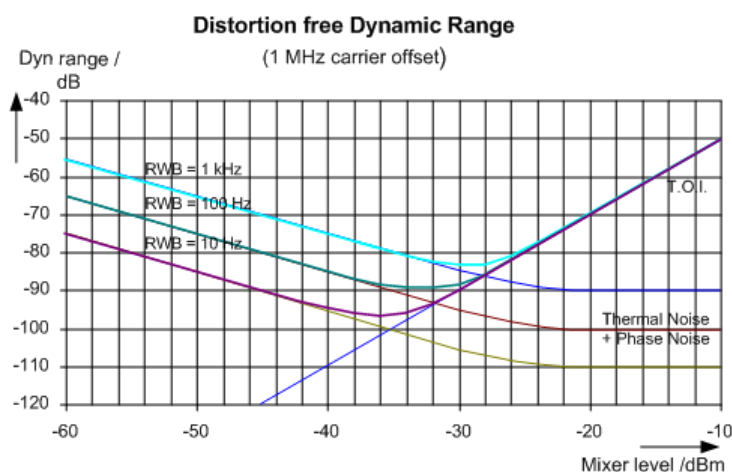


Figure 2-44: Intermodulation-free range as a function of level at the input mixer and the set resolution bandwidth

(Useful signal offset = 1 MHz, DANL = -145 dBm/Hz, TOI = 15 dBm; typical values at 2 GHz)

The optimum mixer level, i.e. the level at which the intermodulation distance is at its maximum, depends on the bandwidth. At a resolution bandwidth of 10 Hz, it is approx. -35 dBm and at 1 kHz increases to approx. -30 dBm.

Phase noise has a considerable influence on the intermodulation-free range at carrier offsets between 10 and 100 kHz (see [Figure 2-45](#)). 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.

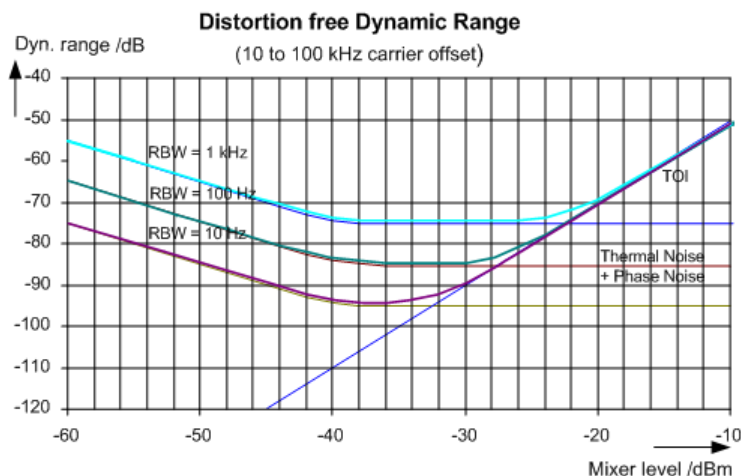


Figure 2-45: Intermodulation-free dynamic range as a function of level at the input mixer and of the selected resolution bandwidth

(Useful signal offset = 10 to 100 kHz, DANL = -145 dBm/Hz, TOI = 15 dBm; typical values at 2 GHz).



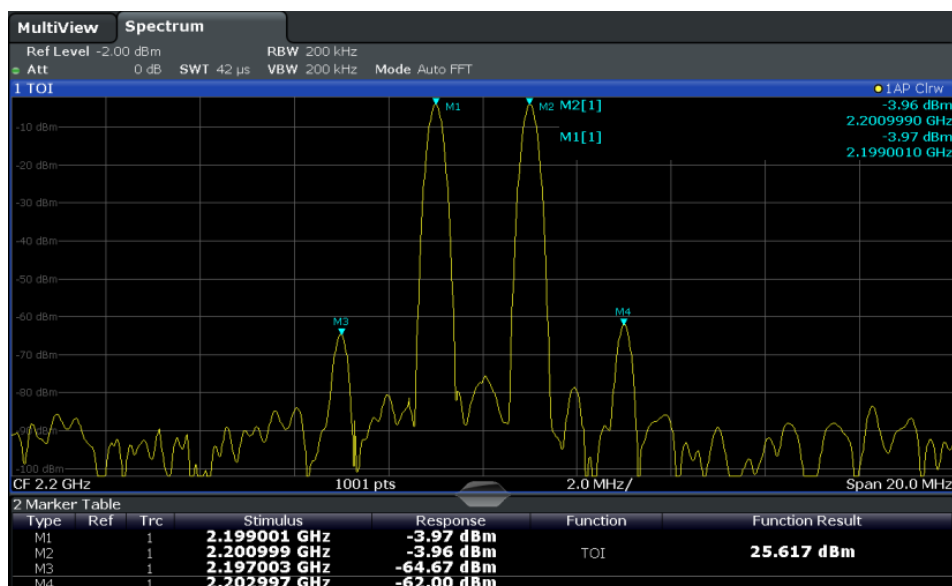
If the intermodulation products of a DUT with a very high dynamic range are to be measured and the resolution bandwidth to be used is therefore very small, it is best to measure the levels of the useful signals and those of the intermodulation products separately using a small span. The measurement time will be reduced, in particular if the offset of the useful signals is large. To find signals reliably when frequency span is small, it is best to synchronize the signal sources and the R&S ESW.

2.11.3 TOI Results

As a result of the TOI measurement, the following values are displayed in the marker area of the diagram:

Label	Description
TOI	Third-order intercept point
M1	Maximum of first useful signal
M2	Maximum of second useful signal
M3	First intermodulation product
M4	Second intermodulation product

Third Order Intercept (TOI) Measurement

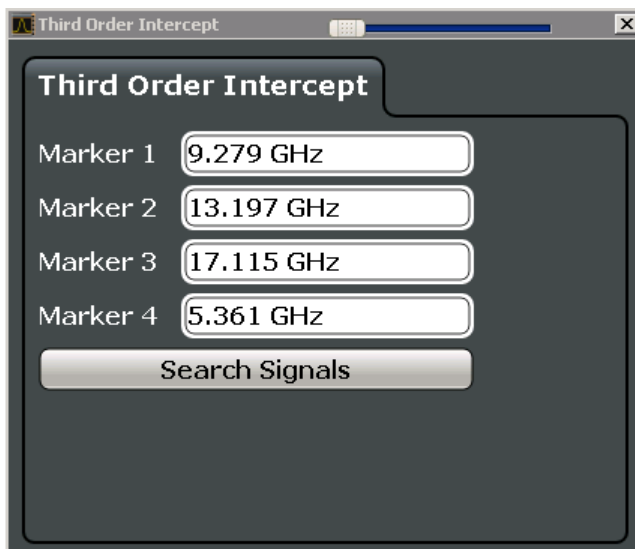


Remote command

The TOI can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNction:TOI:RESult?` on page 525.

2.11.4 TOI Configuration

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



The remote commands required to perform these tasks are described in [Chapter 5.3.11, "Measuring the Third Order Intercept Point"](#), on page 525.

Marker 1/2/3/4	187
Search Signals	187

Marker 1/2/3/4

Indicates the detected characteristic values as determined by the TOI measurement (see [Chapter 2.11.3, "TOI Results"](#), on page 185).

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 640

[CALCulate<n>:DELTaMarker<m>:X](#) on page 637

[CALCulate<n>:DELTaMarker<m>:X:RELative?](#) on page 653

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 526

2.11.5 How to Determine the Third Order Intercept

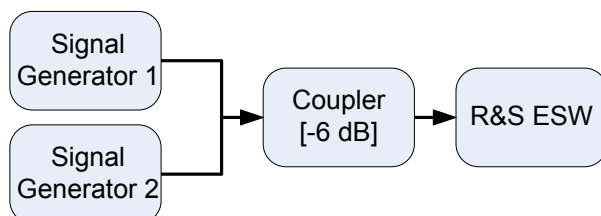


The precise TOI for the R&S ESW in relation to the input signals is provided in the data sheet.

1. Apply a two-tone signal with equal carrier levels to the R&S ESW input.
2. On the R&S ESW, press the MEAS key.
3. Select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.
The calculated TOI is indicated in the marker information. The markers required for calculation are displayed in the marker table.
4. If the signal changes significantly during or after the TOI measurement, use the "Search Signals" function to start a new signal search automatically and restart the calculation of the TOI.

2.11.6 Measurement Example – Measuring the R&S ESW's Intrinsic Intermodulation

Test setup:



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

Device	Level	Frequency
Signal generator 1	-4 dBm	799.6 MHz
Signal generator 2	-4 dBm	800.4 MHz

Setting up the measurement

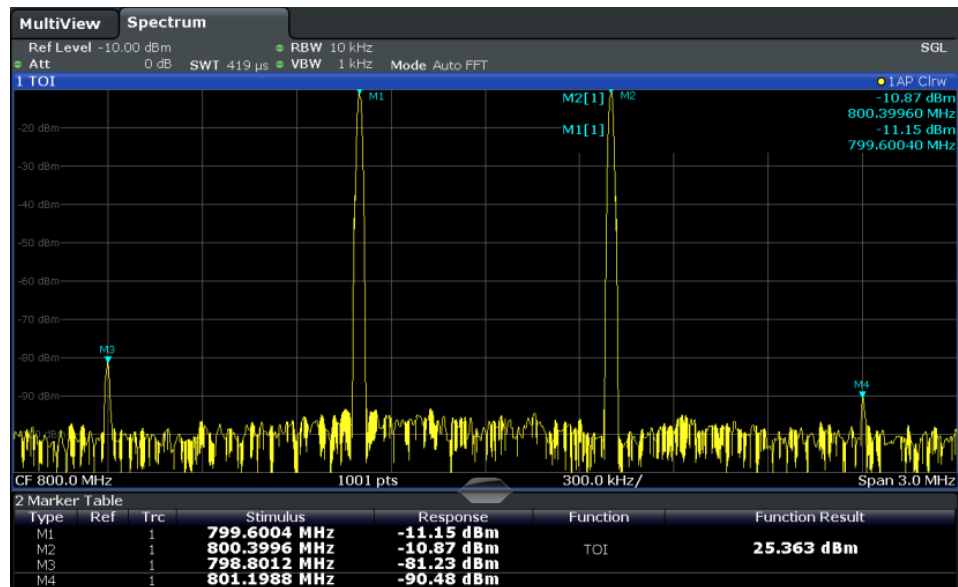
1. Preset the R&S ESW.
2. Set the center frequency to *800 MHz* and the frequency span to *3 MHz*.
3. Set the reference level to *-10 dBm* and RF attenuation to *0 dB*.
4. Set the resolution bandwidth to *10 kHz*.
The noise is reduced, the trace is smoothed further and the intermodulation products can be seen clearly.
5. Set the VBW to "1 kHz".

Measuring intermodulation using the Third Order Intercept (TOI) measurement function

1. Press the MEAS key and select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

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:

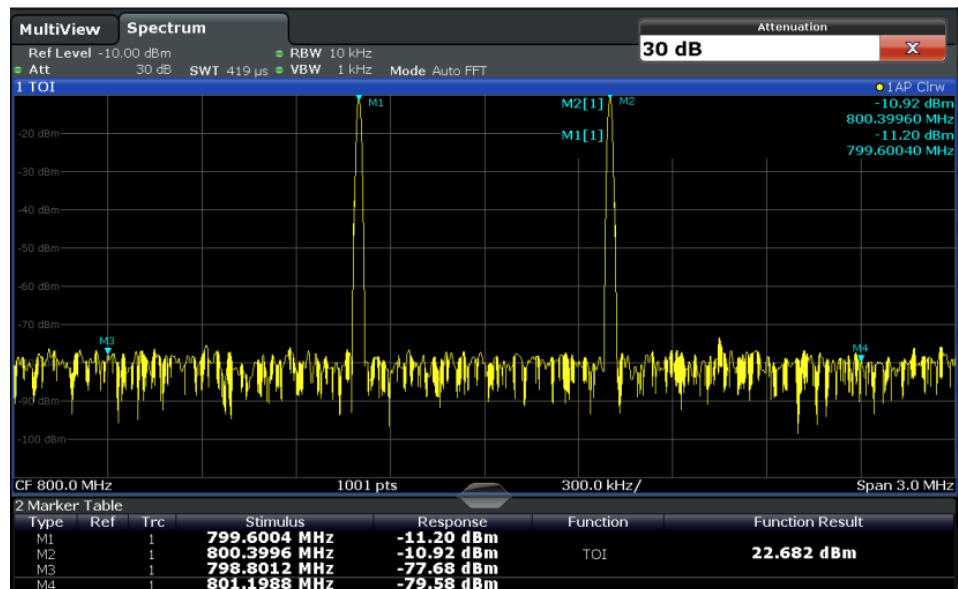
Third Order Intercept (TOI) Measurement



The third order intercept (TOI) is displayed in the marker information.

- 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.



2.12 AM Modulation Depth Measurement

Using the R&S ESW you can measure the AM modulation depth of a modulated signal.

- [About the Measurement](#)..... 190
- [AM Modulation Depth Results](#)..... 190
- [AM Modulation Depth Configuration](#)..... 191
- [Optimizing and Troubleshooting the Measurement](#)..... 192
- [How to Determine the AM Modulation Depth](#)..... 193

2.12.1 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%.

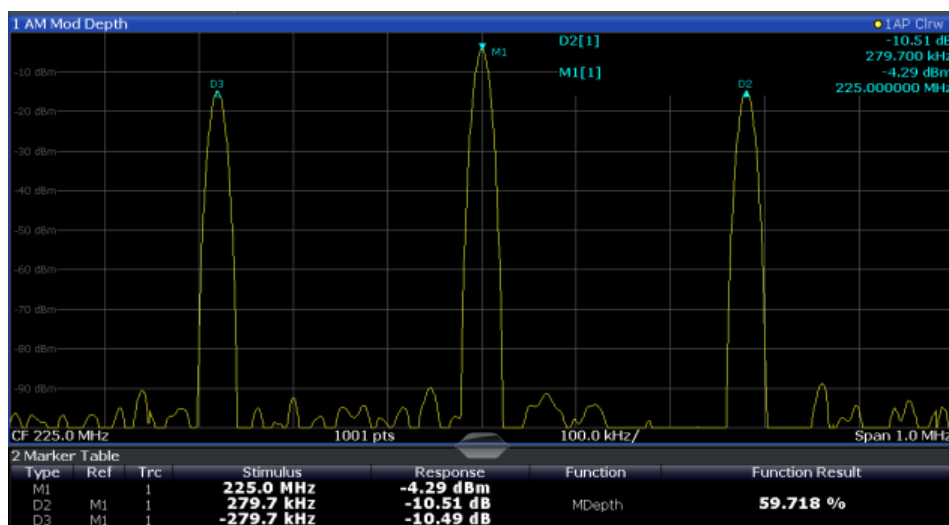
When this measurement is activated, marker 1 is set to the peak level, which is considered to be the carrier level. Delta markers 2 and 3 are automatically set symmetrically to the carrier on the adjacent peak values of the trace. The markers can be adjusted manually, if necessary.

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.

2.12.2 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

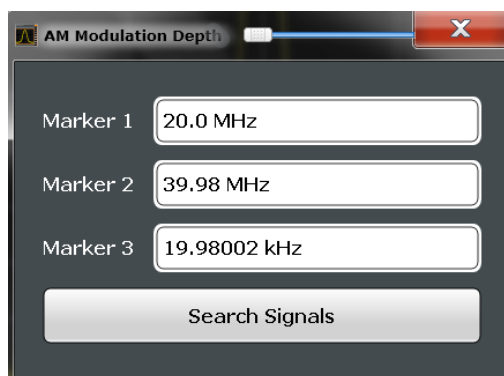


Remote command:

The AM modulation depth can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNction:MDEPth:RESult?` on page 528.

2.12.3 AM Modulation Depth Configuration

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



The remote commands required to perform these tasks are described in [Chapter 5.3.12, "Measuring the AM Modulation Depth"](#), on page 527.

[Marker 1/2/3](#)..... 192

[Search Signals](#)..... 192

Marker 1/2/3

Indicates the detected characteristic values as determined by the AM Modulation Depth measurement:

Marker	Description
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

The marker positions can be edited; the modulation depth is then recalculated according to the new marker values.

To reset all marker positions automatically, use the [Search Signals](#) function.

Note: Moving the marker positions manually. When the position of delta marker 2 is changed, delta marker 3 is moved symmetrically with respect to the reference marker 1.

Delta marker 3, on the other hand, can be moved for fine adjustment 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 640

[CALCulate<n>:DELTamarker<m>:X](#) on page 637

[CALCulate<n>:DELTamarker<m>:X:RELative?](#) on page 653

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 528

2.12.4 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.

2.12.5 How to Determine the AM Modulation Depth

1. Apply a modulated carrier signal to the R&S ESW input.
2. On the R&S ESW, press the MEAS key.
3. Select the "AM Modulation Depth" measurement function from the "Select Measurement" dialog box.

The calculated AM Modulation Depth is indicated in the marker information. The markers required for calculation are displayed in the marker table.

4. If the signal changes significantly during or after the AM Modulation Depth measurement, use the "Search Signals" function to start a new peak search automatically and restart the calculation of the AM Modulation Depth.

2.13 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

2.13.1 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 would lead to very high measurement times.

Splitting the measurement procedure into several stages, however, can eliminate this problem.

The first stage, or peak search, is used to get a rough idea about the location of peak levels that may indicate interference over the required frequency range. You can use 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.

2.13.2 EMI Measurement Results

As the result of an R&S ESW EMI measurement, the measured signal levels and active markers are displayed in a Spectrum diagram.

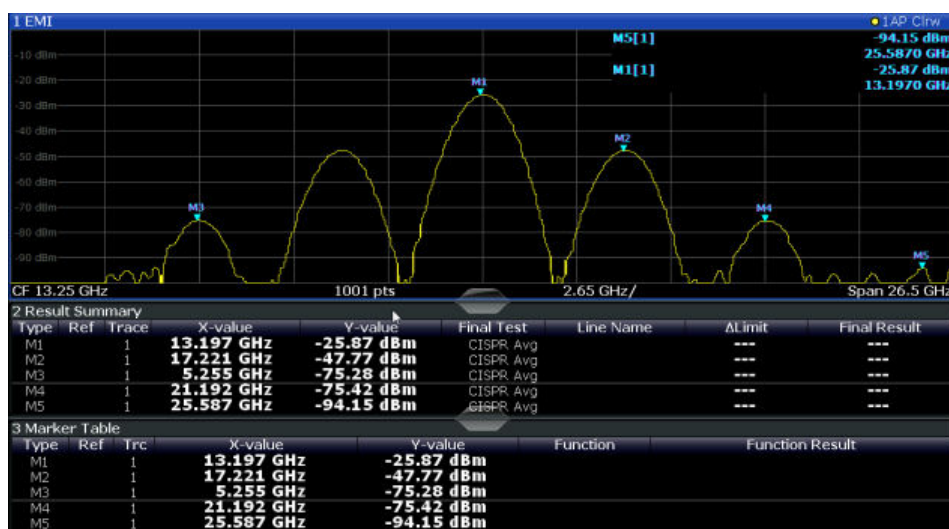


Figure 2-46: EMI measurement results

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**.

(Note: 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
Δ Limit	Delta between measured level and limit line (if active) The value is colored to indicate the following states: <ul style="list-style-type: none"> • green: does not exceed limit • yellow: within margin • red: exceeds limit
Final Result	Value measured during final EMI test using specified detector at marker frequency

2.13.3 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](#).....195
- [Detectors and Dwell Time](#).....196
- [Frequency Resolution - Sweep Points and Scaling](#).....199
- [Controlling V-Networks \(LISN\)](#).....200
- [Using Transducer Factors](#).....201
- [Initial Measurement - Peak Search](#).....201
- [Final Measurement at the Marker Position](#).....202
- [Limit Checks](#).....203

2.13.3.1 Resolution Bandwidth and Filter Types

EMI testing requires resolution filters with a 6 dB bandwidth. The R&S ESW EMI measurement adds the following bandwidths that 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 Quasipeak detector, see ["Quasipeak detector \(CISPR filter only\)"](#) on page 197)

Military (MIL Std)

- 10 Hz
- 100 Hz
- 1 kHz
- 10 kHz
- 100 kHz
- 1 MHz

For the Quasipeak, CISPR Average, or Average RMS detector, the bandwidth is fixed depending on the frequency. For more information see [Chapter 2.13.3.2, "Detectors and Dwell Time"](#), on page 196.

2.13.3.2 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.

The detector to be used for the initial peak search is configured in the trace settings (see [Chapter 4.3.2.1, "Trace Settings"](#), on page 331), while the detector for the final test is configured in the EMI marker settings, see [Chapter 2.13.4.1, "EMI Marker Configuration"](#), on page 204.

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; the individual requirements on the dwell time are described for each detector. For details on defining the dwell time for an R&S ESW EMI measurement see ["Defining a Dwell Time for the Final Measurement"](#) on page 203.

Positive and negative peak detector

The maximum and minimum peak detectors display the maximum and minimum signal level that was detected during the specified dwell time.

The minimum and maximum peak detectors are already available with the base unit.

Consider the following when defining the dwell time:

- **Unmodulated signals:** minimum time required by the detector
- **Pulsed signals:** the time must be long enough to capture at least one complete pulse

Average detector

The average detector displays the average signal level of the samples that were collected during the specified dwell time.

The average detector is already available with the base unit.

Consider the following when defining the dwell time:

- **Unmodulated signals:** minimum time required by the detector
- **Pulsed signals:** the time must be long enough to capture several complete pulses (at least 10)
- The time is determined by the lowest modulation frequency to be averaged

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.

The RMS detector is already available with the base unit.

The same considerations apply to the dwell time as for the average detector.

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.

Quasipeak detector (CISPR filter only)

The quasipeak detector displays the maximum signal level weighted to CISPR 16-1-1 that was detected during the dwell time.

The quasipeak detector is only available for the CISPR filter, and not for an RBW of 1 MHz.

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.

Table 2-16: Required parameters depending on frequency for CISPR quasipeak detector

	Band A	Band B	Band C/D
Frequency range	< 150 kHz	150 kHz to 30 MHz	> 30 MHz
Resolution bandwidth	200 Hz	9 kHz	120 kHz
Charge time	45 ms	1 ms	1 ms
Discharge time	500 ms	160 ms	550 ms
Time lag of the simulated pointer instrument	160 ms	160 ms	100 ms

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
- **Known signals:** shorter dwell time possible, as the signal level does not change during the final measurement

When you change the frequency or the attenuation, the R&S ESW waits until the low-pass filter has settled before starting the measurement.

CISPR Average detector (CISPR filter only)

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 dwell time.

The CISPR Average 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 filter bandwidth and time lag 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.

Table 2-17: Required parameters depending on frequency for CISPR Average detector

	Band A	Band B	Band C/D	Band E
Frequency range	<150 kHz	150 kHz to 30 MHz	30 MHz to 1 GHz	>1 GHz
IF bandwidth	200 Hz	9 kHz	120 kHz	1 MHz
Time lag of the simulated pointer instrument	160 ms	160 ms	100 ms	100 ms

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

When you change the frequency or the attenuation, the R&S ESW waits until the low-pass filter has settled before starting the measurement. In this case, the measurement time depends on the resolution bandwidth and the characteristics of the signal.

RMS Average detector (CISPR filter only)

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, for example, to measure broadband emissions and may replace the quasipeak detector in the future.

The detector parameters 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.

Table 2-18: Required parameters depending on frequency for RMS Average detector

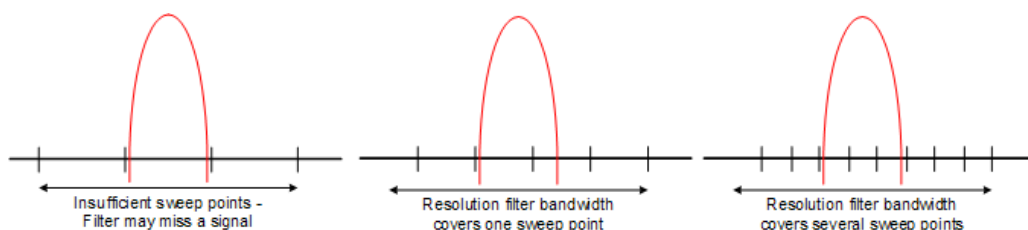
	Band A	Band B	Band C/D	Band E
Frequency range	<150 kHz	150 kHz to 30 MHz	30 MHz to 1 GHz	>1 GHz
IF bandwidth	200 Hz	9 kHz	120 kHz	1 MHz
Time lag of simulated pointer instrument	160 ms	160 ms	100 ms	100 ms
Corner frequency	10 Hz	100 Hz	100 Hz	1 kHz

The same considerations apply to the dwell time as for the CISPR average detector.

2.13.3.3 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.

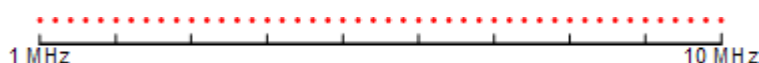
Because EMI measurements often cover a large frequency range you should define an adequate number of sweep points, especially when performing the measurement on a logarithmic axis. As on a linear axis, the distance from one sweep point to the next is calculated graphically on a logarithmic axis, and 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 could be missed during refined measurement of narrowband interferers. If the distance between two sweep points is larger than $RBW/3$, a warning is displayed in the status bar ("Increase sweep points").

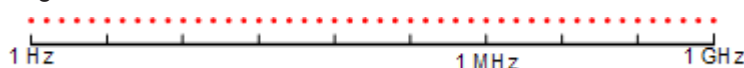
Example:

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.

The R&S ESW EMI measurement supports a maximum of 200000 sweep points. 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.

2.13.3.4 Controlling V-Networks (LISN)

For measurements on power lines, the R&S ESW EMI measurement adds functionality 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 R&S ESW EMI measurement supports several V-networks. For each type of network, you can define the phase you want to test for interferences. The R&S ESW EMI measurement allows you to test one phase at a time.

Table 2-19: Supported networks and phases

Network type	Phases
Two-line V-networks	
ESH3-Z5	N, L1
ENV216	N, L1
Four-line V-networks	
ESH2-Z5	N, L1, L2, L3
ENV4200	N, L1, L2, L3

For the ENV216 network, a 150 kHz high pass filter is available to protect the input of the R&S ESW.

2.13.3.5 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 useful signals. The transducer converts the measured value such as field strength, current or RFI voltage into a voltage across 50 Ω . 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.

The R&S ESW EMI measurement adds several predefined transducer factors. In addition you can also create new and edit existing transducer factors.

For more information about transducer factors see the User Manual of the R&S ESW.

2.13.3.6 Initial Measurement - Peak Search

The purpose of an initial peak search is to find signals with a high interference level quickly. Usually 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 2.13.2, "EMI Measurement Results"](#), on page 194).

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 cursor keys, or position it to a particular frequency with the number keys.

Setting markers is the same as setting markers in other Spectrum measurements. For more information see [Chapter 4.4.2, "Marker Settings"](#), on page 361.

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, provided that 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 so that the distribution of narrowband and wideband sources of interference can be taken into account.

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 quasipeak detector.

2.13.3.7 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 may 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 detection 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 2.13.2, "EMI Measurement Results"](#), on page 194).

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 2.13.3.2, "Detectors and Dwell Time"](#), on page 196.

2.13.3.8 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. The R&S ESW EMI measurement adds further predefined limit lines designed in compliance with several EMC standards.

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 may be determined using a different detector than the final test results, the two limit check results may 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 4.5.2, "Basics on Limit Lines"](#), on page 388.

2.13.4 EMI Measurement Configuration

On the R&S ESW, EMI measurement configuration consists of the following settings, most of which are accessible from the main EMI menu. This menu is displayed when you select the EMI measurement and then press the MEAS CONFIG key.

In addition, some common settings are also relevant for EMI measurements:

- [Chapter 4.5.3.2, "Limit Line Settings and Functions"](#), on page 393
- [EMI Marker Configuration](#)..... 204
- [EMI Final Measurement Configuration](#)..... 207
- [LISN Control Settings](#)..... 209

2.13.4.1 EMI Marker Configuration

The initial peak search for the R&S ESW EMI measurement is defined by the marker configuration.

To configure EMI markers select the EMI measurement, then press the MEAS CONFIG or MKR key and select "Marker Config".

Selected Marker	204
Marker State	204
Marker Position (X-value)	204
Marker Type	205
Reference Marker	205
Linking to Another Marker	205
Assigning the Marker to a Trace	205
Final Test Detector	206
Select Marker	206

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 639

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 637

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 640

[CALCulate<n>:DELTAmarker<m>:X](#) on page 637

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 639

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 637

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 365), the reference point ("FXD") can also be selected instead of another marker.

Remote command:

[CALCulate<n>:DELTAmarker<m>:MREF](#) on page 636

Linking to Another Marker

Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:

[CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>](#) on page 638

[CALCulate<n>:DELTAmarker<m>:LINK:TO:MARKer<m>](#) on page 635

[CALCulate<n>:DELTAmarker<m>:LINK](#) on page 634

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 639

Final Test Detector

Defines the detector to be used for the final EMI test at the marker frequency.

For details see [Chapter 2.13.3.2, "Detectors and Dwell Time"](#), on page 196.

Note: The trace detector configured in the trace settings is used for the initial peak search only, see [Chapter 4.3.2.1, "Trace Settings"](#), on page 331.

"Off"	No final test is performed.
"Positive peak"	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.
"Quasipeak"	Determines the maximum signal level weighted to CISPR 16-1-1 that was detected during the dwell time. The quasipeak 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. 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. 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). 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.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DETECTOR](#) on page 540

[CALCulate<n>:DELTAmarker<m>:FUNCTION:FMEasurement:DETECTOR](#) on page 540

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 639

CALCulate<n>:DELTaMarker<m>[:STATe] on page 637

2.13.4.2 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 206.

Filter Type.....	207
RBW.....	207
Automatic Peak Search.....	208
Dwell Time.....	208
Frequency Axis Scaling.....	208
Res BW CISPR.....	208
Res BW MIL.....	209

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
- 5-Pole (not available for sweep type "FFT")

For more information see Chapter 3.6.1.6, "Which Data May Pass: Filter Types", on page 273.

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 595

RBW

Defines the resolution bandwidth. The available resolution bandwidths are specified in the data sheet. 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 more information see [Chapter 3.6.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth"](#), on page 270.

For EMI measurements using the quasipeak detector, the 1 MHz RBW filter is not available (see [Chapter 2.13.3.1, "Resolution Bandwidth and Filter Types"](#), on page 195).

Remote command:

`[SENSe:]BANDwidth[:RESolution]` on page 594

`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 594

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 / Min Peak Search](#) are not available for EMI measurements.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:PEAKsearch:AUTO`
on page 541

Dwell Time

Sets the dwell time for the EMI marker measurement.

For more information see [Chapter 2.13.3.2, "Detectors and Dwell Time"](#), on page 196.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DWELL` on page 542

Frequency Axis Scaling

Switches between linear and logarithmic scaling for the frequency axis.

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 3.4.1.4, "Coping with Large Frequency Ranges - Logarithmic Scaling"](#), on page 254.

Remote command:

`DISPlay[:WINDow<n>]:TRACe:X:SPACing` on page 587

Res BW CISPR

Defines the measurement bandwidth for commercial EMC standards according to CISPR.

For more information see [Chapter 2.13.3.1, "Resolution Bandwidth and Filter Types"](#), on page 195.

Remote command:

Filter type:

`[SENSe:]BANDwidth[:RESolution]:TYPE` on page 595

Filter bandwidth:

[SENSe:]BANDwidth[:RESolution] on page 594

Res BW MIL

Defines the measurement bandwidth for military EMC standards.

For more information see [Chapter 2.13.3.1, "Resolution Bandwidth and Filter Types"](#), on page 195.

Remote command:

Filter type:

[SENSe:]BANDwidth[:RESolution]:TYPE on page 595

Filter bandwidth:

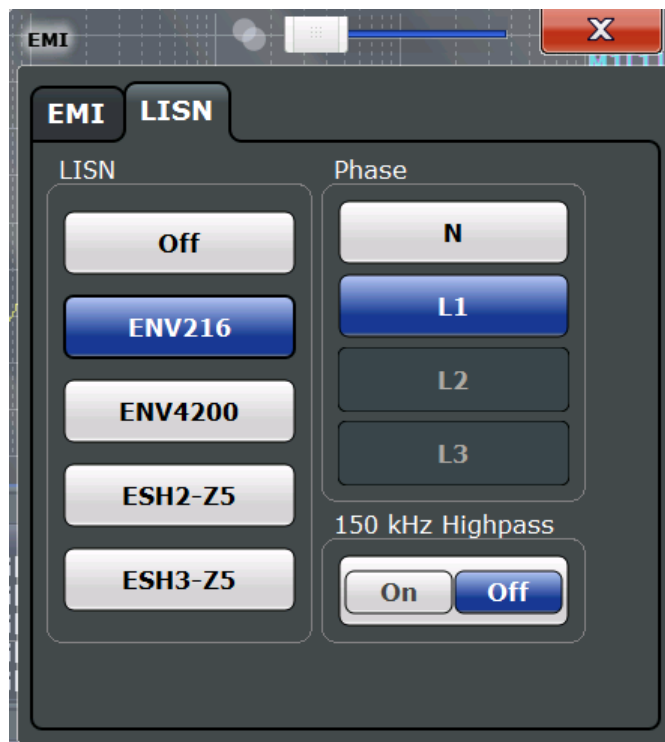
[SENSe:]BANDwidth[:RESolution] on page 594

2.13.4.3 LISN Control Settings

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). LISN control requires the EMI measurement (R&S ESW-K54) option.

The LISN control settings are available when you do one of the following:

- If the EMI measurement is selected, press the MEAS CONFIG key, then select "LISN Config".
- Press the INPUT/OUTPUT key, then select "LISN Config".
- In the "Overview", select "Output", then select "LISN Config".



For more information see [Chapter 2.13.3.4, "Controlling V-Networks \(LISN\)"](#), on page 200.

LISN Type	210
Phase	210
150 kHz Highpass Filter	210

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 2-19](#)).

"Off" disables LISN control and output.

Remote command:

`INPut:LISN:TYPE` on page 543

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 542

150 kHz Highpass Filter

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 542

2.13.5 EMI Result Analysis

The R&S ESW 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 R&S ESW 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 with headphones or with the internal speaker.

For more information see [Chapter 4.4.4.7, "Marker Demodulation"](#), on page 379.

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.

The R&S ESW EMI measurement adds further predefined limit lines designed in compliance with several EMC standards.

Limit line configuration is described in [Chapter 4.5.3.2, "Limit Line Settings and Functions"](#), on page 393.

2.13.6 How to Perform EMI Measurements

The following step-by-step instructions demonstrate how to perform an EMI measurement with the R&S ESW EMI measurement option.

1. Press the MODE key on the front panel and select the "Spectrum" application.
2. Define the frequency range of the EMI measurement.
 - a) Press the FREQ key and then the "Frequency Config" softkey.
 - b) Define the start and stop frequency.
3. Configure the traces for the initial EMI measurement.
 - a) Press the TRACE key.
 - b) Select the "Trace Config" softkey 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. Press the MEAS key on the front panel and select the "EMI" measurement.

The EMI main menu is displayed.
5. Select the "EMI Config" softkey and 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.
6. Define the dwell time for which each marker position is measured during the final measurement.
7. 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.
8. Define the type of scaling for the frequency axis according to the definition of the limit lines in the standard.
9. Optionally, select the "LISN Config" softkey to configure a LISN control.
10. Configure the EMI measurement markers.
 - a) Select the "Marker Config" softkey and activate the number of markers or delta markers you want to analyze.

- b) For each active marker, select a detector to be used for the "Final Test", i.e. the subsequent EMI measurement at the marker position.
 - c) 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 7](#)).
11. Optionally, select the "Marker Demod Config" softkey 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).
12. Increase the number of sweep points for the EMI measurement.
 - a) Press the SWEEP key on the front panel.
 - b) Select the "Sweep Config" softkey.
 - c) Set the number of "Sweep Points" (up to 200001) so that the distance between two sweep points is smaller than RBW/3.
13. Optionally, select or configure limit lines against which the marker results are checked.
 - a) Press the LINES key and then the "Lines Config" softkey, then select the "Lines Config" tab.
 - b) 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 EMI measurement settings are displayed in the overview.
 - c) 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.
14. Define a suitable unit for the measured values, as the default unit dBm is not suitable for EMI measurements, or select a transducer.
To change the unit:
Press the AMPT key, then select the "Amplitude Config" softkey and, in the "Amplitude" dialog box, select the required unit.
To select a transducer:
 - a) Press the SETUP key.
 - b) Select the "Transducer" softkey.
 - 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) Select a transducer line in the overview and select the "Active" setting for it.
15. Press the RUN SINGLE key 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.

2.13.7 Measurement Example: Measuring Radio Frequency Interference

A common measurement task that you can do with the R&S ESW 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. As the captured signal characteristics will most likely be unknown, 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.

Preparing the measurement

1. Press the PRESET key.
The R&S ESW restores the default settings.
2. Define the frequency range of the measurement.
 - a) Press the FREQ key.
 - b) Press the "Start Frequency" softkey and enter a frequency of 150 kHz.
 - c) Press the "Stop Frequency" softkey and enter a frequency of 1 GHz.The R&S ESW scales the horizontal axis accordingly.
3. Press the MEAS key on the front panel and select the "EMI" measurement.
The EMI main menu is displayed.
4. Select the "EMI Config" softkey and 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 6R&S ESWdB bandwidth.
5. Define the dwell time for which each marker position is measured during the final measurement.
6. To obtain an overview of exceptional values in the input signal during the initial measurement, activate the "Auto Peak Search".
7. Select the measurement bandwidth.
 - a) Select the "Res BW CISPR" softkey.
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.

8. Configure the traces for the initial EMI measurement.
 - a) Press the TRACE key.
 - b) Press the "Trace Config" softkey 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.
9. Increase the number of sweep points for the EMI measurement.
 - a) Press the SWEEP key on the front panel.
 - b) Select the "Sweep Config" softkey.
 - c) Set the number of "Sweep Points" to *200000*.
10. Press the AMPT key, then select the "Amplitude Config" softkey and, in the "Amplitude" dialog box, select V as the "Unit".

Performing the measurement

1. Configure the EMI measurement markers. In this example we will use 6 markers.
 - a) Select the "Marker Config" softkey and activate six normal markers.
 - b) Set markers 1 to 3 on trace 1. Set markers 4 to 6 on trace 2.
 - c) 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 against which the marker results are checked.
 - a) Press the LINES key and then the "Lines Config" softkey, then select the "Lines Config" tab.
 - b) 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 EMI measurement settings are displayed in the overview.
 - c) In the overview, click the "Check Traces" setting for the `EN55011A` limit line and select trace 1 to be included in the limit check. (Trace 2, which is defined as the average, will always be lower than trace 1, which contains peak values.)
3. Press the RUN SINGLE key 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.

2.13.8 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 interferences. See [Chapter 2.13.3.3, "Frequency Resolution - Sweep Points and Scaling"](#), on page 199.

If the distance between two sweep points is larger than $RBW/3$, 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

3 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.

- [Measurement Basics](#).....216
- [Configuration Overview](#).....216
- [Data Input and Output](#).....218
- [Frequency and Span Configuration](#).....253
- [Amplitude and Vertical Axis Configuration](#).....261
- [Bandwidth, Filter and Sweep Configuration](#).....269
- [Trigger and Gate Configuration](#).....285
- [Adjusting Settings Automatically](#).....302

3.1 Measurement Basics

- [IF and Video Signal Output](#).....216

3.1.1 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/DEMOD 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

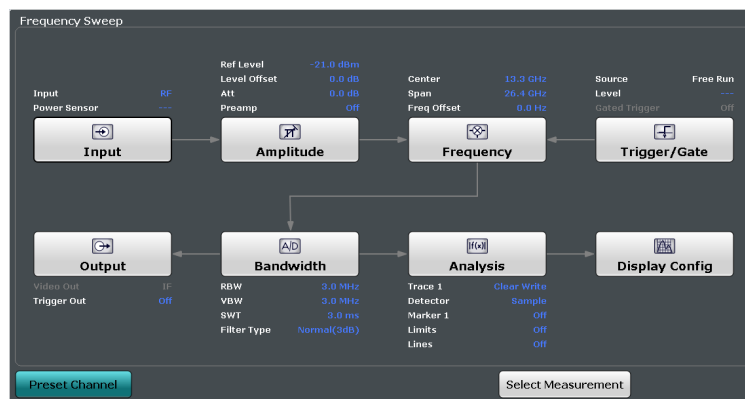
Note the following restrictions for IF output:

- IF and video output is only available in the time domain (zero span).
- For I/Q data, only IF output is available.

3.2 Configuration Overview



Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the configuration "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

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

1. "Select Measurement"
See [Chapter 2.1, "Available Measurement Functions"](#), on page 15
2. Input
[Chapter 3.3, "Data Input and Output"](#), on page 218
3. Amplitude
[Chapter 3.5, "Amplitude and Vertical Axis Configuration"](#), on page 261
4. Frequency
See [Chapter 3.4, "Frequency and Span Configuration"](#), on page 253
5. (Optionally:) Trigger/Gate
See [Chapter 3.7, "Trigger and Gate Configuration"](#), on page 285
6. Bandwidth
See [Chapter 3.6.2, "Bandwidth, Filter and Sweep Settings"](#), on page 275
(For SEM measurements: SEM Setup, see [Chapter 2.6.5, "SEM Configuration"](#), on page 114)
(For Spurious measurements: Spurious Setup, see [Chapter 2.7.4, "Spurious Emissions Measurement Configuration"](#), on page 147)
7. (Optionally:) Outputs
See [Chapter 3.3.5, "Output Settings"](#), on page 250
8. Analysis
See [Chapter 4, "Common Analysis and Display Functions"](#), on page 305
9. Display
See [Chapter 4.1, "Result Display Configuration"](#), on page 305

To configure settings

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

Preset Channel

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

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

Remote command:

`SYSTem:PRESet:CHANnel[:EXECute]` on page 562

3.3 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](#)..... 218
- [Input Source Settings](#).....222
- [Configuring the Preselector](#).....224
- [Optional External Generator Control](#).....224
- [Output Settings](#)..... 250

3.3.1 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 \(or Avoiding an Input Mixer Overload\)](#).....218
- [Receiving and Providing Trigger Signals](#)..... 222

3.3.1.1 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 might damage the input mixer.

NOTICE

Risk of damage to the input mixer

Do not overload the input mixer.

Overloading the input mixer can damage it. The following topics contain advice on how to avoid an overload of the input mixer. Read them carefully before applying a signal.

Protecting the input mixer

Protecting the input mixer from damage should always be considered first when setting up a measurement.

The input mixer of the R&S ESW is equipped with an overload protection mechanism. If you apply a signal whose power exceeds the specified limit (see datasheet), the connection between the RF input and the input mixer is cut off and the R&S ESW displays a corresponding message in the status display.

Note that pulses have different level characteristics. Refer to the data sheet for more information on the allowed maximum pulse energy.

The signal level at the input mixer is calculated as follows.

$$\text{Mixer Level} = \text{Input Level} - \text{attenuation} + \text{gain}$$



RF input protection

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](#).....219
- [Using the Preamplifier](#).....220
- [Using the Preselector](#).....221

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 might 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, a compromise must be found between a high sensitivity, low intermodulation and input mixer protection. This is best done by letting 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 this feature on ("[10 dB Minimum Attenuation](#)").

NOTICE

Risk of damage to the input mixer

- Do not apply a 0 dB attenuation when you measure unknown signals or RFI voltage in combination with an artificial network (LISN). During phase switching, such test setups generate very strong pulses which can damage the input mixer.
- When you allow attenuation of less than 10 dB in combination with auto ranging, make sure that the signal level at the RF input does not exceed the allowed limits. 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. If a measurement should be performed at maximum dynamic range, you should turn off the preamplifier.
- The preamplifier is located after the preselection filters; this reduces 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 poorer large-signal immunity (intermodulation) is reduced by the preselector.

Using the Preselector

The third tool that allows you to control measurement sensitivity is the preselector.

Preselection has the following effects on the measurement:

- Preselection rejects most of the spectrum's 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 currently 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).

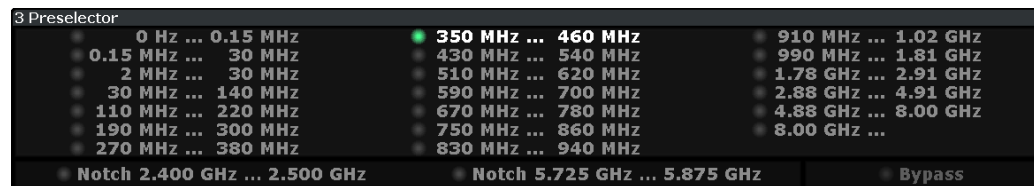


Figure 3-1: Preselector result display. The green LED indicates the currently applied filter.

In the frequency range from 150 kHz to 30 MHz, you can select whether to preselect in a single stage (150 kHz to 30 MHz), or 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 may 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.

3.3.1.2 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" for the R&S ESW.

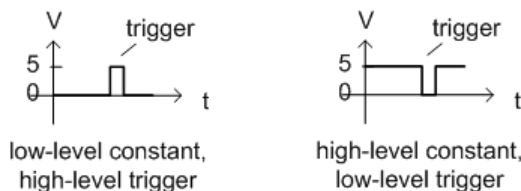
Trigger output

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 the "Send Trigger" button is selected. Then, a low pulse is provided.



3.3.2 Input Source Settings

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

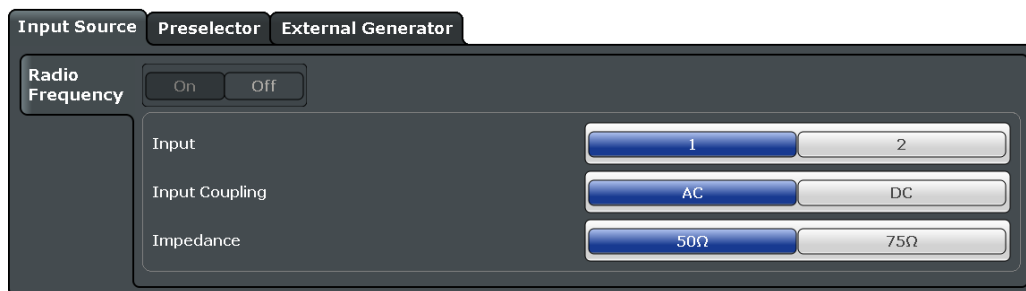
Input settings can be configured in the "Input" dialog box.

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

- [Radio Frequency Input](#).....223

3.3.2.1 Radio Frequency Input

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.



[Radio Frequency State](#)..... 223
[Input Coupling](#)..... 223
[Impedance](#)..... 223

Radio Frequency State

Activates input from the RF INPUT connector.

Remote command:

[INPut:SElect](#) on page 568

Input Coupling

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

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

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

Remote command:

[INPut:COUPling](#) on page 568

Impedance

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

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

This value also affects the unit conversion.

Remote command:

[INPut : IMPedance](#) on page 569

3.3.3 Configuring the Preselector

The preselector works the same as in the Receiver.

For more information refer to the R&S ESW User Manual.

3.3.4 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](#).....224
- [Basics on External Generator Control](#).....224
- [External Generator Control Settings](#).....237
- [How to Work With External Generator Control](#).....243
- [Measurement Example: Calibration with an External Generator](#).....246

3.3.4.1 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 in order to obtain accurate information on the DUT.

3.3.4.2 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 Spectrum, I/Q Analyzer, Analog Demodulation and Noise Figure applications.

- [External Generator Connections](#).....225
- [Overview of Supported Generators](#).....228
- [Generator Setup Files](#).....230
- [Calibration Mechanism](#).....230

- [Normalization](#)..... 231
- [Reference Trace, Reference Line and Reference Level](#).....232
- [Coupling the Frequencies](#)..... 233
- [Displayed Information and Errors](#).....236

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 233.

In [Figure 3-2](#) the TTL connection is illustrated using an R&S SMU generator, for example.

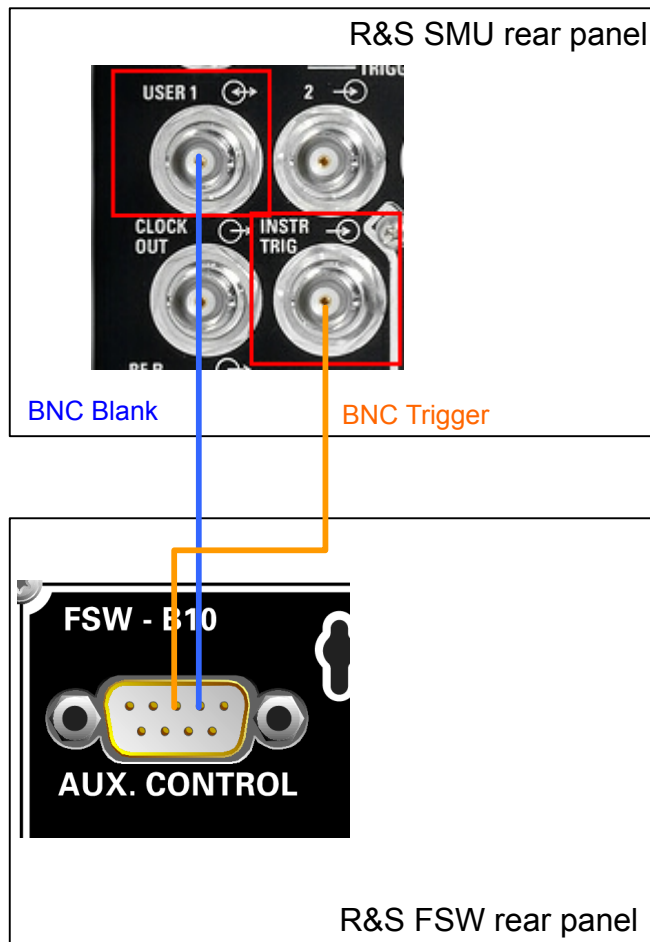


Figure 3-2: TTL connection for an R&S SMU generator

In [Figure 3-3](#), the connection for an R&S SMW is shown.

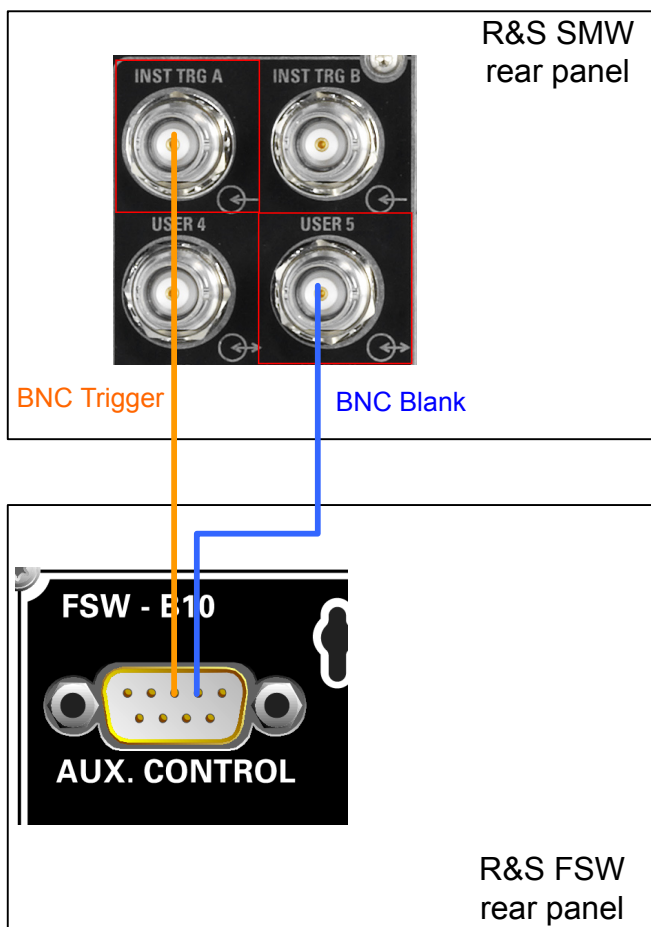


Figure 3-3: TTL connection for an R&S SMW generator

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).

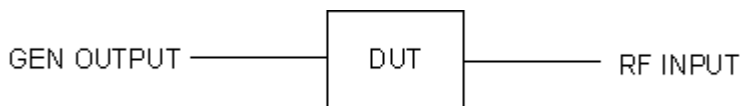


Figure 3-4: Test setup for transmission measurement

Reflection Measurement

Scalar reflection measurements can be carried out using a reflection-coefficient measurement bridge.

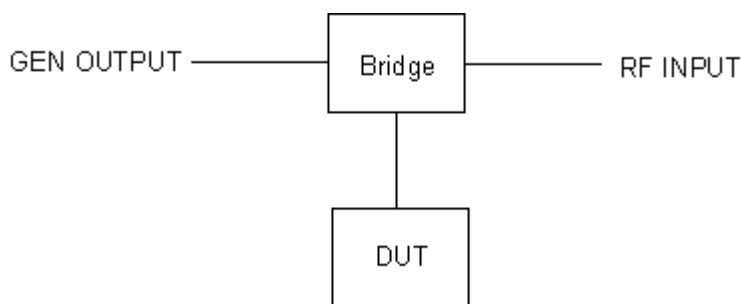


Figure 3-5: Test setup for reflection measurement

Generated signal input

In order 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

In order to enhance measurement accuracy, a common reference frequency should be used for both the R&S ESW and the generator. If no independent 10 MHz reference frequency is available, it is recommended that you connect the reference output of the generator with the reference input of the R&S ESW and that you 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 236).

Overview of Supported Generators

Generator type	TTL support	Generator type	TTL support
SGS100A6	-	SMP03	X
SGS100A12	-	SMP04	X
SMA01A ¹⁾	X	SMP22	X
SMA100A3	X	SMR20	-
SMA100A6	X	SMR20B11 ³⁾	X
SMB100A1	X	SMR27	X

1) Requires firmware version V2.10.x or higher on the signal generator
 2) Requires firmware version V1.10.x or higher on the signal generator
 3) Requires the option SMR-B11 on the signal generator
 4) Requires firmware version V3.20.200 or higher on the signal generator

Generator type	TTL support	Generator type	TTL support
SMB100A12	X	SMR27B11 ³⁾	X
SMB100A2	X	SMR30	X
SMB100A20	X	SMR30B11 ³⁾	X
SMB100A3	X	SMR40	X
SMB100A40	X	SMR40B11 ³⁾	X
SMBV100A3	X	SMR50	X
SMBV100A6	X	SMR50B11 ³⁾	X
SMC100A1	-	SMR60	X
SMC100A3	-	SMR60B11 ³⁾	X
SME02	X	SMT02	-
SME03	X	SMT03	-
SME06	X	SMT06	-
SMF100A	X	SMU02	X
SMF22	X	SMU02B31 ²⁾	X
SMF22B2	X	SMU03 ²⁾	X
SMF43	X	SMU03B31 ²⁾	X
SMF43B2	X	SMU04 ²⁾	X
SMG	-	SMU04B31 ²⁾	X
SMGL	-	SMU06 ²⁾	X
SMGU	-	SMU06B31 ²⁾	X
SMH	-	SMV03	-
SMHU	-	SMW03	X ⁴⁾
SMIQ02	X	SMW06	X ⁴⁾
SMIQ02B	X	SMW20	X ⁴⁾
SMIQ02E	-	SMW40	X ⁴⁾
SMIQ03	X	SMX	-
SMIQ03B	X	SMY01	-
SMIQ03E	-	SMY02	-
SMIQ04B	X	HP8254A	-
SMIQ06B	X	HP8257D	-
1) Requires firmware version V2.10.x or higher on the signal generator 2) Requires firmware version V1.10.x or higher on the signal generator 3) Requires the option SMR-B11 on the signal generator 4) Requires firmware version V3.20.200 or higher on the signal generator			

Generator type	TTL support	Generator type	TTL support
SMJ03	X	HP8340A	-
SMJ06	X	HP8648	-
SML01	-	HP ESG-A Series 1000A, 2000A, 3000A, 4000A	-
SML02	-	HP ESG B Series	-
SML03	-		
SMP02	X		
1) Requires firmware version V2.10.x or higher on the signal generator 2) Requires firmware version V1.10.x or higher on the signal generator 3) Requires the option SMR-B11 on the signal generator 4) Requires firmware version V3.20.200 or higher on the signal generator			

Generator Setup Files

For each signal generator type to be controlled by the R&S ESW a generator setup file must be configured and stored on the R&S ESW. The setup file defines the frequency and power ranges supported by the generator, as well as information required for communication. For the signal generators listed in ["Overview of Supported Generators"](#) on page 228, default setup files are provided. If necessary, these files can be edited or duplicated for varying measurement setups or other instruments.

The existing setup files can be displayed in an editor in read-only mode directly from the "External Generator" configuration dialog box. From there, they can be edited and stored under a different name, and are then available on the R&S ESW.

(For details see ["To define a new generator setup file"](#) on page 244).

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 in order 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 233). 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 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. This is done 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 $\langle \text{calibration trace} \rangle - \langle \text{reference trace} \rangle = 0$.

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 will no longer be 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. This is indicated by the "APX" label in the channel bar (instead of "NOR").

This is the case 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 taken into account 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, i.e. the reference dataset is extended by constant values.

Thus, the instrument settings can be changed in a wide area without giving up normalization. This reduces the necessity to carry out a new normalization to a minimum.

If approximation becomes too poor, however, normalization is aborted and an error message is displayed (see ["Displayed Information and Errors"](#) on page 236).

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 233).

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.

This is 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 245.



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 will be 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](#).

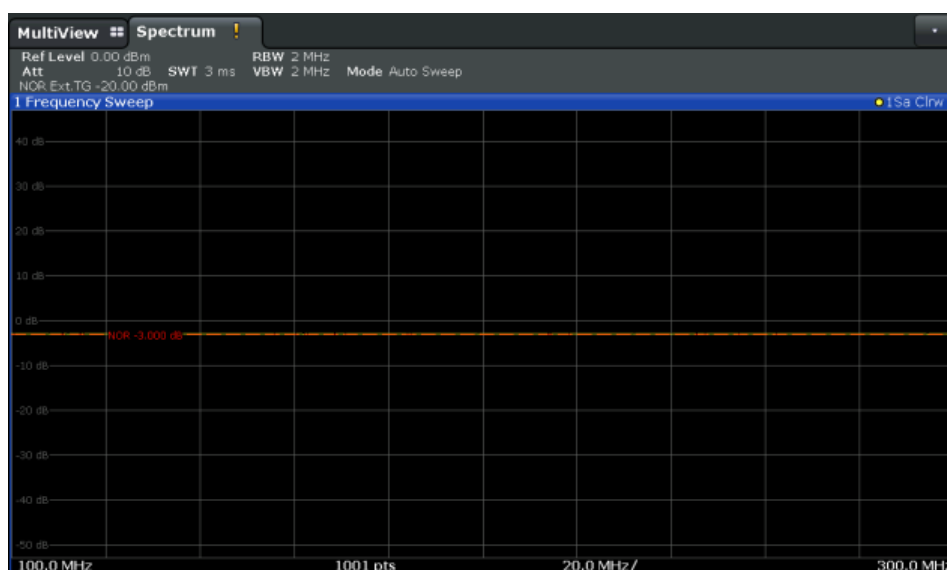


Figure 3-6: Shifted reference line

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 3.3.4.5, "Measurement Example: Calibration with an External Generator"](#), on page 246.

Coupling the Frequencies

As described in ["Normalization"](#) on page 231, 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.

Two different methods are available to define the frequencies for calibration, that is to couple the frequencies of the R&S ESW with those of the signal generator:

- **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:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Equation 3-1: Output frequency of the generator

where:

$F_{\text{Generator}}$ = output frequency of the generator

F_{Analyzer} = current frequency at the RF input of the R&S ESW

Numerator = multiplication factor for the current analyzer frequency

Denominator = division factor for the current analyzer frequency

F_{Offset} = frequency offset for the current analyzer frequency, 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 236).

Swept frequency range

The F_{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 the "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 236) and 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, and 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 than pure GPIB control, 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

$$F_{\text{AnalyzerStart}} = 100 \text{ MHz}$$

$$F_{\text{AnalyzerStop}} = 200 \text{ MHz}$$

$$F_{\text{Offset}} = -150 \text{ MHz}$$

$$F_{\text{min}} = 20 \text{ MHz}$$

$$\text{Numerator} = \text{Denominator} = 1$$

$$\rightarrow F_{\text{GeneratorStart}} = 50 \text{ MHz}$$

$$\rightarrow F_{\text{GeneratorStop}} = 50 \text{ MHz via } F_{\text{min}}$$

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 " Source Offset " on page 239)
FRQ	Frequency Offset (see " (Automatic) Source Frequency (Numerator/Denominator/Offset) " on page 240)
NOR	Normalization on; No difference between reference setting and measurement
APX (approximation)	Normalization on; Deviation from the reference setting occurs
-	Aborted normalization or no calibration performed yet

Error and status messages

The following status and error messages may occur during external generator control.

Message	Description
"Ext. Generator GPIB Handshake Error!" / "Ext. Generator TCPIP Handshake Error!" / "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 " Reverse sweep " on page 235
"Ext. Generator File Syntax Error!"	Syntax error in the generator setup file (see " Generator Setup Files " on page 230)
"Ext. Generator Command Error!"	Missing or wrong command in the generator setup file (see " Generator Setup Files " on page 230)
"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 239 in "External Generator > Measurement Configuration")
- Increasing the reference level ([Reference Level](#) in the "Amplitude" menu)

3.3.4.3 External Generator Control Settings

The "External Generator" settings are available in the "Input" dialog box 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.

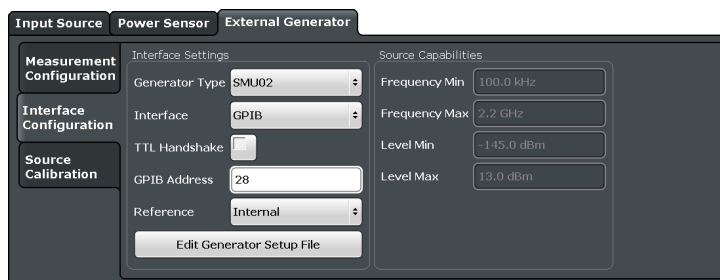
To display this dialog box, press the INPUT/OUPUT key and then select "External Generator Config".

For more information on external generator control see [Chapter 3.3.4.2, "Basics on External Generator Control"](#), on page 224.

- [Interface Configuration Settings](#).....237
- [Measurement Settings](#)..... 239
- [Source Calibration Functions](#).....241

Interface Configuration Settings

The interface settings for the connection to the external generator are defined in the "Interface Configuration" subtab of the "External Generator" tab.



- [Generator Type](#)..... 238
- [Interface](#)..... 238
- [TTL Handshake](#).....238
- [GPIB Address / TCP/IP Address](#).....238
- [Reference](#).....238

Edit Generator Setup File.....	239
Frequency Min. / Frequency Max.....	239
Level Min. / Level Max.....	239

Generator Type

Selects the generator type and thus defines the generator setup file to use.

For an overview of supported generators see "[Overview of Supported Generators](#)" on page 228. For information on generator setup files see "[Generator Setup Files](#)" on page 230.

Remote command:

[SYSTem:COMMunicate:RDEvice:GENerator:TYPE](#) on page 577

Interface

Type of interface connection used. The following interfaces are currently supported:

- GPIB
- TCP/IP (not by all generators)

For details on which signal generators support which interfaces, see the documentation of the corresponding signal generator.

Remote command:

[SYSTem:COMMunicate:RDEvice:GENerator:INTerface](#) on page 576

TTL Handshake

If available for the specified generator type, this option activates TTL synchronization via handshake for GPIB connections.

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 more information on TTL synchronization see "[TTL synchronization](#)" on page 234.

For an overview of which generators support TTL synchronization see "[Overview of Supported Generators](#)" on page 228.

Remote command:

[SYSTem:COMMunicate:RDEvice:GENerator:LINK](#) on page 577

GPIB Address / TCP/IP Address

For LAN connections: TCP/IP address of the signal generator

For GPIB connections: GPIB address of the signal generator.

Remote command:

[SYSTem:COMMunicate:GPIB:RDEvice:GENerator:ADDRESS](#) on page 576

[SYSTem:COMMunicate:TCPIP:RDEvice:GENerator:ADDRESS](#) on page 577

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:EXTernal:ROSCillator\[:SOURce\]](#) on page 576

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 will only be detected and displayed when you try to use the new generator (see also "[Displayed Information and Errors](#)" on page 236).

For details see "[Generator Setup Files](#)" on page 230.

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

The measurement settings for external generator control are configured in the "Measurement Configuration" subtab of the "External Generator" tab.

Source State	239
Source Power	239
Source Offset	239
Source Frequency Coupling	240
(Manual) Source Frequency	240
(Automatic) Source Frequency (Numerator/Denominator/Offset)	240
Result Frequency Start	241
Result Frequency Stop	241

Source State

Activates or deactivates control of an external generator.

Remote command:

[SOURce:EXTernal\[:STATe\]](#) on page 575

Source Power

The output power of the external generator. The default output power is -20 dBm. The range is specified in the data sheet.

Remote command:

[SOURce:EXTernal:POWer\[:LEVel\]](#) on page 575

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 236).

With this offset, attenuators or amplifiers at the output connector of the external generator can be taken into account for the displayed output power values on screen or during data entry, for example. Positive offsets apply to an amplifier and negative offsets to an attenuator subsequent to the external generator.

Remote command:

`SOURce:POWer[:LEVel][:IMMediate]:OFFSet` on page 575

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 233.

- | | |
|----------|--|
| "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 " (Automatic) Source Frequency (Numerator/Denominator/Offset) " on page 240); 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 (Manual) Source Frequency which is displayed when you select "Manual" coupling. |

Remote command:

`SOURce:EXTErnal:FREQuency:COUPling[:STATe]` on page 573

(Manual) Source Frequency

Defines the fixed frequency to be used by the generator.

Remote command:

`SOURce:EXTErnal:FREQuency` on page 573

(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 may differ from the input from the R&S ESW. The RF frequency may 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 and 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 233. For more information on error messages and the channel bar see "[Displayed Information and Errors](#)" on page 236.

Remote command:

`SOURce:EXTErnal:FREQuency[:FACTor]:DENominator` on page 573

`SOURce:EXTErnal:FREQuency[:FACTor]:NUMerator` on page 574

`SOURce:EXTErnal:FREQuency:OFFSet` on page 574

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

The calibration functions of the external generator are available in the "Source Calibration" subtab of the "External Generator" tab, but *only if external generator control is active* (see "Source State" on page 239).

Calibrate Transmission.....	241
Calibrate Reflection Short.....	241
Calibrate Reflection Open.....	241
Source Calibration Normalize.....	242
Recall.....	242
Save As Trd Factor.....	242
Reference Position.....	242
Reference Value.....	243

Calibrate Transmission

Starts a transmission type measurement to determine a reference trace. This trace is used to calculate the difference for the normalized values.

For details see "Calibration Mechanism" on page 230.

Remote command:

[SENSe:]CORRection:MEtHod on page 571

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 571

Selects the reflection method.

[SENSe:]CORRection:COLLect[:ACQuire] on page 570

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 571

Selects the reflection method.

`[SENSe:]CORRection:COLLect[:ACQuire]` on page 570

Starts the sweep for open-circuit calibration.

Source Calibration Normalize

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 231.

Remote command:

`[SENSe:]CORRection[:STATe]` on page 572

Recall

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 572

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:\r_s\instr\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" softkey in the SETUP menu.

For more information on transducers see the R&S ESW User Manual.

This function is only available if [Source Calibration Normalize](#) is switched on.

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 will be 0 dB for the entire span (by definition of the normalized trace).

Remote command:

`[SENSe:]CORRection:TRANsducer:GENerator` on page 572

Reference Position

Defines the position of the [Result Frequency Stop](#) 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 "[Source Calibration Normalize](#)" on page 242).

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>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 592

Reference Value

Defines the reference value to be displayed at the specified [Result Frequency Start](#).

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>]:TRACe<t>:Y[:SCALe]:RVALue` on page 593

3.3.4.4 How to Work With External Generator Control

The following step-by-step instructions demonstrate how to work with the optional External Generator Control.

- [How to Calibrate a Measurement Setup using an External Generator](#)..... 243
- [How to Remove the Effects of a Particular Component from Measurement Results Using Calibration](#).....245
- [How to Compensate for Additional Gain or Attenuation after Calibration](#)..... 245

How to Calibrate a Measurement Setup using an External Generator

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. If the signal generator supports TTL synchronization, connect the signal generator to the optionalAUX.CONTROL port.
4. If the measurement setup does not require the full span of the R&S ESW, change the "Frequency Start" and "Frequency Stop" values (FREQ key > "Frequency Config" softkey).
5. Press the INPUT/OUTPUT key and select "External Generator Config".
6. 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 ["To define a new generator setup file"](#) on page 244.
7. Select the type of interface and the address used to connect the generator to the R&S ESW.

8. If the generator supports "TTL Synchronization", activate this function.
9. Select "Reference: External" to synchronize the analyzer with the generator.
10. Switch to the "Measurement Configuration" subtab.
11. Set the "Source State" to "On".
12. Define the generator output level as the "Source Power".
13. Optionally, to define a constant level offset for the external generator, define a "Source Offset".
14. The default frequency list for the calibration sweep contains 1001 values, divided in equi-distant frequencies between the R&S ESW's start and stop frequency. For most cases, this automatic coupling should be correct. Check the "Result Frequency Start" and "Result Frequency Stop" values to make sure the required measurement span is covered. If necessary, change the frequency settings on the R&S ESW (FREQ key > "Frequency Config" softkey), or use a different generator type.
15. Switch to the "Source Calibration" subtab.
16. Select the "Source Calibration Type": "Transmission" to perform a calibration sweep and store a reference trace for the measurement setup.
17. Select "Source Calibration Normalize": "On".
18. 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.

To define a new generator setup file

1. Press the INPUT/OUTPUT key 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 will only be detected and displayed when you try to use the new generator (see also "[Displayed Information and Errors](#)" on page 236).
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 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 243.
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 the SETUP key, then select the "Transducer" softkey.
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 243)

1. Insert the additional component in the calibrated measurement setup and perform a new measurement.
2. Press the INPUT/OUTPUT key 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.

3.3.4.5 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 246
- ["Measuring the effects of the DUT"](#) on page 247
- ["Compensating the effects of additional attenuation after calibration"](#) on page 249

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 the FREQ key, select "Frequency Config" and enter "Frequency Start": *100 MHz*.
 - b) Enter "Frequency Stop": *300 MHz*
4. Press the INPUT/OUTPUT key 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 3-7: 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 3-8: 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.

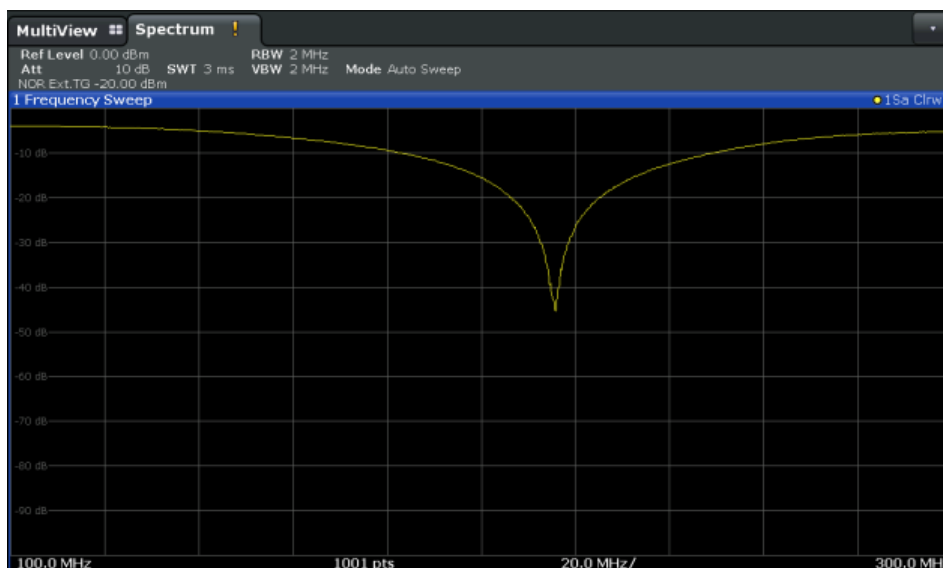


Figure 3-9: Band elimination filter results

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 $[-100.0\text{ dB to }0\text{ dB}]$ to $[-50\text{ dB to }+50\text{ dB}]$.

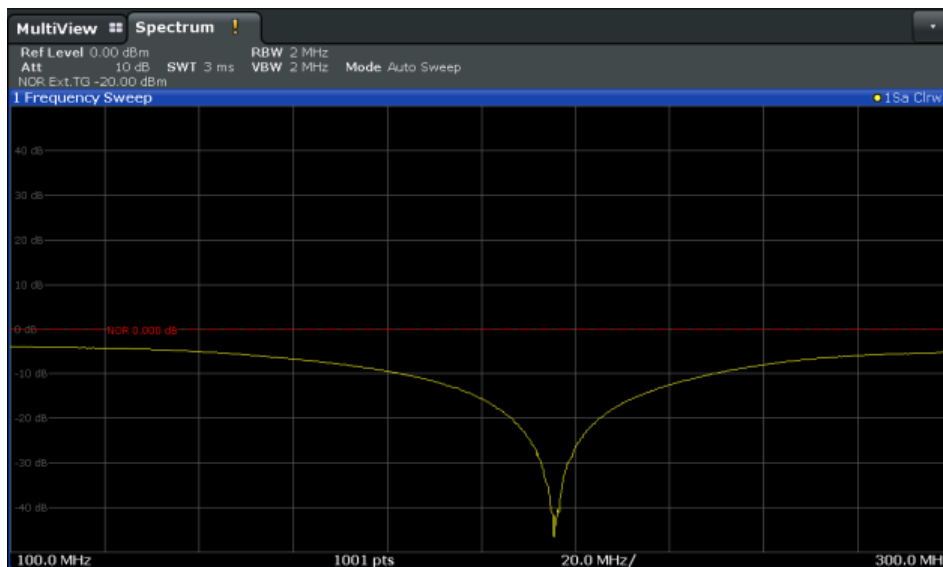


Figure 3-10: Reference line shifted to middle of diagram (50%)

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.

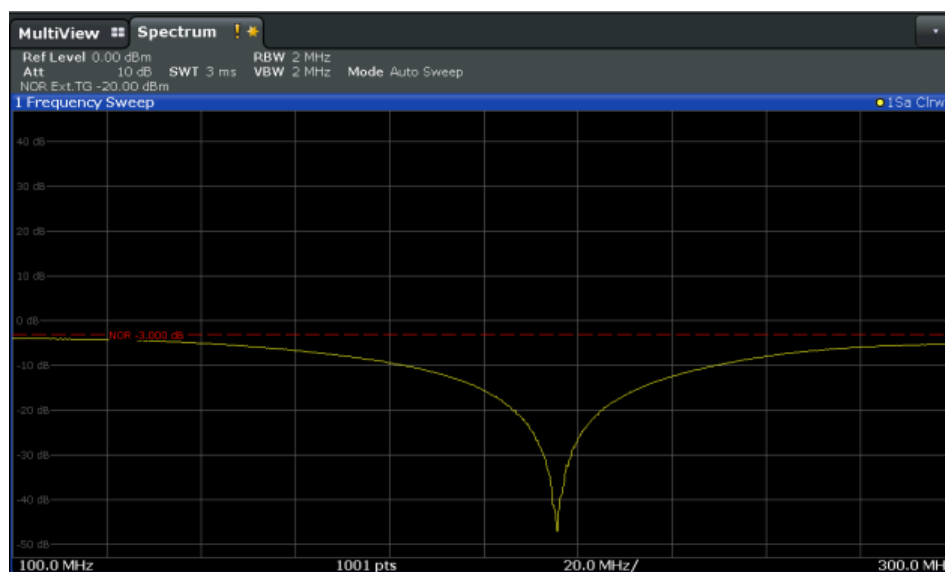


Figure 3-11: Measurement results with additional attenuator

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].

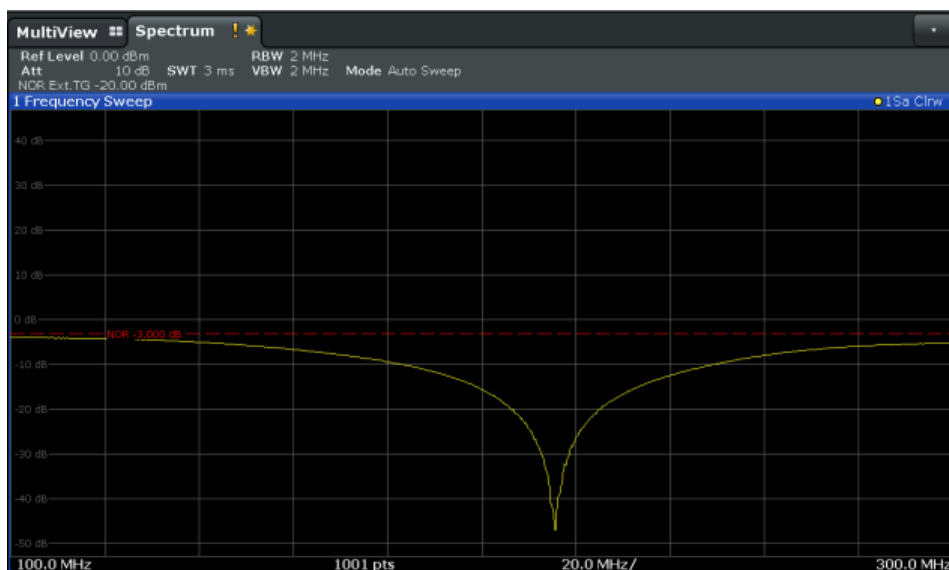


Figure 3-12: Reference line with an offset of -3 dB and shifted to middle of diagram (50%)

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 the AMPT key, then select "Scale Config" > "Range".
 - b) Enter 10 dB.

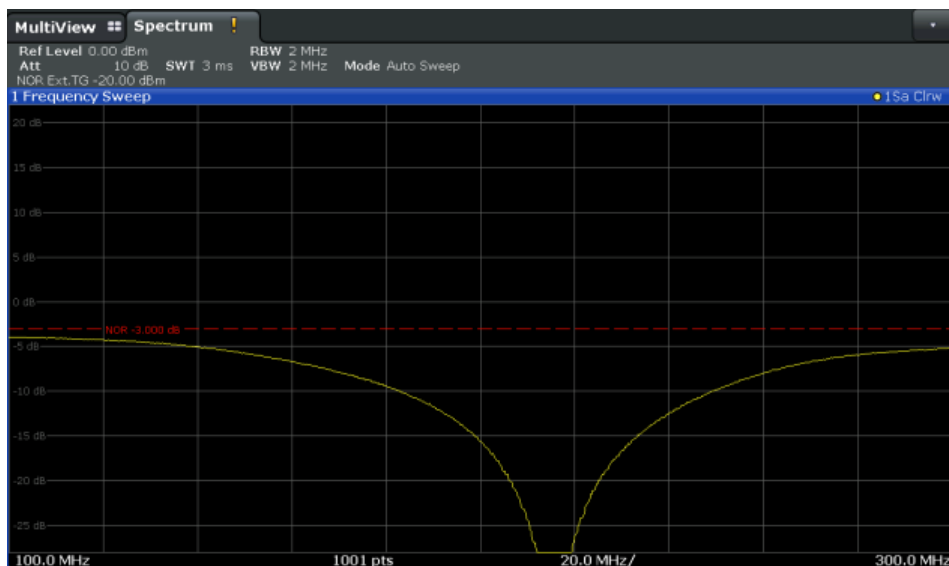


Figure 3-13: Reference line with measurement results using larger scale

3.3.5 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 \(IF / Video / Demodulation\)](#)..... 251
- [Configuring Line Impedance Stabilization Networks \(LISN\)](#)..... 251
- [Configuring Additional Outputs](#)..... 251

3.3.5.1 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.

3.3.5.2 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.

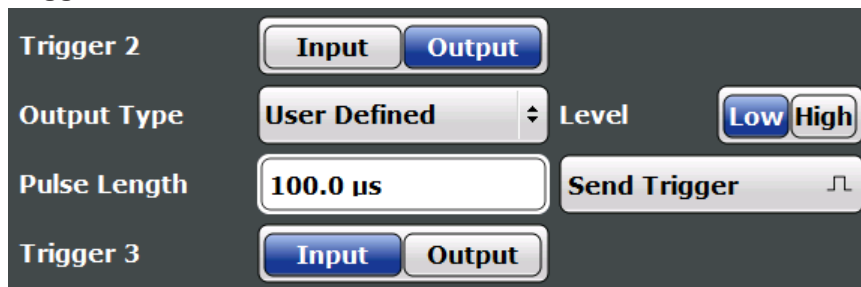
3.3.5.3 Configuring Additional Outputs

The R&S ESW provides additional outputs that you can use for various tasks. The functionality is the same as in the Receiver application.

For more information refer to the R&S ESW User Manual.

Trigger 2/3.....	251
L Output Type.....	252
L Level.....	252
L Pulse Length.....	252
L Send Trigger.....	252

Trigger 2/3



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

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

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

- "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<port>:DIRection](#) on page 579

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 user selects "Send Trigger" button.
In this case, further parameters are available for the output signal.

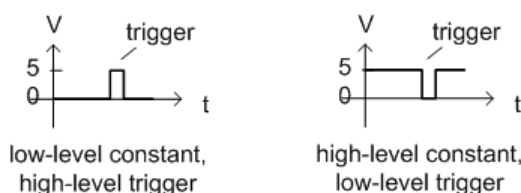
Remote command:

[OUTPut:TRIGger<port>:OTYPe](#) on page 579

Level ← Output Type ← Trigger 2/3

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

The trigger pulse level is always opposite to the constant signal level defined here, e.g. for "Level = High", a constant high signal is output to the connector until the [Send Trigger](#) function is selected. Then, a low pulse is provided.



Remote command:

[OUTPut:TRIGger<port>:LEVel](#) on page 579

Pulse Length ← Output Type ← Trigger 2/3

Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:

[OUTPut:TRIGger<port>:PULSe:LENGth](#) on page 580

Send Trigger ← Output Type ← Trigger 2/3

Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output [Level](#) setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" function is selected. Then, a low pulse is sent.

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

Remote command:

`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 580

3.4 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](#).....253
- [Frequency and Span Settings](#).....255
- [How To Define the Frequency Range](#).....260
- [How to Move the Center Frequency through the Frequency Range](#).....261
- [How to Keep the Center Frequency Stable](#).....261

3.4.1 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](#).....253
- [Stepping Through the Frequency Range - Center Frequency Stepsize](#).....253
- [Keeping the Center Frequency Stable - Signal Tracking](#).....254
- [Coping with Large Frequency Ranges - Logarithmic Scaling](#).....254

3.4.1.1 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 \(Auto Freq\)](#)" on page 303).

3.4.1.2 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.

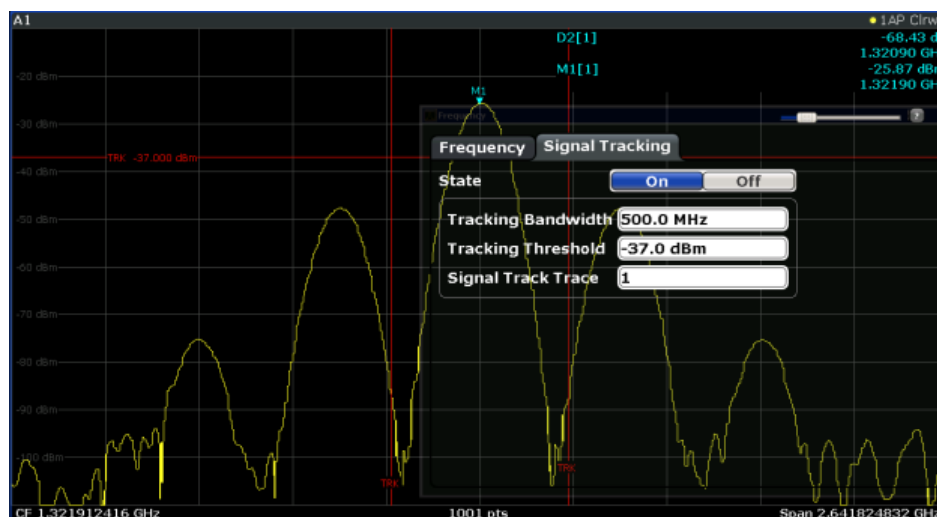
By default, the step size is set in relation to the selected span or resolution bandwidth (for zero span measurements). In some cases, however, it may be useful to set the step size to other values.

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.

3.4.1.3 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".



3.4.1.4 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 3-14: 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.

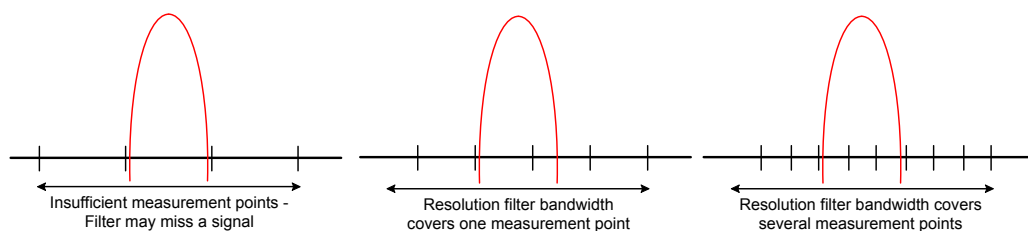
However, with logarithmic scaling, the frequency resolution between two sweep points deteriorates with higher frequencies.



Figure 3-15: Logarithmic x-axis scaling: the distance between sweep points is variable

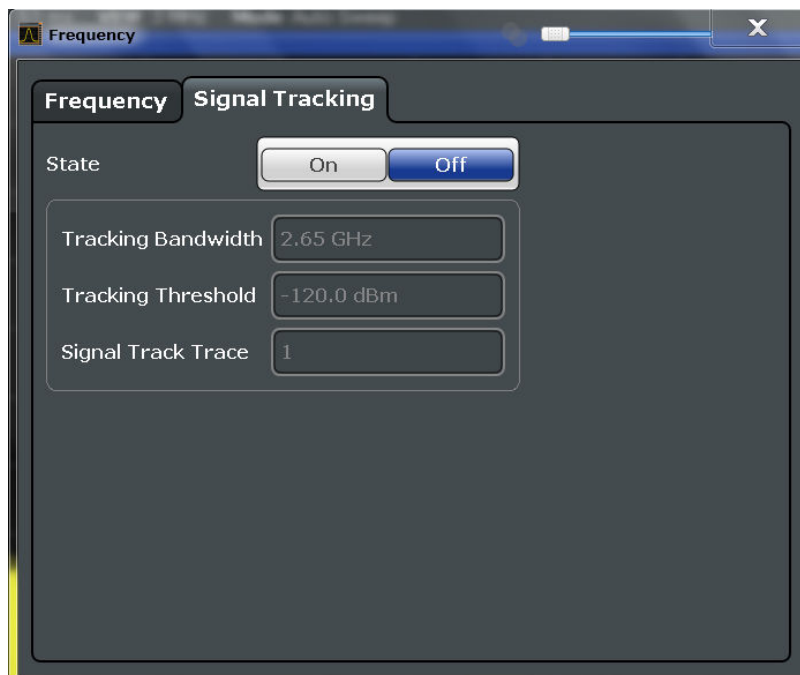
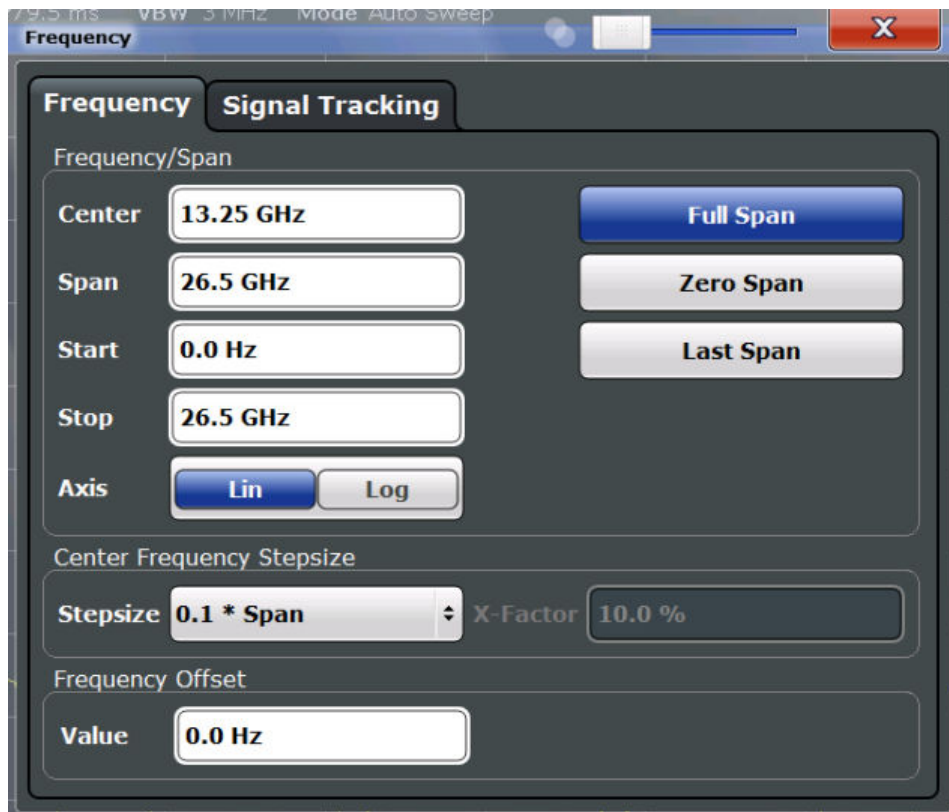
In the spectrum from 10 Hz to 100 Hz, the distance is a few Hz. Between 100 MHz and 1 GHz, the distance is several MHz.

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.



3.4.2 Frequency and Span Settings

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box. For details see [Chapter 3.4.3, "How To Define the Frequency Range"](#), on page 260.



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L Signal Tracking State.....	259
L Tracking Bandwidth.....	260
L Tracking Threshold.....	260
L Signal Track Trace.....	260

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.

$$\text{span} > 0: \text{span}_{\min}/2 \leq f_{\text{center}} \leq f_{\text{max}} - \text{span}_{\min}/2$$

$$\text{zero span}: 0 \text{ Hz} \leq f_{\text{center}} \leq f_{\text{max}}$$

f_{max} and span_{\min} depend on the instrument and are specified in the data sheet.

Remote command:

[SENSe:] FREQuency: CENTer on page 582

Span

Defines the frequency span. The center frequency is kept constant. The following range is allowed:

$$\text{span} = 0: 0 \text{ Hz}$$

span >0:

$$\text{span}_{\min} \leq f_{\text{span}} \leq f_{\text{max}}$$

f_{max} and span_{\min} are specified in the data sheet.

For more information see [Chapter 3.4.1.1, "Defining the Scope of the Measurement - Frequency Range"](#), on page 253.

Remote command:

[SENSe:] FREQuency: SPAN on page 584

Start / Stop

Defines the start and stop frequencies.

The following range of values is allowed:

$$f_{\min} \leq f_{\text{start}} \leq f_{\text{max}} - \text{span}_{\min}$$

$$f_{\min} + \text{span}_{\min} \leq f_{\text{stop}} \leq f_{\text{max}}$$

f_{\min} , f_{max} and span_{\min} are specified in the data sheet.

Remote command:

[SENSe:] FREQuency: START on page 584

[SENSe:] FREQuency: STOP on page 585

Frequency Axis Scaling

Switches between linear and logarithmic scaling for the frequency axis.

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 3.4.1.4, "Coping with Large Frequency Ranges - Logarithmic Scaling"](#), on page 254.

Remote command:

`DISPlay[:WINDow<n>]:TRACe:X:SPACing` on page 587

Full Span

Sets the span to the full frequency range of the R&S ESW specified in the data sheet. This setting is useful for overview measurements.

Remote command:

`[SENSe:]FREQuency:SPAN:FULL` on page 584

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 2.2, "Basic Measurements"](#), on page 20.

Remote command:

`FREQ:SPAN 0Hz`, see `[SENSe:]FREQuency:SPAN` on page 584

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 584

Center Frequency Stepsize

Defines the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob the center frequency changes in steps of only 1/10 of the span.

The step size can be coupled to the span (span > 0) or the resolution bandwidth (span = 0), or it can be manually set to a fixed value.

For more details see [Chapter 3.4.1.2, "Stepping Through the Frequency Range - Center Frequency Stepsize"](#), on page 253.

"0.1 * Span / RBW"

Sets the step size for the center frequency to 10 % of the span / RBW.

This is the default setting.

"0.5 * Span / RBW"

Sets the step size for the center frequency to 50 % of the span / RBW.

"X * Span / RBW"	<p>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.</p> <p>Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.</p>
"= Center"	<p>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.</p>
"= Marker"	<p>This setting is only available if a marker is active.</p> <p>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.</p>
"Manual"	<p>Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.</p>

Remote command:

[\[SENSe:\] FREQuency:CENTer:STEP:LINK](#) on page 583

[\[SENSe:\] FREQuency:CENTer:STEP:LINK:FACTOR](#) on page 583

[\[SENSe:\] FREQuency:CENTer:STEP](#) on page 582

Frequency Offset

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

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

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

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

Remote command:

[\[SENSe:\] FREQuency:OFFSet](#) on page 583

Signal Tracking

Defines the settings for signal tracking. These settings are only available for spans > 0.

For more details see [Chapter 3.4.1.3, "Keeping the Center Frequency Stable - Signal Tracking"](#), on page 254.

Signal Tracking State ← Signal Tracking

Activates or deactivates signal tracking. This function is only available for spans > 0.

If activated, after each sweep, the center frequency is set to the maximum level of the specified trace found within the searched bandwidth.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:STRack\[:STATe\]](#) on page 586

Tracking Bandwidth ← Signal Tracking

Defines the search bandwidth for signal tracking around the center frequency.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:STRack:Bandwidth` on page 586

Tracking Threshold ← Signal Tracking

Defines the threshold value for signal tracking. If the signal level does not pass the threshold, the center frequency is not changed.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:STRack:ThReshold` on page 586

Signal Track Trace ← Signal Tracking

Defines the trace to be tracked.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:STRack:TRACe` on page 586

3.4.3 How To Define the Frequency Range

The following step-by-step instructions demonstrate how to configure the frequency and span settings. For details on individual functions and settings see [Chapter 3.4.2, "Frequency and Span Settings"](#), on page 255.

The remote commands required to perform these tasks are described in [Chapter 5.8.3, "Defining the Frequency"](#), on page 581.

To configure the frequency and span

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box.

1. To display the "Frequency" dialog box, do one of the following:
 - Select "Frequency" from the "Overview".
 - Select the FREQ key and then the "Frequency Config" softkey.
 - Select the SPAN key and then the "Frequency Config" softkey.
2. Define the frequency range using one of the following methods:
 - Define the "Center frequency" and "Span".
 - Define the "Start frequency" and "Stop frequency".
 - To perform a measurement in the time domain, define the "Center frequency" and select the "Zero span" button.
 - To perform a measurement over the entire available frequency range, select the "Full span" button.
 - To return to the previously set frequency range, select the "Last span" button.

3.4.4 How to Move the Center Frequency through the Frequency Range

In some cases it may be useful to move the center frequency through a larger frequency range, for example from one harmonic to another.

1. In the "Frequency" dialog box, define the "Center Frequency Stepsize". This is the size by which the center frequency is to be increased or decreased in each step. Enter a manual or relative value, or set the step size to the current center frequency or marker value. To move from one harmonic to the next, use the center frequency or marker value.
2. Select the "Center Frequency" dialog field.
3. Use the arrow keys to move the center frequency in discrete steps through the available frequency range.

3.4.5 How to Keep the Center Frequency Stable

If the signal is slightly instable on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**.

1. In the "Frequency" dialog box, select the "Signal Tracking" tab.
2. Define the following settings:
 - "Signal Tracking Bandwidth": the frequency range around the center frequency to be tracked
 - "Signal Tracking Threshold": the minimum level the trace must reach to be detected as a maximum
 - "Signal Tracking Trace": the trace to be tracked
3. Activate signal tracking by selecting "State: ON".

After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above the defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".

3.5 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](#).....262
- [Amplitude Settings](#)..... 264
- [Scaling the Y-Axis](#).....267
- [How to Optimize the Amplitude Display](#).....268

3.5.1 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](#).....262
- [Scaling](#)..... 263

3.5.1.1 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 OVLD" 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 264).

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 266), 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 (50 Ω or 75 Ω, see "[Impedance](#)" on page 223), conversion to other units is possible.

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:

$1 \text{ dBm (displayed ref level)} - 3 \text{ dB (offset)} = -2 \text{ dBm}$.

3.5.1.2 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.

3.5.2 Amplitude Settings

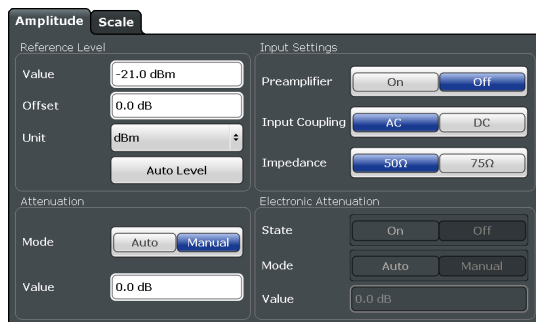
Amplitude settings determine how the R&S ESW must process or display the expected input power levels.

The dialog box also contain settings to scale the diagrams, which are described in [Chapter 3.5.3, "Scaling the Y-Axis"](#), on page 267.

To configure the amplitude settings

Amplitude settings can be configured via the AMPT key or in the "Amplitude" dialog box.

- ▶ To display the "Amplitude" dialog box, do one of the following:
 - Select "Amplitude" from the "Overview".
 - Select "Input/Frontend" from the "Overview" and then switch to the "Amplitude" tab.
 - Select the AMPT key and then the "Amplitude Config" softkey.



The remote commands required to define these settings are described in [Chapter 5.8.4, "Amplitude Settings"](#), on page 587.

Functions in the "Amplitude" dialog box described elsewhere:

- ["Input Coupling"](#) on page 223
- ["Impedance"](#) on page 223

Reference Level	264
L Shifting the Display (Offset)	265
L Unit	265
10 dB Minimum Attenuation	265
Attenuation	266
Preampifier	266
Noise Cancelation	266

Reference Level

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

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

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

For details see [Chapter 3.5.1.1, "Reference Level"](#), on page 262.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 588

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 will be shifted by this value.

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

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal) 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).

For details see ["Reference level offset"](#) on page 262.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 589

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 of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω , see ["Impedance"](#) on page 223), conversion to other units is possible.

The following units are available and directly convertible:

- dBm
- dBmV
- dB μ V
- dB μ A
- dBpW
- Volt
- Ampere
- Watt

Remote command:

`INPut:IMPedance` on page 569

`CALCulate<n>:UNIT:POWer` on page 588

10 dB Minimum Attenuation

Turns the availability of attenuation levels of less than 10 dB on and off.

When you turn the feature on, the attenuation level is always at least 10 dB to protect the input mixer and avoid accidental setting of 0 dB, especially if you measure DUTs 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<n>:ATTenuation:PROTection[:STATe]` on page 590

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 may be reduced. For more information see ["Using the Preamplifier"](#) on page 220.

Notice: For more information see [Chapter 3.3.1.1, "Increasing Measurement Sensitivity \(or Avoiding an Input Mixer Overload\)"](#), on page 218.

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<n>:ATTenuation` on page 589

Attenuation mode: `INPut<n>:ATTenuation:AUTO` on page 589

Preamplifier

Configures the preamplifier.

In addition to the standard preamplifier, a low noise amplifier is available as an optional hardware component.

- **Off**
Turns the preamplifier off.
- **LN Amplifier**
Turns the optional low noise amplifier on.
- **Auto Preamp**
Turns the preamplifier on (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<n>:GAIN:STATe` on page 591

Low Noise preamplifier:

State (global): `INPut<n>:GAIN:LNA:STATe` on page 590

Noise Cancelation

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

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

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

Noise cancellation is also available in zero span.

Currently, noise cancellation is only available for the following trace detectors:

- RMS
- Average
- Sample
- Positive Peak

Remote command:

[SENSe:]POWER:NCORrection on page 587

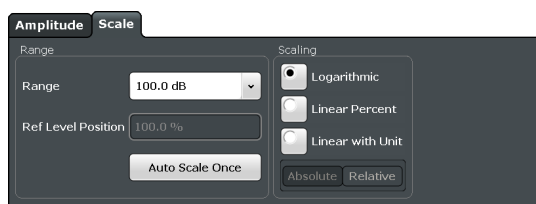
3.5.3 Scaling the Y-Axis

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

To configure the y-axis scaling settings

Vertical Axis settings can be configured via the AMPT key or in the "Amplitude" dialog box.

- ▶ To display the "Amplitude" dialog box, do one of the following:
 - Select "Amplitude" from the "Overview".
 - Select the AMPT key and then the "Scale Config" softkey.



The remote commands required to define these settings are described in [Chapter 5.8.5, "Scaling the Y-Axis"](#), on page 591.

Range	267
Ref Level Position	268
Auto Scale Once	268
Scaling	268

Range

Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 591

Ref Level Position

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

For spectrograms, this value defines the position of the reference level value within the span covered by the color map. In this case, the value is given in %, where 0 % corresponds to the maximum (right end) and 100 % to the minimum (left end) of the color map.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 592

Auto Scale Once

Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 591

Scaling

Defines the scaling method for the y-axis.

For more information see [Chapter 3.5.1.2, "Scaling"](#), on page 263.

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

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 593

`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE` on page 592

3.5.4 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" function (AUTO menu) to optimize the scaling.
4. **To determine a precise level at a specific point in the signal:**
 - Reduce the "Range" of the y-axis to a small area around the required level. If necessary, change the "Ref Level Position" so the required range remains visible.
 - Select "Linear Unit" scaling.

Now you can set a marker at the point in question and read the result.
5. **To detect a spurious signal close to the noise floor:**
 - Set the "RF attenuation" to "Manual" mode and reduce the "Value" to lower the noise floor.
 - Select "Relative - Logarithmic" scaling.

Now you can determine if any spurious levels of a certain size are visible.

3.6 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](#).....269
- [Bandwidth, Filter and Sweep Settings](#)..... 275
- [Reference: List of Available RRC and Channel Filters](#)..... 283

3.6.1 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:

$$T_{\text{sweepMIN}} = K * \text{Span} / \text{RBW}^2$$

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:

$$\text{RBW} = 100 * \text{Span}$$

$$\text{VBW} = \text{RBW} = 100 * \text{Span}$$

$$\text{Sweep time} = T_{\text{min}} \text{ for set Span, RBW, VBW}$$

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](#).....270
- [Smoothing the Trace Using the Video Bandwidth](#)..... 271
- [Coupling VBW and RBW](#)..... 271
- [Coupling Span and RBW](#)..... 272
- [How Data is Measured: the Sweep Type](#).....272
- [Which Data May Pass: Filter Types](#)..... 273
- [How Long the Data is Measured: Sweep Time](#).....274
- [How Much Data is Measured: Sweep Points and Sweep Count](#)..... 274
- [How Often Data is Measured: Sweep Mode](#).....274

3.6.1.1 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 measurement time.

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

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77 dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

If there are large level differences between signals, the resolution is determined by selectivity as well as by the resolution bandwidth that has been selected. The measure of selectivity used for signal analyzers is the ratio of the 60 dB bandwidth to the 3 dB bandwidth (= shape factor).

For the R&S 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.

3.6.1.2 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 or average detector is used, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS or average detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS or average detector. Normally, if the RMS or average detector is used the sweep time should be increased to get more stable traces.

3.6.1.3 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 3-1: Overview of RBW/VBW ratios and recommendations for use

Ratio RBW/VBW	Recommendation for use
1/1	Recommended for sinusoidal signals This is the default setting for automatic coupling.
0.1	Recommended when the amplitudes of pulsed signals are to be measured correctly. The IF filter is exclusively responsible for the pulse shape. No additional evaluation is performed by the video filter.
10	Recommended to suppress noise and pulsed signals in the video domain.
Manually set (0.001 to 1000)	Recommended for other measurement requirements

3.6.1.4 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.

A higher span/RBW ratio (i.e. low RBW values and large frequency spans), however, results in large amounts of data.

3.6.1.5 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 partial span which is covered by one FFT analysis depends on the RBW. The partial span cannot be defined directly, but it can be optimized according to measurement requirements.

Narrow partial spans provide a higher dynamic range, and also allow you to perform measurements near a carrier with a reduced reference level. With a wide partial span, 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 partial span, this is less likely to happen, so the reference level can be reduced.

For an **optimal dynamic range**, the narrowest possible partial span (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 partial span, the more steps are required to cover the entire span, thus increasing analysis and calculation time. To **optimize the sweep rate**, the widest possible partial span (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 partial span is used.

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.

3.6.1.6 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 [Chapter 3.6.3, "Reference: List of Available RRC and Channel Filters"](#), on page 283.

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) sweep filters are listed in the R&S ESW 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.

3.6.1.7 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.

3.6.1.8 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. Up to 200 000 points can be swept at once.

The number of sweeps to be performed in single sweep mode is defined by the "Sweep Count". Values from 0 to 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 4.3.1.2, "Analyzing Several Traces - Trace Mode"](#), on page 320).

3.6.1.9 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 4.3.1.2, "Analyzing Several Traces - Trace Mode"](#), on page 320).

3.6.2 Bandwidth, Filter and Sweep Settings

To configure the bandwidth, filter and sweep

Bandwidth and filter settings can be configured via the "Bandwidth" tab of the "Bandwidth" dialog box.

Sweep settings can be configured in the Sweep dialog box or via the "Sweep" tab of the "Bandwidth" dialog box.

1. To display the "Bandwidth" dialog box, do one of the following:
 - Select "Bandwidth" from the "Overview".
 - Select the BW key and then the "Bandwidth Config" softkey.
 - Select the SWEEP key and then the "Sweep Config" softkey.
2. To display the "Sweep" dialog box, do one of the following:
 - Select "Bandwidth" from the "Overview" and switch to the "Sweep" tab in the "Bandwidth" dialog box.
 - Select the SWEEP key and then the "Sweep Config" softkey.

The remote commands required to define these settings are described in [Chapter 5.8.6, "Remote Commands to Define Filter Characteristics"](#), on page 594.

How to perform a basic sweep measurement is described in [Chapter 2.2.1, "How to Perform a Basic Sweep Measurement"](#), on page 20.

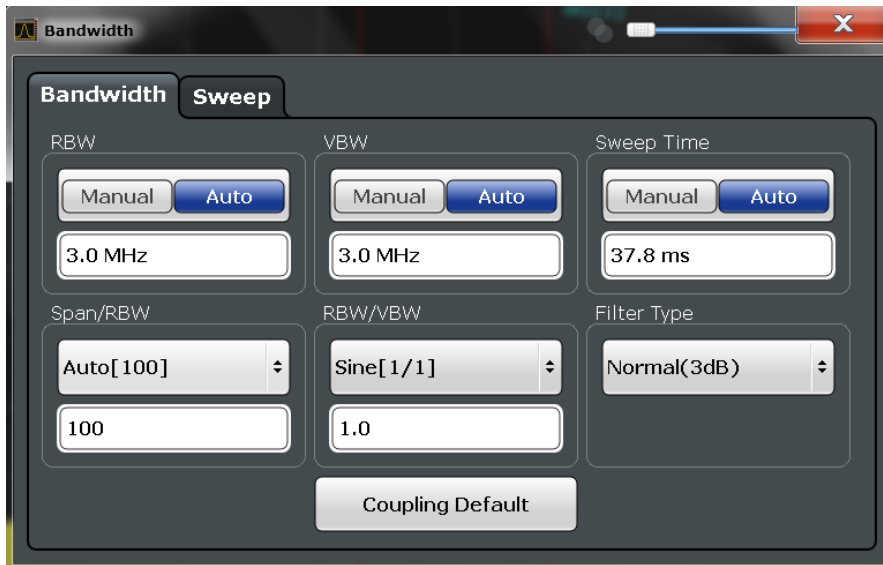


Figure 3-16: Bandwidth dialog box

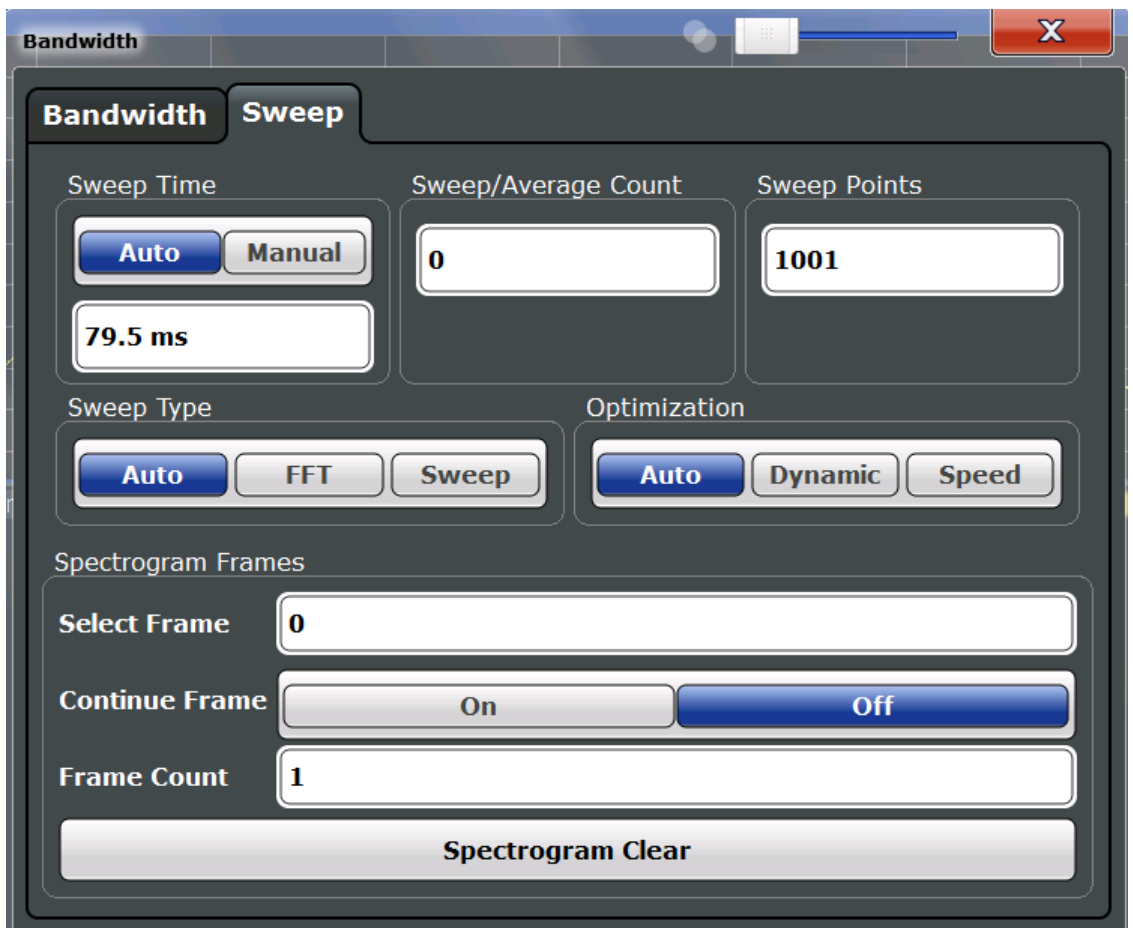


Figure 3-17: Sweep dialog box for spectrogram display

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RBW

Defines the resolution bandwidth. The available resolution bandwidths are specified in the data sheet. 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 more information see [Chapter 3.6.1.1, "Separating Signals by Selecting an Appropriate Resolution Bandwidth"](#), on page 270.

For EMI measurements using the quasipeak detector, the 1 MHz RBW filter is not available (see [Chapter 2.13.3.1, "Resolution Bandwidth and Filter Types"](#), on page 195).

Remote command:

`[SENSe:]BANDwidth[:RESolution]` on page 594

`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 594

VBW

Defines the video bandwidth automatically or manually.

For more information see [Chapter 3.6.1.2, "Smoothing the Trace Using the Video Bandwidth"](#), on page 271.

"Auto" The video bandwidth is coupled to the resolution bandwidth. If the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

"Manual" For manual mode, define the bandwidth value. The available video bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.
If the video bandwidth is defined manually, a green bullet is displayed next to the "VBW" display in the channel bar.

Remote command:

[SENSe:]BANDwidth:VIDeo:AUTO on page 596

[SENSe:]BANDwidth:VIDeo on page 595

Sweep Time

Defines the duration of a single sweep, during which the defined number of sweep points are measured. The sweep time can be defined automatically or manually.

The allowed sweep times depend on the device model; refer to the data sheet.

For more information see [Chapter 3.6.1.7, "How Long the Data is Measured: Sweep Time"](#), on page 274.

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 sweeps. For FFT sweeps, an estimated duration is indicated behind the sweep time in the channel bar (in the Spectrum application 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 data sheet. Numeric input is always rounded to the nearest possible sweep time.

Remote command:

[SENSe:]SWEep:TIME:AUTO on page 602

Span/RBW

Sets the coupling ratio if [RBW](#) is set to auto mode.

For more information see [Chapter 3.6.1.4, "Coupling Span and RBW"](#), on page 272.

"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 595

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 3.6.1.3, "Coupling VBW and RBW"](#), on page 271.

"Sine [1/1]"	"video bandwidth = resolution bandwidth" This is the default setting for the coupling ratio RBW/VBW and is recommended if sinusoidal signals are to be measured.
"Pulse [.1]"	"video bandwidth = 10 × resolution bandwidth" or "video bandwidth = 10 MHz (= max. VBW)" Recommended for pulse signals
"Noise [10]"	"video bandwidth = resolution bandwidth/10" Recommended for noise measurements
"Manual"	The coupling ratio is defined manually. The RBW/VBW ratio can be set in the range of 0.001 to 1000.

Remote command:

[\[SENSe:\]BANDwidth:VIDeo:AUTO](#) on page 596

[\[SENSe:\]BANDwidth:VIDeo:RATio](#) on page 596

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
- 5-Pole (not available for sweep type "FFT")

For more information see [Chapter 3.6.1.6, "Which Data May Pass: Filter Types"](#), on page 273.

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 595

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 3.6.1.3, "Coupling VBW and RBW"](#), on page 271.

Remote command:

[\[SENSe:\]BANDwidth\[:RESolution\]:AUTO](#) on page 594

[\[SENSe:\]BANDwidth:VIDeo:AUTO](#) on page 596

[\[SENSe:\]SWEep:TIME:AUTO](#) on page 602

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 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274.

For spectrogram displays, the sweep count determines how many sweeps are combined in one frame in the spectrogram, i.e. how many sweeps the R&S ESW performs to plot one trace in the spectrogram result display. For more details see ["Time Frames"](#) on page 325.

Remote command:

[SENSe:] SWEEp:COUNT on page 599

Sweep Points

Defines the number of measured values to be collected during one sweep.

For details see [Chapter 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274.

All values from 101 to 100001 can be set. The default value is 1001 sweep points.

Remote command:

[SENSe:] SWEEp:POINTs on page 601

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 *partial span*. The partial span cannot be defined directly, but it can be optimized according to measurement requirements.

Table 3-2: Optimization parameters in FFT mode

Optimization mode	Description
Dynamic	Optimizes the dynamic range by using the narrowest possible partial span (depending on the RBW). 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 partial span (depending on the RBW). 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). It is recommended that you set the Sweep Time to "Auto" to optimize the sweep rate.
Auto	Uses a medium-sized partial span to obtain a compromise between a large dynamic range and a fast sweep rate. The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 3-3: 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.

Remote command:

[SENSe:]SWEep:OPTimize on page 600

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"	The FFT sweep samples on a defined frequency value and transforms it to the spectrum by fast Fourier transformation (FFT) (see also Chapter 3.6.1.5, "How Data is Measured: the Sweep Type" , on page 272). FFT is not available in the following cases: <ul style="list-style-type: none"> • when using 5-Pole filters, Channel filters or RRC filters • when using the Quasi peak detector In these cases, frequency sweep is used.

Remote command:

[SENSe:]SWEep:TYPE on page 602

Single Sweep/ RUN SINGLE

After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.

Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

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

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

Remote command:

Measurement mode: [INITiate<n>:CONTInuous](#) on page 409

Run measurement: [INITiate<n>\[:IMMEDIATE\]](#) on page 407

[CALCulate<n>:SPECTrogram:CONT](#) on page 628

Continuous Sweep/RUN CONT

After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.

Furthermore, the RUN CONT key 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:

[INITiate<n>:CONTInuous](#) on page 409

Measurement mode: [INITiate<n>:CONTInuous](#) on page 409

Run measurement: [INITiate<n>\[:IMMEDIATE\]](#) on page 407

Continue Single Sweep

After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

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

Remote command:

[INITiate<n>:CONMeas](#) on page 408

Spectrogram Frames

These settings are only available if spectrogram display is active.

For more information see [Chapter 4.3.5, "How to Display and Configure a Spectrogram"](#), on page 343.

Selecting a frame to display ← 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 325.

Remote command:

`CALCulate<n>:SPECTrogram:FRAMe:SElect` on page 629

Continue Frame ← Spectrogram Frames

Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold", "Min Hold", and "Average".

This function is available in single sweep mode only.

- **On**
When the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also taken into account.
- **Off**
The average or peak values are determined from the results of the newly swept frames only.

Remote command:

`CALCulate<n>:SPECTrogram:CONT` on page 628

Frame Count ← Spectrogram Frames

Determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). The maximum number of possible frames depends on the history depth (see ["History Depth"](#) on page 338).

Remote command:

`CALCulate<n>:SPECTrogram:FRAMe:COUNT` on page 628

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 627

3.6.3 Reference: List of Available RRC and Channel Filters

For power measurement a number of especially steep-edged channel filters are available (see the following table). The indicated filter bandwidth is the 3 dB bandwidth. For RRC filters, the fixed roll-off factor (α) is also indicated.



The available Gaussian 3 dB sweep filters are listed in the R&S ESW data sheet.

Table 3-4: Filter types

Filter Bandwidth	Filter Type	Application
100 Hz	CFILter	
200 Hz	CFILter	

Bandwidth, Filter and Sweep Configuration

Filter Bandwidth	Filter Type	Application
300 Hz	CFILter	
500 Hz	CFILter	
1 kHz	CFILter	
1.5 kHz	CFILter	
2 kHz	CFILter	
2.4 kHz	CFILter	SSB
2.7 kHz	CFILter	
3 kHz	CFILter	
3.4 kHz	CFILter	
4 kHz	CFILter	DAB, Satellite
4.5 kHz	CFILter	
5 kHz	CFILter	
6 kHz	CFILter	
6 kHz, a=0.2	RRC	APCO
8.5 kHz	CFILter	ETS300 113 (12.5 kHz channels)
9 kHz	CFILter	AM Radio
10 kHz	CFILter	
12.5 kHz	CFILter	CDMAone
14 kHz	CFILter	ETS300 113 (20 kHz channels)
15 kHz	CFILter	
16 kHz	CFILter	ETS300 113 (25 kHz channels)
18 kHz, a=0.35	RRC	TETRA
20 kHz	CFILter	
21 kHz	CFILter	PDC
24.3 kHz, a=0.35	RRC	IS 136
25 kHz	CFILter	APCO 25-P2
30 kHz	CFILter	CDPD, CDMAone
50 kHz	CFILter	
100 kHz	CFILter	
150 kHz	CFILter	FM Radio

Filter Bandwidth	Filter Type	Application
192 kHz	CFILter	PHS
200 kHz	CFILter	GSM
300 kHz	CFILter	
500 kHz	CFILter	J.83 (8-VSB DVB, USA); RF ID 14333
1 MHz	CFILter	CDMAone
1.228 MHz	CFILter	CDMAone
1.28 MHz, a=0.22	RRC	TD-SCDMA
1.5 MHz	CFILter	DAB
2 MHz	CFILter	
3 MHz	CFILter	
3.75 MHz	CFILter	
3.84 MHz, a=0.22	RRC	W-CDMA 3GPP
4.096 MHz, a=0.22	RRC	W-CDMA NTT DOCoMo
5 MHz	CFILter	
	CFILter	
	CFILter	
	CFILter	

3.7 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.

- [Basics of Triggering and Gated Measurements](#).....285
- [Trigger and Gate Settings](#).....291
- [How to Configure a Triggered and Gated Measurement](#).....299
- [How to Output a Trigger Signal](#).....301

3.7.1 Basics of Triggering and Gated Measurements

Some background knowledge on triggering and gated measurements is provided here for a better understanding of the required configuration settings.

- [Triggered Measurements](#).....286
- [Gated Measurements](#).....289
- [Determining the Parameters in Preview Mode](#).....291

3.7.1.1 Triggered Measurements

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 will cause the trigger in a jittering signal
- [Trigger Source](#)..... 286
- [Trigger Offset](#)..... 286
- [Trigger Hysteresis](#)..... 287
- [Trigger Drop-Out Time](#)..... 287
- [Trigger Holdoff](#)..... 288

Trigger Source

The trigger source defines which source must fulfill the condition that triggers the measurement. Basically, this can be:

- Time: the measurement is repeated in a regular interval
- Power: an input signal is checked for a defined power level
The trigger signal can be 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 293.

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 296.

Trigger Hysteresis

Setting a hysteresis for the trigger helps avoid unwanted trigger events caused by noise, for example. The hysteresis is a threshold to the trigger level that the signal must fall below on a rising slope or rise above on a falling slope before another trigger event occurs.

Example:

In the following example, the second possible trigger event is ignored as the signal does not exceed the hysteresis (threshold) before it reaches the trigger level again on the rising edge. On the falling edge, however, two trigger events occur as the signal exceeds the hysteresis before it falls to the trigger level the second time.

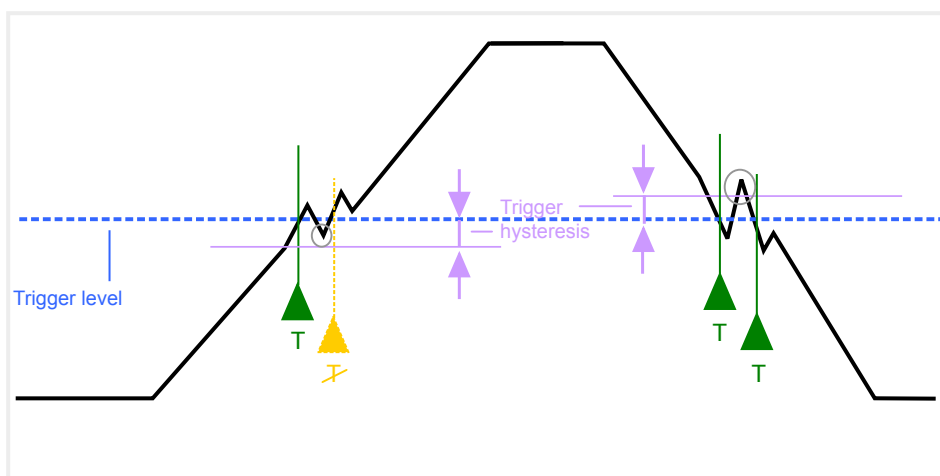


Figure 3-18: Effects of the trigger hysteresis

See "Hysteresis" on page 296

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.

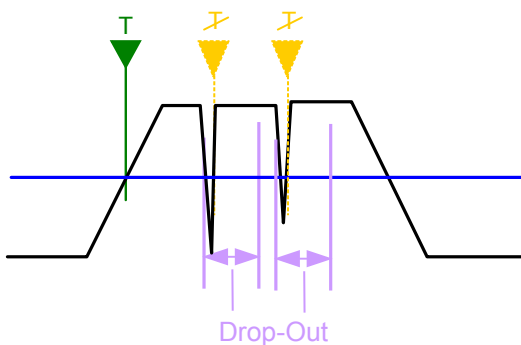


Figure 3-19: Effect of the trigger drop-out time

See ["Drop-Out Time"](#) on page 296.



Drop-out times for falling edge triggers

If a trigger is set to a falling edge ("Slope" = "Falling", see ["Slope"](#) on page 296) 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, so a trigger event will not occur until the pulsed signal is over!

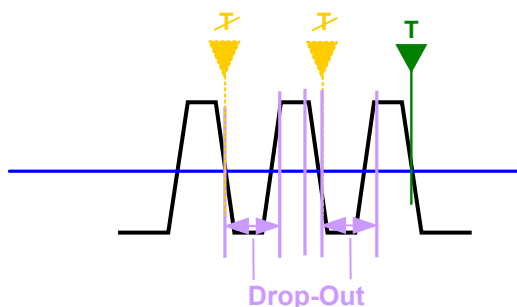


Figure 3-20: Trigger drop-out time for falling edge trigger

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.

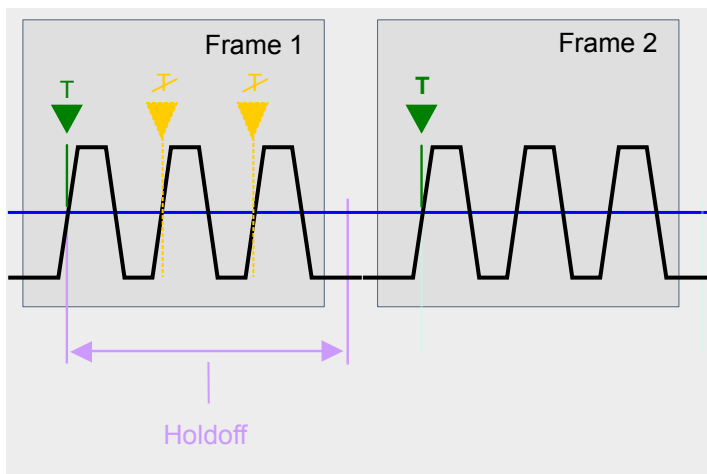


Figure 3-21: Effect of the trigger holdoff

See ["Trigger Holdoff"](#) on page 296.

3.7.1.2 Gated Measurements

Like a gate provides an opening in a fence, a gated measurement lets data from the input signal pass in defined areas only. The *gate* controls exactly when data is included in the measurement results and when not. The gate is opened by the trigger source, which is also the gate source. Gates can be used in two different modes:

- **Level:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the "Gate Level".
Using a pulsed gate signal in level mode, the following behaviour can be achieved: When the gate source signal is active, the input signal data is collected; when the gate signal is inactive, the input signal is ignored.
- **Edge:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined "Gate Length" is reached.

Additionally, a delay time can be defined so that the first few measurement points after the gate opening are ignored.

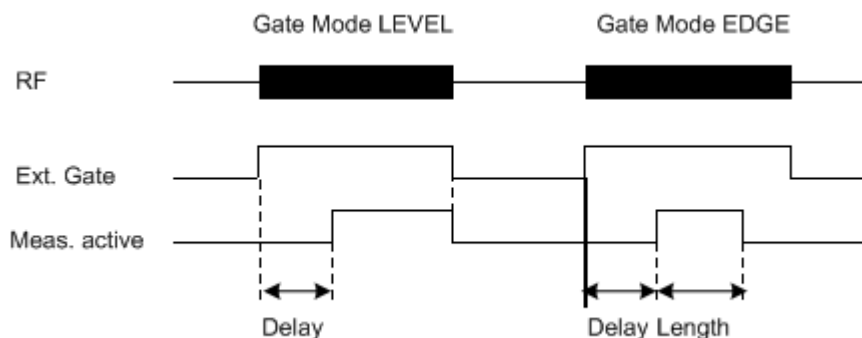


Figure 3-22: Effects of Gate mode, Gate delay and Gate length

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.

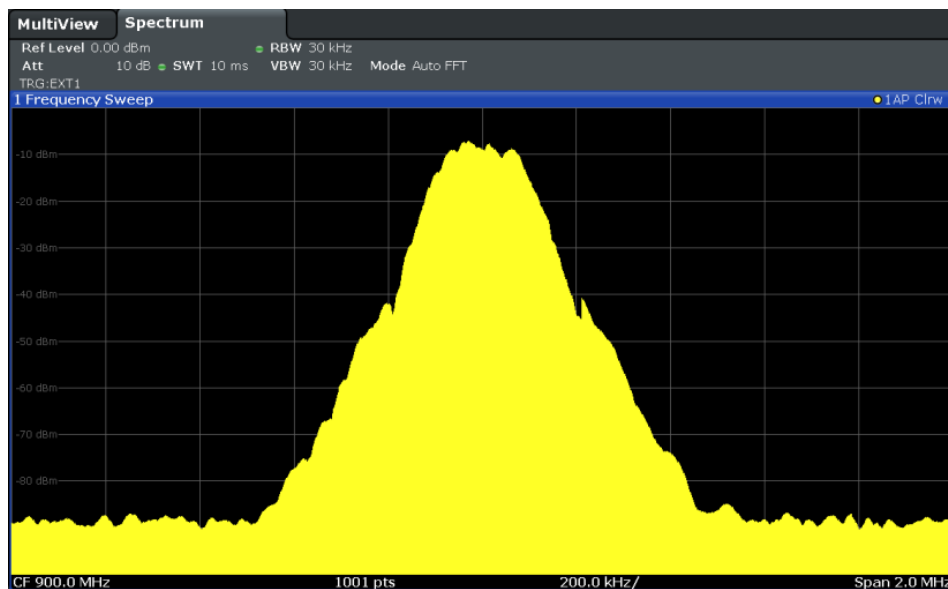


Figure 3-23: GSM signal with GATE OFF

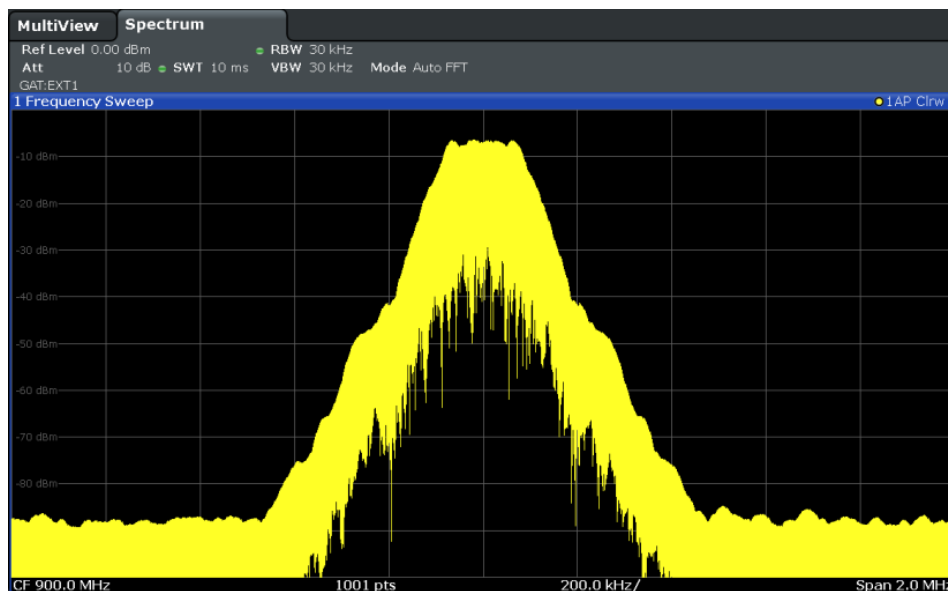


Figure 3-24: GSM signal with GATE ON

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.

3.7.1.3 Determining the Parameters in Preview Mode

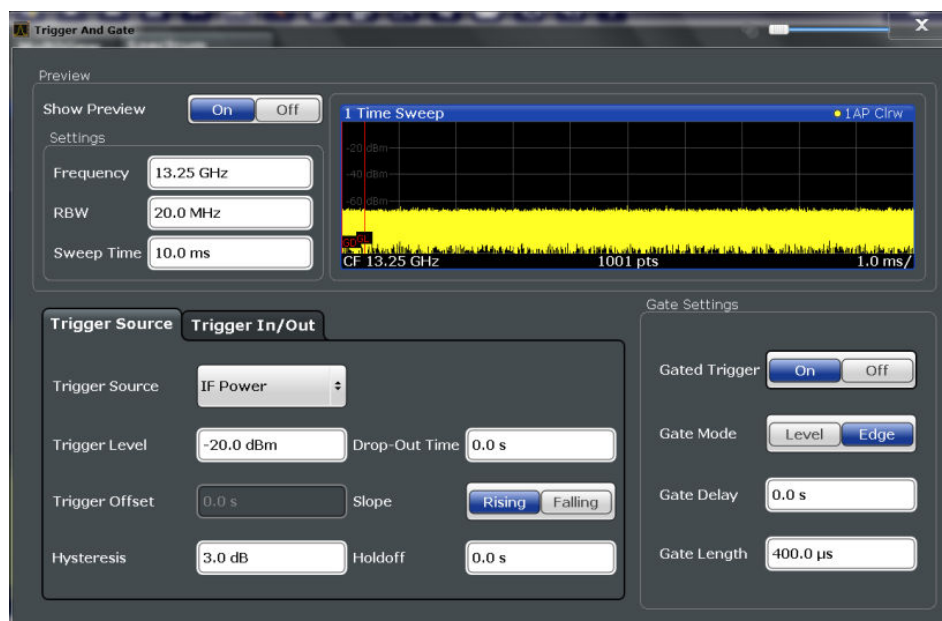
The preview mode allows you to try out trigger and gate settings before actually applying them to the current measurement. When the preview diagram shows the correct results, you can "Update the Main Diagram" and check the results in the background before closing the dialog box.

If preview mode is switched off, changes to the trigger and gate settings are applied to the measurement diagram directly.

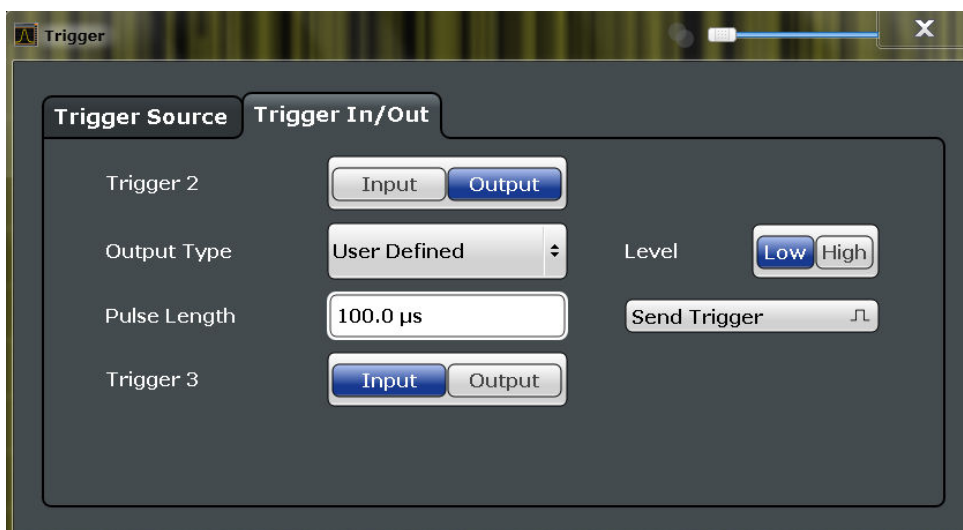
The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time. This is useful to analyze bursts, for example, to determine the required gate settings. The main diagram remains unchanged concerning the zero span settings. Only the trigger and gate settings are applied to the measurement.

3.7.2 Trigger and Gate Settings

Trigger and gate settings can be configured via the TRIG key or in the "Trigger and Gate" dialog box, which is displayed when you select the "Trigger/Gate" button in the "Overview".



External triggers from one of the TRIGGER connectors on the R&S ESW are configured in a separate tab of the dialog box.



For step-by-step instructions on configuring triggered and gated measurements, see [Chapter 3.7.3, "How to Configure a Triggered and Gated Measurement"](#), on page 299.

- Preview..... 293
 - └ Frequency..... 293
 - └ RBW..... 293
 - └ Sweep Time..... 293
- Trigger Settings..... 293
 - └ Trigger Source..... 293
 - └ Free Run..... 294
 - └ Ext. Trigger 1/2..... 294
 - └ Video..... 294
 - └ IF Power..... 294
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 - └ Time..... 295
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 - └ Repetition Interval..... 295
 - └ Drop-Out Time..... 296
 - └ Trigger Offset..... 296
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- Trigger 2/3..... 297
 - └ Output Type..... 297
 - └ Level..... 297
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 - └ Send Trigger..... 298
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 - └ Gate Mode..... 298
 - └ Gate Delay..... 299
 - └ Gate Length..... 299

Preview

The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time.

For details see [Chapter 3.7.1.3, "Determining the Parameters in Preview Mode"](#), on page 291.

Note: The zero span settings refer only to the preview diagram. The main diagram remains unchanged.

The trigger and gate settings are applied to the measurement when the dialog box is closed or "Update Main Diagram" is selected.

If preview mode is switched off, any changes to the settings in this dialog box are applied to the measurement diagram directly. In this case, the zero span settings for the preview diagram are not displayed.

For information on the zero span settings see:

- ["Center frequency"](#) on page 257
- ["RBW"](#) on page 207
- ["Sweep Time"](#) on page 278

Frequency ← Preview

Defines the center frequency.

Remote command:

[\[SENSe:\] FREQuency:CENTer](#) on page 582

RBW ← Preview

Defines the bandwidth value. The available resolution bandwidths are specified in the data sheet. Numeric input is always rounded to the nearest possible bandwidth.

Remote command:

[\[SENSe:\] BANDwidth\[:RESolution\]](#) on page 594

Sweep Time ← Preview

Defines the sweep time. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible sweep time.

Remote command:

[\[SENSe:\] SWEEp:TIME](#) on page 601

Trigger Settings

The trigger settings define the beginning of a measurement.

Trigger Source ← Trigger Settings

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 286.

Remote command:

[TRIGger<n>\[:SEQuence\]:SOURce](#) on page 606

[\[SENSe:\] SWEEp:EGATE:SOURce](#) on page 609

Free Run ← Trigger Source ← Trigger Settings

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

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

Remote command:

`TRIGger<n>[:SEquence]:SOURce` on page 606

Ext. Trigger 1/2 ← Trigger Source ← Trigger Settings

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

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER 1 INPUT 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 "Outputs" configuration (see "Trigger 2/3" on page 251).

"External Trigger 3"

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

Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 251).

Remote command:

`TRIGger<n>[:SEquence]:SOURce` on page 606

Video ← Trigger Source ← Trigger Settings

Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

Video mode is only available in the time domain, and not for I/Q-based data.

Remote command:

`TRIGger<n>[:SEquence]:SOURce` on page 606

IF Power ← Trigger Source ← Trigger Settings

The R&S ESW starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

This trigger source is only available for RF input.

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

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

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

Remote command:

`TRIGger<n>[:SEquence]:SOURce` on page 606

RF Power ← Trigger Source ← Trigger Settings

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

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

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

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

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

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

Remote command:

`TRIGger<n>[:SEquence]:SOURce` on page 606

`SWE:EGAT:SOUR RFP` for gated triggering, see `[SENSe:]SWEep:EGATe:SOURce` on page 609

Time ← Trigger Source ← Trigger Settings

Triggers in a specified repetition interval.

Remote command:

`TRIGger<n>[:SEquence]:SOURce` on page 606

Trigger Level ← Trigger Settings

Defines the trigger level for the specified trigger source.

For gated measurements, this setting also defines the gate level.

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

Remote command:

`TRIGger[:SEquence]:LEVel:IFPower` on page 605

`TRIGger[:SEquence]:LEVel:IQPower` on page 605

`TRIGger<n>[:SEquence]:LEVel[:EXTernal<port>]` on page 605

`TRIGger[:SEquence]:LEVel:RFPower` on page 606

Repetition Interval ← Trigger Settings

Defines the repetition interval for a time trigger. The shortest interval is 2 ms.

The repetition interval should be set to the exact pulse period, burst length, frame length or other repetitive signal characteristic.

Remote command:

`TRIGger[:SEquence]:TIME:RINterval` on page 607

Drop-Out Time ← Trigger Settings

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

For more information on the drop-out time see "[Trigger Drop-Out Time](#)" on page 287.

Remote command:

`TRIGger [:SEquence] :DTIME` on page 603

Trigger Offset ← Trigger Settings

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

For more information see "[Trigger Offset](#)" on page 286.

offset > 0:	Start of the sweep is delayed
offset < 0:	Sweep starts earlier (pretrigger) Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off Maximum allowed range limited by the sweep time: $\text{pretrigger}_{\text{max}} = \text{sweep time}_{\text{max}}$

Remote command:

`TRIGger<n> [:SEquence] :HOLDoff [:TIME]` on page 603

Hysteresis ← Trigger Settings

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

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

For more information see "[Trigger Hysteresis](#)" on page 287.

Remote command:

`TRIGger [:SEquence] :IFPower:HYSteresis` on page 604

Trigger Holdoff ← Trigger Settings

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

For more information see "[Trigger Holdoff](#)" on page 288.

Remote command:

`TRIGger [:SEquence] :IFPower:HOLDoff` on page 604

Slope ← Trigger Settings

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

Remote command:

`TRIGger<n> [:SEquence] :SLOPe` on page 606

`[SENSe:]SWEep:EGATe:POLarity` on page 609

Trigger 2/3

The screenshot shows a configuration panel for Trigger 2 and Trigger 3. For Trigger 2, there are 'Input' and 'Output' buttons. The 'Output Type' is set to 'User Defined' and the 'Level' is set to 'Low'. The 'Pulse Length' is set to '100.0 μs' and there is a 'Send Trigger' button with a pulse icon. For Trigger 3, there are also 'Input' and 'Output' buttons.

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

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

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

"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<port>:DIRection](#) on page 579

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 user selects "Send Trigger" button. In this case, further parameters are available for the output signal.

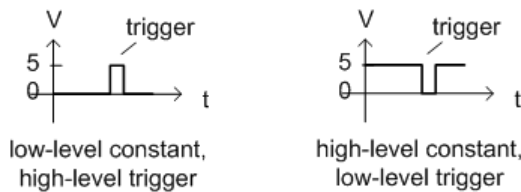
Remote command:

[OUTPut:TRIGger<port>:OTYPe](#) on page 579

Level ← Output Type ← Trigger 2/3

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

The trigger pulse level is always opposite to the constant signal level defined here, e.g. for "Level = High", a constant high signal is output to the connector until the [Send Trigger](#) function is selected. Then, a low pulse is provided.



Remote command:

[OUTPut:TRIGger<port>:LEVel](#) on page 579

Pulse Length ← Output Type ← Trigger 2/3

Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:

[OUTPut:TRIGger<port>:PULSe:LENGth](#) on page 580

Send Trigger ← Output Type ← Trigger 2/3

Sends a user-defined trigger to the output connector immediately.

Note that the trigger pulse level is always opposite to the constant signal level defined by the output [Level](#) setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" function is selected. Then, a low pulse is sent.

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

Remote command:

[OUTPut:TRIGger<port>:PULSe:IMMediate](#) on page 580

Gate Settings

Gate settings define one or more extracts of the signal to be measured.

Note: Gating is not available for measurements on I/Q-based data.

Gated Trigger ← Gate Settings

Switches gated triggering on or off.

If the gate is switched on, a gate signal applied to one of the "TRIGGER INPUT" connectors or the internal IF power detector controls the sweep.

Note: Gating is not available for measurements on I/Q based data.

Gate Mode ← Gate Settings

Sets the gate mode.

For more information see [Chapter 3.7.1.2, "Gated Measurements"](#), on page 289

"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 610

Gate Delay ← Gate Settings

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 3.7.1.2, "Gated Measurements"](#), on page 289

Remote command:

[SENSe:] SWEEp:EGATe:HOLDoff on page 608

Gate Length ← Gate Settings

Defines how long the gate is open when it is triggered. The gate length can only be set in the edge-triggered gate mode. In the level-triggered mode the gate length depends on the level of the gate signal.

In the Spectrum application, the gate length in relation to the sweep is indicated by a line labeled "GL".

For more information see [Chapter 3.7.1.2, "Gated Measurements"](#), on page 289

Remote command:

[SENSe:] SWEEp:EGATe:LENGth on page 609

3.7.3 How to Configure a Triggered and Gated Measurement

The following step-by-step instructions demonstrate how to configure a triggered and gated measurement manually.

Trigger and gate settings are configured in the "Trigger and Gate" dialog box.

To display the "Trigger and Gate" dialog box, do one of the following:

- Select "Trigger/Gate" from the "Overview".
- Select the TRIG key and then the "Trigger/Gate Config" softkey.

The following tasks are described:

3.7.3.1	How to Determine the Required Trigger/Gate Parameters.....	300
3.7.3.2	How to Configure a Triggered Measurement.....	300
3.7.3.3	How to Configure a Gated Measurement.....	301

3.7.3.1 How to Determine the Required Trigger/Gate Parameters

1. In the "Trigger and Gate" dialog box, switch on "Show Preview".
A zero span measurement for the currently defined center frequency is displayed.
2. Set the "Frequency", "RBW" and "Sweep Time" such that the relevant part of the signal is displayed, for example a complete burst.
3. Determine the parameters you want to use to define the trigger and gate conditions from the preview diagram, for example:
 - the length of a burst or slot
 - the upper or lower power level of a pulse
 - the maximum noise level
 - the power level or time at which a certain incident occurs
4. Try out different trigger and gate settings as described in [How to Configure a Triggered Measurement](#) and [How to Configure a Gated Measurement](#), then select "Update Main Diagram" to see the effect of the current settings on the main measurement in the background.
5. If the results are as expected, close the dialog box to keep the changes permanently. Otherwise, correct the settings as necessary.

3.7.3.2 How to Configure a Triggered Measurement

To define a time trigger:

1. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "Time".
2. Define the "Repetition Interval": the time after which a new measurement is started.

To define an external trigger:

1. Connect an external device that will provide the trigger signal to one of the trigger 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. If you are using the variable TRIGGER 2 INPUT / OUTPUT connector, you must define its use as an input connector. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the corresponding trigger to "Input".
4. Configure the external trigger as described for the other power triggers.

To define a power trigger:

1. In the "Trigger and Gate" dialog box, define the "Trigger Source" = "IF Power" or "Video". Note that the video signal corresponds to the envelope of the IF signal: it has been processed by the resolution and video filters and the selected detector.

2. Define the "Trigger Level": the power level at which the measurement will start. For a "Video" trigger source you can move the level line graphically to define the level. If you define the value numerically, you must enter a percentage of the full diagram height as the level.
3. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
4. To start the measurement with a time delay, define a "Trigger Offset".
5. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. The holdoff time should be slightly larger than the burst.

3.7.3.3 How to Configure a Gated Measurement

1. Determine the required parameters as described in [Chapter 3.7.3.1, "How to Determine the Required Trigger/Gate Parameters"](#), on page 300.
2. The gate is opened by a trigger event, which must be based on a power source. Define the trigger as described in [Chapter 3.7.3.2, "How to Configure a Triggered Measurement"](#), on page 300. 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".

3.7.4 How to Output a Trigger Signal

Using the variable TRIGGER 2 INPUT / OUTPUT connector of the R&S ESW, the internal trigger signal can be output for use by other connected devices. For details on the connectors see the R&S ESW "Getting Started" manual.

To output a trigger to a connected device

1. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the trigger to be used to "Output".
2. Define whether the trigger signal is to be output automatically ("Output Type" = "Device triggered" or "Trigger Armed") or whether you want to start output manually ("Output Type" = "User-defined").
3. For manual output: Specify the constant signal level and the length of the trigger pulse to be output. Note that the level of the trigger pulse is opposite to the constant output "Level" setting (compare the graphic on the "Send Trigger" button).
4. Connect a device that will receive the trigger signal to the configured TRIGGER 2 INPUT / OUTPUT connector.
5. Start a measurement and wait for an internal trigger, or select the "Send Trigger" button.

The configured trigger is output to the connector.

3.8 Adjusting Settings Automatically

Some settings can be adjusted by the R&S ESW automatically according to the current measurement settings. In order to do so, a measurement is performed. The duration of this measurement can be defined automatically or manually.

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



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
 - For Video trigger:
Trigger Level = 85 %

Remote command:

[SENSe:]ADJust:CONFigure:TRIG on page 612

Adjusting all Determinable Settings Automatically (Auto All).....	303
Adjusting the Center Frequency Automatically (Auto Freq).....	303
Setting the Reference Level Automatically (Auto Level).....	303
Resetting the Automatic Measurement Time (Meastime Auto).....	303
Changing the Automatic Measurement Time (Meastime Manual).....	304
Upper Level Hysteresis.....	304
Lower Level Hysteresis.....	304

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings.

This includes:

- [Auto Frequency](#)
- [Auto Level](#)

Remote command:

`[SENSe:]ADJust:ALL` on page 610

Adjusting the Center Frequency Automatically (Auto Freq)

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.

Remote command:

`[SENSe:]ADJust:FREQuency` on page 613

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 so the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S ESW.

If necessary, you can optimize the reference level further by manually decreasing the attenuation level to the lowest possible value before an overload occurs, then decreasing the reference level in the same way.

You can change the measurement time for the level measurement if necessary (see "[Changing the Automatic Measurement Time \(Meastime Manual\)](#)" on page 304).

Remote command:

`[SENSe:]ADJust:LEVel` on page 613

Resetting the Automatic Measurement Time (Meastime Auto)

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

Remote command:

`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 611

Changing the Automatic Measurement Time (Meastime Manual)

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:DURation:MODE](#) on page 611

[\[SENSe:\]ADJust:CONFigure:DURation](#) on page 611

Upper Level Hysteresis

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:HYSTeresis:UPPer](#) on page 612

Lower Level Hysteresis

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:HYSTeresis:LOWer](#) on page 612

4 Common Analysis and Display Functions

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings and functions that may deviate from these common settings.

The analysis settings and functions are available via the "Analysis" dialog box, which is displayed when you select the "Analysis" button in the "Overview". Additional measurement-specific analysis functions may be available in separate tabs in the "Analysis" dialog box. These are described with the individual [measurements](#).

- [Result Display Configuration](#).....305
- [Zoomed Displays](#)..... 312
- [Configuring Traces](#).....317
- [Marker Usage](#).....350
- [Display and Limit Lines](#)..... 387

4.1 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 SmartGrid, 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.

- [Basic Evaluation Methods](#).....305
- [Laying out the Result Display with the SmartGrid](#).....307

4.1.1 Basic Evaluation Methods

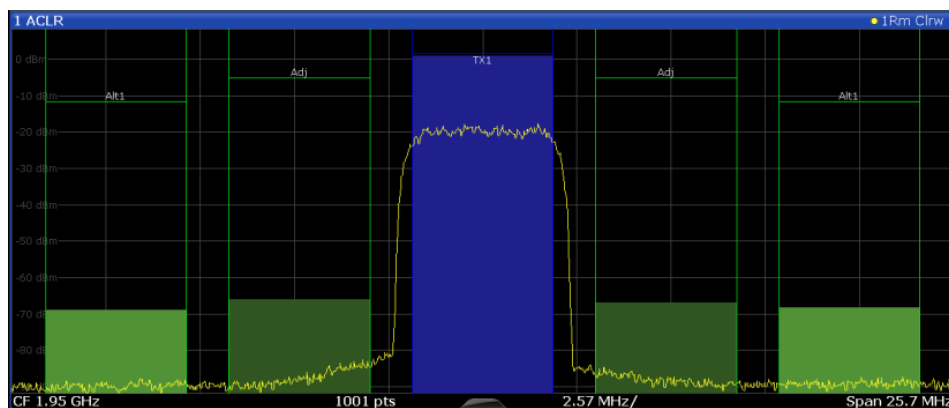
Measurement results can be displayed and evaluated using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

The evaluation methods described here are available for most measurements in the Spectrum application.

Diagram.....306
 Marker Table..... 306
 Marker Peak List..... 306
 Result Summary.....307
 Spectrogram.....307

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 556

Marker Table

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

This table may be displayed automatically if configured accordingly.

2 Marker						
Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.19705
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 556

Results:

CALCulate<n>:MARKer<m>:X on page 640

CALCulate<n>:MARKer<m>:Y? on page 654

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

2 Marker Peak List		
No	Stimulus	Response
1	64.400000 MHz	-30.352 dBm
2	128.400000 MHz	-51.896 dBm
3	192.300000 MHz	-40.227 dBm
4	257.200000 MHz	-60.699 dBm
5	320.200000 MHz	-44.273 dBm
6	384.100000 MHz	-53.494 dBm
7	448.100000 MHz	-47.460 dBm
8	513.000000 MHz	-55.603 dBm

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 556

Results:

CALCulate<n>:MARKer<m>:X on page 640

CALCulate<n>:MARKer<m>:Y? on page 654

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

Remote command:

LAY:ADD? '1',RIGH, RSUM, see LAYout:ADD[:WINDow]? on page 556

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 4.3.1.7, "Working with Spectrograms", on page 324.

Remote command:

LAY:ADD? '1',RIGH, SGR, see LAYout:ADD[:WINDow]? on page 556

4.1.2 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 measurement 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.
- [Background Information: The SmartGrid Principle](#).....308
 - [How to Activate SmartGrid Mode](#).....310
 - [How to Add a New Result Window](#)..... 310
 - [How to Close a Result Window](#).....311
 - [How to Arrange the Result Windows](#)..... 311

4.1.2.1 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.

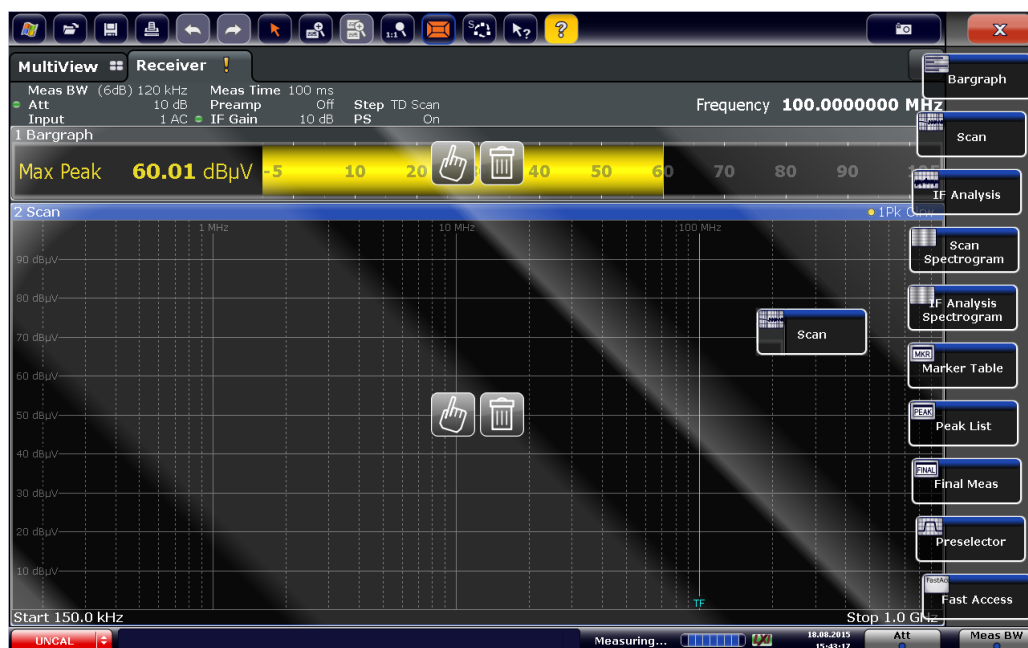


Figure 4-1: Moving a window in SmartGrid mode

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 4-2). 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).

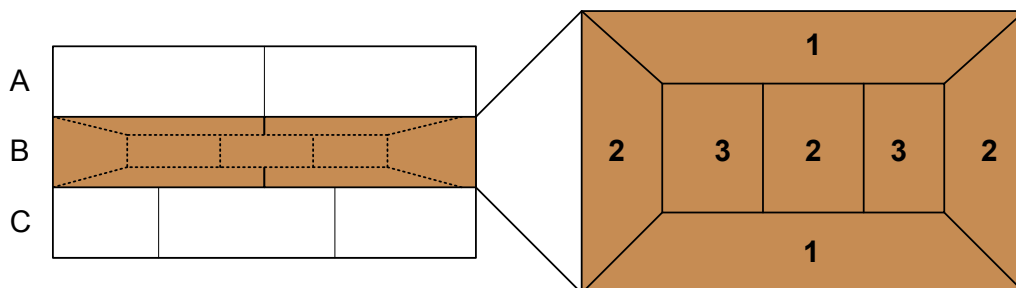


Figure 4-2: SmartGrid window positions

- 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.

4.1.2.2 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 the "Display Config" button in the configuration "Overview".
- Select the "Display Config" softkey from the MEAS CONFIG menu.

The SmartGrid functions and the evaluation bar are displayed.



To close the SmartGrid mode and restore the previous softkey menu select the "Close" icon in the right-hand corner of the toolbar, or press any key.

4.1.2.3 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 measurement 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 4.1.2.5, "How to Arrange the Result Windows"](#), on page 311 for more information on positioning the window).

Remote command:

[LAYout:ADD\[:WINDow\]? on page 556](#) / [LAYout:WINDow<n>:ADD? on page 560](#)

4.1.2.4 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 558](#) / [LAYout:WINDow<n>:REMove on page 561](#)

4.1.2.5 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 558](#) / [LAYout:WINDow<n>:REPLace on page 561](#)

4.2 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.



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 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274).

- [Single Zoom Versus Multiple Zoom](#)..... 312
- [Zoom Functions](#)..... 314
- [How to Zoom Into a Diagram](#)..... 315

4.2.1 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.

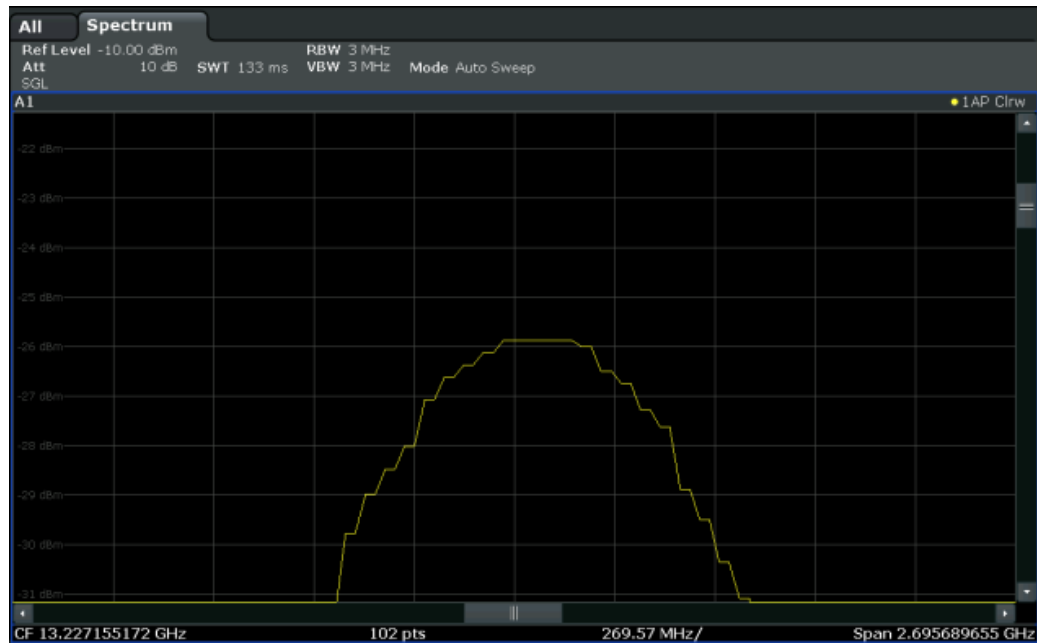


Figure 4-3: Single zoom

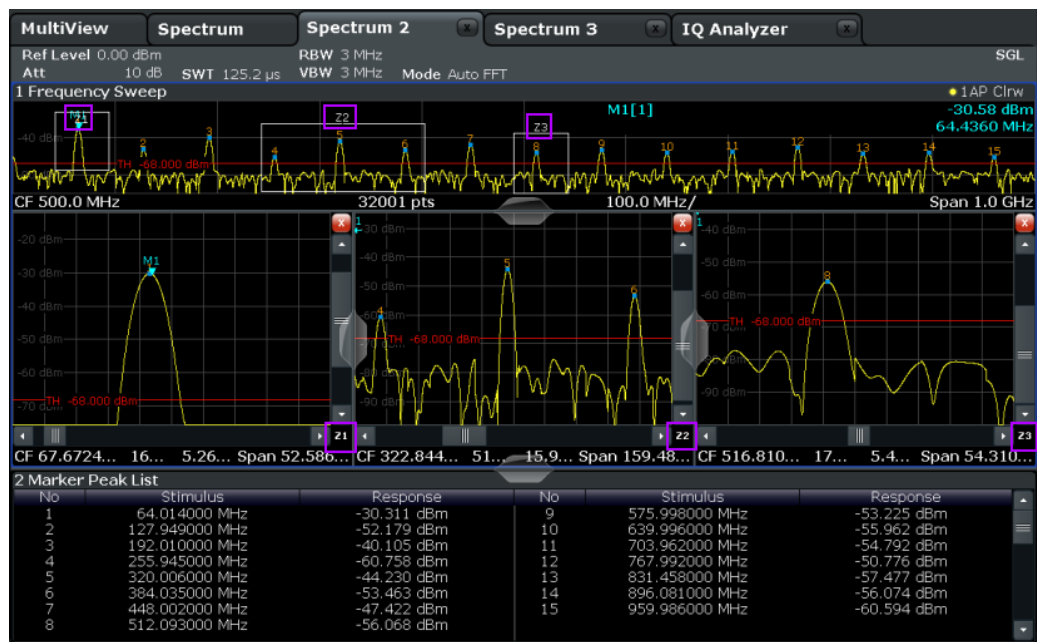


Figure 4-4: Multiple zoom



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 "Using Zoom Limits" on page 368).

4.2.2 Zoom Functions

Access: "Zoom" icons in toolbar

Single Zoom.....	314
Multiple Zoom.....	314
Restore Original Display.....	314
👉 Deactivating Zoom (Selection mode).....	314

Single Zoom



A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

Remote command:

`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 615

`DISPlay[:WINDow<n>]:ZOOM:AREA` on page 614

Multiple Zoom



In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Remote command:

`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 615

`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA` on page 614

Restore Original Display



Restores the original display, that is, the originally calculated displays for the entire capture buffer, and closes all zoom windows.

Remote command:

Single zoom:

`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 615

Multiple zoom:

`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 615 (for each multiple zoom window)

👉 Deactivating Zoom (Selection mode)

Deactivates any zoom mode.

Tapping the screen no longer invokes a zoom, but selects an object.

Remote command:

Single zoom:

`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 615

Multiple zoom:

`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 615 (for each multiple zoom window)

4.2.3 How to Zoom Into a Diagram

The following tasks are described here:

- "To zoom into the diagram at one position" on page 315
- "To return to selection mode in the diagram" on page 316
- "To return to original display" on page 316
- "To zoom into multiple positions in the diagram" on page 316

To zoom into the diagram at one position

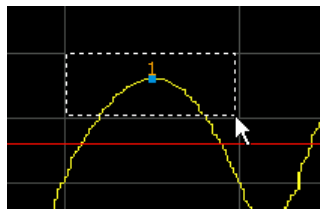
1.



Click on the "Single Zoom" icon in the toolbar.

Zoom mode is activated.

2. Select the area in the diagram to be enlarged on the touchscreen. The selected area is indicated by a dotted rectangle.



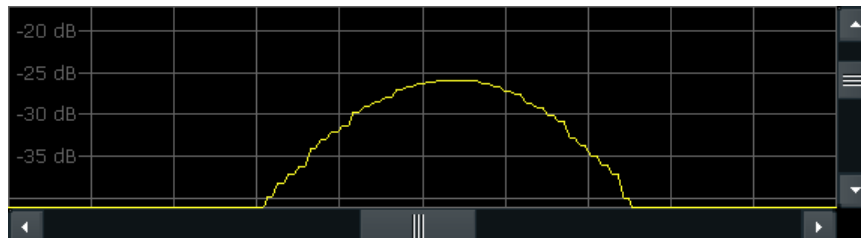
When you leave the touchscreen, the diagram is replaced by the zoomed trace area.

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 selection mode in the diagram

While you are in zoom mode, touching the screen changes the zoom area. In order to select or move a trace or marker, you must switch back to selection mode:



Select the "Selection mode" icon in the toolbar.

To return to original display



Click on the "Zoom Off" icon in the toolbar.

The original trace display is restored. Zoom mode remains active, however.

To switch off zoom mode and return to selection mode, select the "Selection mode" icon in the toolbar.

To zoom into multiple positions in the diagram



Click on the "Multiple Zoom" icon in the toolbar.

Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged as described in ["To zoom into the diagram at one position"](#) on page 315. 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 4-4](#)).

3. In the overview diagram, select the next area to be enlarged.
The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.

4. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

1. If necessary, switch off zoom mode and return to selection mode by selecting the "Selection mode" icon in the toolbar.
2. To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.
To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.

The contents of the zoom windows are adapted accordingly.

4.3 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.

- [Basic Information about Traces](#)..... 317
- [Trace Configuration](#).....331
- [How to Configure a Standard Trace](#).....341
- [How to Export Trace Data and Numerical Results](#).....342
- [How to Display and Configure a Spectrogram](#)..... 343
- [Reference: ASCII File Export Format](#).....347
- [Formats for Returned Values: ASCII Format and Binary Format](#).....349

4.3.1 Basic Information about Traces

Some background knowledge on traces is provided here for a better understanding of the required configuration settings.

- [Mapping Samples to sweep Points with the Trace Detector](#).....317
- [Analyzing Several Traces - Trace Mode](#)..... 320
- [How Many Traces are Averaged - Sweep Count + Sweep Mode](#).....321
- [How Trace Data is Averaged - the Averaging Mode](#).....322
- [Trace Mathematics](#).....323
- [Trace Smoothing](#).....323
- [Working with Spectrograms](#)..... 324

4.3.1.1 Mapping Samples to sweep Points with the Trace Detector

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

Example:

Assume the following measurement parameters:

- Sample rate: 32 MSamples / s
- sweep points: 1000
- sweep time: 100 ms
- Span: 5 GHz

During a single sweep, $3.2 * 10^6$ samples are collected and distributed to 1000 sweep points, i.e. 3200 samples are collected per sweep point. For each sweep point, the measured data for a frequency span of 5 MHz ($\text{span}/\langle \text{sweep points} \rangle$) is analyzed.

Note that if you increase the number of sweep points, the frequency span analyzed for each point in the trace decreases, making the result more stable.

See also [Chapter 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274.

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

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



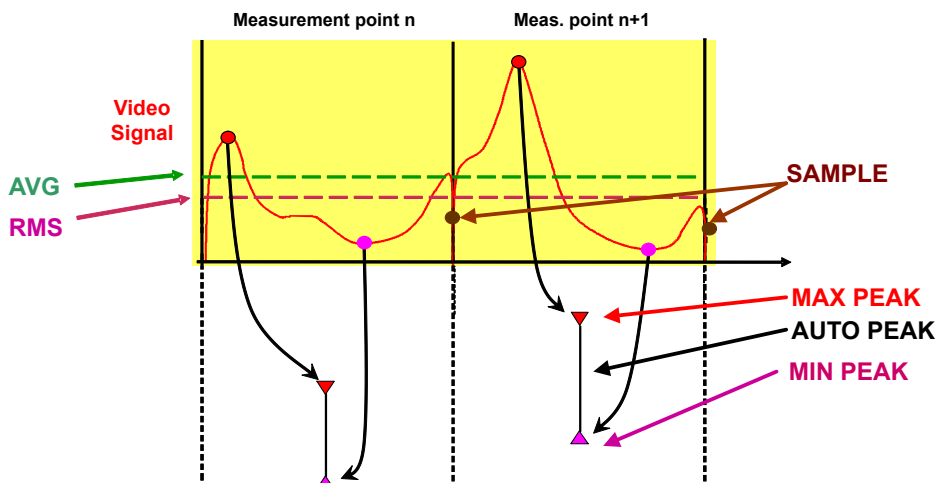
The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation.

Table 4-1: Detector types

Detector	Abbrev.	Description
Positive Peak	Pk	Determines the largest of all positive peak values of the levels measured at the individual frequencies which are displayed in one sample point
Negative Peak	Mi	Determines the smallest of all negative peak values of the levels measured at the individual frequencies which are displayed in one sample point
Auto Peak	Ap	Combines the peak detectors; determines the maximum and the minimum value of the levels measured at the individual frequencies which are displayed in one sample point (not available for SEM)
RMS	Rm	Calculates the root mean square of all samples contained in a sweep point. To this effect, R&S ESW uses the linear voltage after envelope detection. The sampled linear values are squared, summed and the sum is divided by the number of samples (= root mean square). For logarithmic display the logarithm is formed from the square sum. For linear display the root mean square value is displayed. Each sweep point thus corresponds to the power of the measured values summed up in the sweep point. The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors to measure the power of the different signal classes are not required.

Detector	Abbrev.	Description
Average	Av	<p>Calculates the linear average of all samples contained in a sweep point.</p> <p>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 logarithmic display the logarithm is formed from the average value. For linear display the average value is displayed. Each sweep point thus corresponds to the average of the measured values summed up in the sweep point.</p> <p>The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).</p>
Sample	Sa	<p>Selects the last measured value of the levels measured at the individual frequencies which are displayed in one sample point; all other measured values for the frequency range are ignored</p>

The result obtained from the selected detector for a sweep point is displayed as the value at this frequency point in the trace.



The trace detector for the individual traces can be selected manually by the user or set automatically by the R&S ESW.

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.



RMS detector and VBW

If the RMS detector is selected, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if the RMS detector is used the sweep time should be increased to get more stable traces.

Auto detector

If the R&S ESW is set to define the appropriate detector automatically, the detector is set depending on the selected trace mode:

Trace mode	Detector
Clear Write	Auto Peak
Max Hold	Positive Peak
Min Hold	Negative Peak
Average	Sample Peak
View	–
Blank	–

4.3.1.2 Analyzing Several Traces - Trace Mode

If several sweep are performed one after the other, or continuous sweep are performed, the trace mode determines how the data for subsequent traces is processed. After each sweep, the trace mode determines whether:

- the data is frozen (View)
- the data is hidden (Blank)
- the data is replaced by new values (Clear Write)
- the data is replaced selectively (Max Hold, Min Hold, Average)



Each time the trace mode is changed, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see [Chapter 4.3.1.1, "Mapping Samples to sweep Points with the Trace Detector"](#), on page 317.

The R&S ESW supports the following trace modes:

Table 4-2: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting. All available detectors can be selected.
Max Hold	The maximum value is determined over several measurements and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one. This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope. This mode is not available for statistics measurements.

Trace Mode	Description
Min Hold	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. 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. This mode is not available for statistics measurements.
Average	The average is formed over several measurements and displayed. The Sweep / Average Count determines the number of averaging procedures. This mode is not available for statistics measurements.
View	The current contents of the trace memory are frozen and displayed.



If a trace is frozen ("View" mode), the measurement settings, apart from scaling settings, can be changed 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 have an effect on the scaling of the diagram axes, the R&S ESW automatically adapts the trace data to the changed display range. This allows you to zoom into the diagram after the measurement in order to show details of the trace.

4.3.1.3 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 4-5: 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 4-6: 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

4.3.1.4 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 prior to averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals the two methods yield the same result.

Logarithmic averaging is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved and the negative peak values are

increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the R&S ESW offers the selection of linear averaging. The trace data is linearized prior to averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

4.3.1.5 Trace Mathematics

If you have several traces with different modes, for example an average trace and a maximum trace, it may be of interest to compare the results of both traces. In this example, you could analyze the maximum difference between the average and maximum values. To analyze the span of result values, you could subtract the minimum trace from the maximum trace. For such tasks, mathematical functions on trace results are provided.

4.3.1.6 Trace Smoothing

A Video Bandwidth Filter (VBW) is a hardware-based method of smoothing the trace (see also [Chapter 3.6.1.2, "Smoothing the Trace Using the Video Bandwidth"](#), on page 271). However, other sweep and bandwidth settings may be coupled to the VBW, and 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 visually remove anomalies in the trace that may distort the results. The smoothing process is based on a moving average over the complete measurement range. The number of samples included in the averaging process (the *aperture* size) is variable and is a percentage of all samples that the trace consists of.

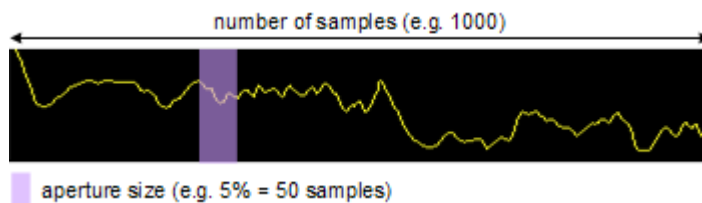


Figure 4-7: Sample size included in trace smoothing



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 will differ from results based on the original trace.

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 4-1: Linear trace smoothing

with:

s = sample number

x = sample offset from s

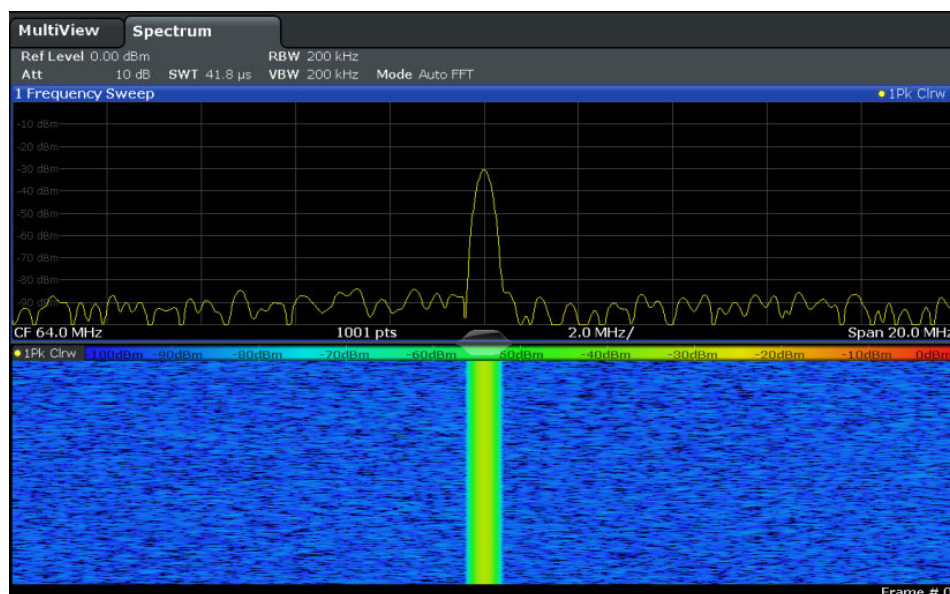
n = aperture size

4.3.1.7 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:

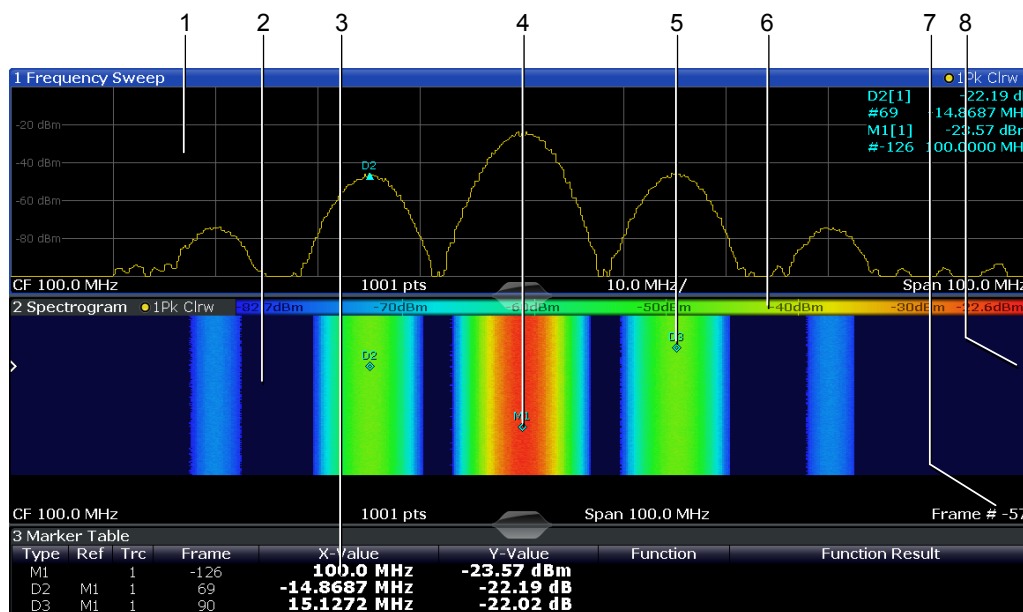


Figure 4-8: Screen layout of the spectrogram result display

- 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 4.3.2.4, "Spectrogram Settings"](#), on page 337.

Remote commands:

Activating and configuring spectrograms:

[Chapter 5.9.2.5, "Configuring Spectrograms"](#), on page 627

Storing results:

`MMEMory:STORe<n>:SPECTrogram` on page 633

- [Time Frames](#)..... 325
- [Color Maps](#)..... 327
- [Markers in the Spectrogram](#)..... 330

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 the "Split/Maximize" key.



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 4-8](#)).

Displaying individual frames

The current frame number is indicated in the diagram footer, or alternatively a time-stamp, if activated. The current frame, displayed at the top of the diagram, is frame number 0. Older frames further down in the diagram are indicated by a negative index, e.g. "-10". You can display the spectrum diagram of a previous frame by changing the current frame number.

Color Maps

Spectrograms assign power levels to different colors in order to visualize them. The legend above the spectrogram display describes the power levels the colors represent.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use (Color scheme)
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e. where the focus of the visualization lies (shape of the color curve)

The individual colors are assigned to the power levels automatically by the R&S ESW.

The Color Scheme

You can select which colors are assigned to the measured values. Four different color ranges or "schemes" are available:

- **Hot**



Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

- **Cold**



Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

The "Cold" color scheme is the inverse "Hot" color scheme.

- **Radar**



Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high ones.

- **Grayscale**



Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high ones.

The Value Range of the Color Map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range so it becomes easier to distinguish between values that are close together, and only parts of interest are displayed at all.

The Shape and Focus of the Color Curve

The color mapping function assigns a specified color to a specified power level in the spectrogram display. By default, colors on the color map are distributed evenly. However, if a certain area of the value range is to be visualized in greater detail than the rest, you can set the focus of the color mapping to that area. Changing the focus is performed by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large number of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.

Example:

In the color map based on the linear color curve, the range from -100 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.

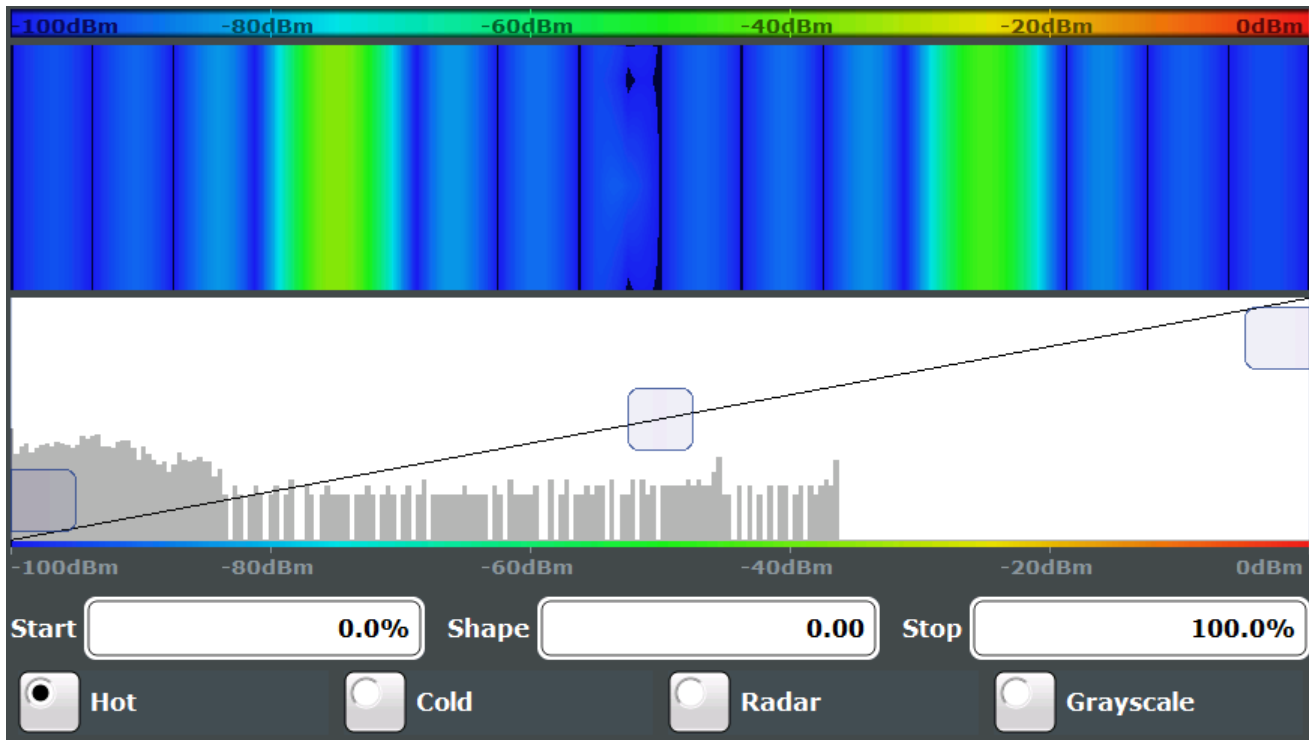


Figure 4-9: Spectrogram with (default) linear color curve shape = 0

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), which occurs more often in the example. The range from -60 dBm to -20 dBm, on the other hand, is dominated by various shades of red only.

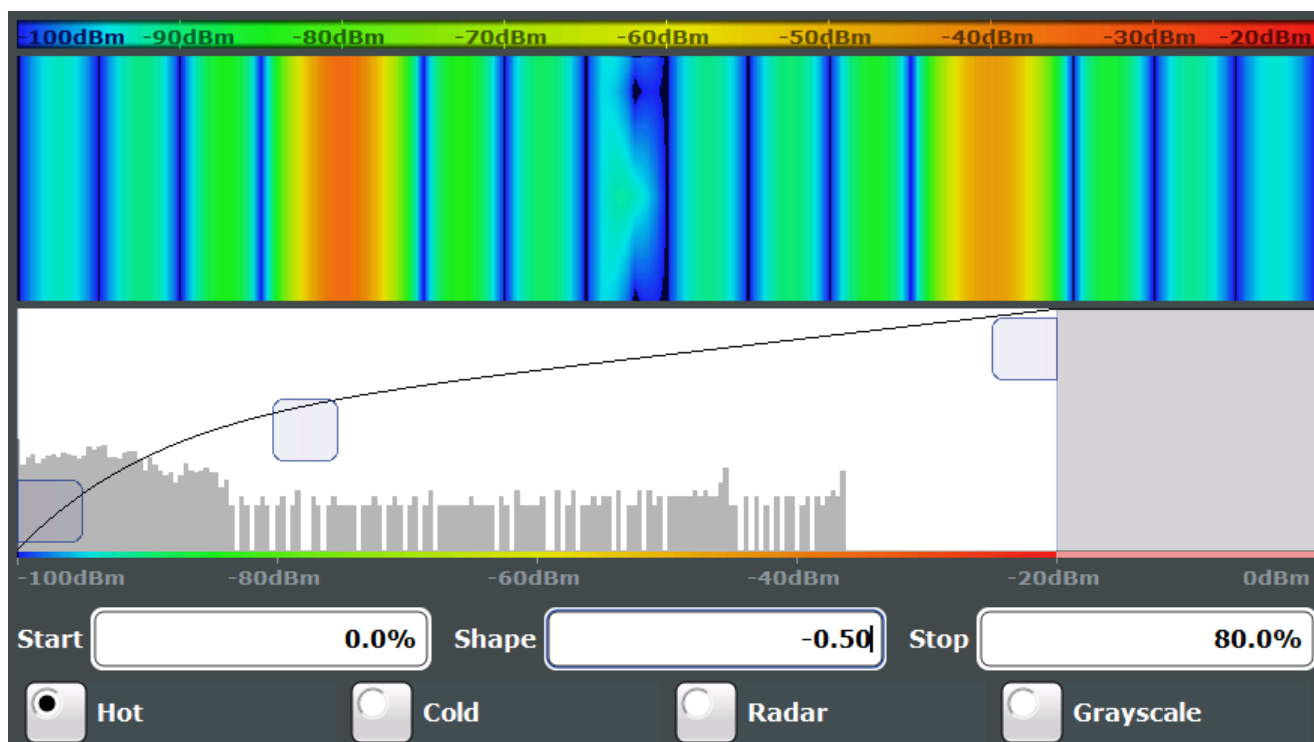
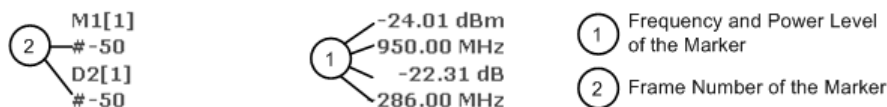


Figure 4-10: Spectrogram with non-linear color curve shape = -0.5

Markers in the Spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They are only displayed in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

In the spectrum result display, the markers and their frequency and level values (1) are displayed as usual. Additionally, the frame number is displayed to indicate the position of the marker in time (2).



In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers.

In the spectrum result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode this means that only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the spectrum result display, you must stop the measurement and select the corresponding frame.

4.3.2 Trace Configuration

- [Trace Settings](#).....331
- [Trace / Data Export Configuration](#).....335
- [Trace Math](#).....336
- [Spectrogram Settings](#).....337

4.3.2.1 Trace Settings

You can configure the settings for up to 6 individual traces.

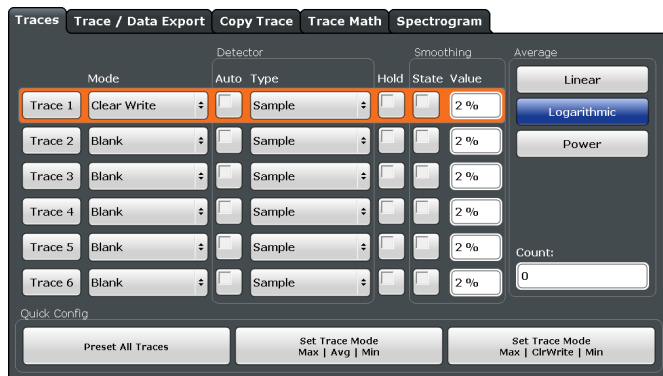
The trace settings are configured in the "Traces" dialog box which is displayed when you do one of the following:

- Press the TRACE key, then select "Trace Config".
- In the "Overview", select "Analysis", then switch to the vertical "Traces" tab.

For settings on spectrograms, see [Chapter 4.3.2.4, "Spectrogram Settings"](#), on page 337.



Trace data can also be exported to an ASCII file for further analysis. For details see [Chapter 4.3.2.2, "Trace / Data Export Configuration"](#), on page 335.



- [Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6](#).....331
- [Trace Mode](#).....332
- [Detector](#).....332
- [Hold](#).....332
- [Smoothing](#).....333
- [Average Mode](#).....333
- [Average Count](#).....334
- [Predefined Trace Settings - Quick Config](#).....334
- [Trace 1/Trace 2/Trace 3/Trace 4 \(Softkeys\)](#).....334
- [Copy Trace](#).....335

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>]:TRACe<t>[:STATe] on page 622

Trace Mode

Defines the update mode for subsequent traces.

For details see [Chapter 4.3.1.2, "Analyzing Several Traces - Trace Mode"](#), on page 320.

"Clear Write"	Overwrite mode: the trace is overwritten by each sweep. This is the default setting. The "Detector" is automatically set to "Auto Peak".
"Max Hold"	The maximum value is determined over several sweeps and displayed. The R&S ESW saves each trace point in the trace memory only if the new value is greater than the previous one. The "Detector" is automatically set to "Positive Peak". This mode is not available for statistics measurements.
"Min Hold"	The minimum value is determined from several measurements and displayed. The R&S ESW saves each trace point in the trace memory only if the new value is lower than the previous one. The "Detector" is automatically set to "Negative Peak". This mode is not available for statistics measurements.
"Average"	The average is formed over several sweeps. The Sweep / Average Count determines the number of averaging procedures. The "Detector" is automatically set to "Sample". This mode is not available for statistics measurements.
"View"	The current contents of the trace memory are frozen and displayed.
"Blank"	Removes the selected trace from the display.

Remote command:

DISPlay[:WINDow<n>]:TRACe<t>:MODE on page 620

Detector

Defines the trace detector to be used for trace analysis.

For details see [Chapter 4.3.1.1, "Mapping Samples to sweep Points with the Trace Detector"](#), on page 317.

"Auto"	Selects the optimum detector for the selected trace and filter mode. This is the default setting.
"Type"	Defines the selected detector type.

Remote command:

[SENSe:] [WINDow<n>:] DETector<t>[:FUNctIon] on page 619

[SENSe:] [WINDow<n>:] DETector<t>[:FUNctIon]:AUTO on page 618

Hold

If activated, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started again after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONTinuous` on page 621

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 will differ from results based on the original trace.

For more information see [Chapter 4.3.1.6, "Trace Smoothing"](#), on page 323.

Remote command:

`DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]` on page 621

`DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture` on page 620

Average Mode

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

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

How many sweeps are averaged is defined by the ["Sweep / Average Count"](#) on page 279.

For details see [Chapter 4.3.1.4, "How Trace Data is Averaged - the Averaging Mode"](#), on page 322.

"Linear"	The power level values are converted into linear units prior to averaging. After the averaging, the data is converted back into its original unit.
"Logarithmic"	For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.
"Power"	Activates linear power averaging. The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit. Use this mode to average power values in Volts or Amperes correctly.

Remote command:

`[SENSe:]AVERAge<n>:TYPE` on page 598

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 597

Predefined Trace Settings - Quick Config

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

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write Auto Detector (Auto Peak)
	Traces 2-6:	Blank Auto Detector
Set Trace Mode Max Avg Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Average Auto Detector (Sample)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector
Set Trace Mode Max ClrWrite Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Clear Write Auto Detector (Auto Peak)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector

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

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

For details see [Chapter 4.3.3, "How to Configure a Standard Trace"](#), on page 341.

Remote command:

[DISPlay\[:WINDow<n>\]: TRACe<t>\[:STATe\]](#) on page 622

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.

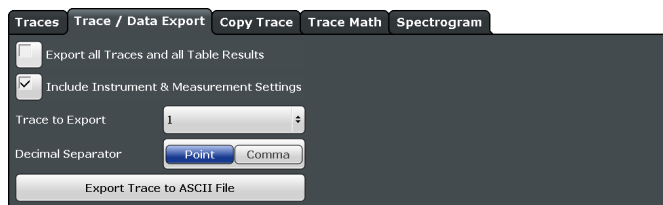
Remote command:

`TRACe<n>:COPY` on page 623

4.3.2.2 Trace / Data Export Configuration

Access: "Overview" > "Analysis" > "Traces" > "Trace/Data Export"

The R&S ESW provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with other, external applications. In this case, you can export the measurement data to an ASCII file.



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[Include Instrument Measurement Settings](#).....335

[Trace to Export](#).....335

[Decimal Separator](#)..... 336

[Export Trace to ASCII File](#)..... 336

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 627

Include Instrument Measurement Settings

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

See [Chapter 4.3.6, "Reference: ASCII File Export Format"](#), on page 347 for details.

Remote command:

`FORMat:DEXPort:HEADer` on page 626

Trace to Export

Defines an individual trace that will be exported to a file.

This setting is not available if [Export all Traces and all Table Results](#) is selected.

Decimal Separator

Defines the decimal separator for floating-point numerals for the data export files. Evaluation programs require different separators in different languages.

Remote command:

`FORMat:DEXPort:DSEParator` on page 626

Export Trace to ASCII File

Opens a file selection dialog box and saves the selected trace in ASCII format (.dat) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation may take some time.

For details on the file format in the Spectrum application see [Chapter 4.3.6, "Reference: ASCII File Export Format"](#), on page 347.

Remote command:

`MMEMorY:STORe<n>:TRACe` on page 616

4.3.2.3 Trace Math

Access: TRACE > "Trace Math"

Trace Math Function	336
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Trace Math Mode	337

Trace Math Function

Defines which trace is subtracted from trace 1. The result is displayed in trace 1 and refers to the zero point defined with the [Trace Math Position](#) setting. The following subtractions can be performed:

"T1-T2 -> T1"	Subtracts trace 2 from trace 1.
"T1-T3 -> T1"	Subtracts trace 3 from trace 1
"T1-T4 -> T1"	Subtracts trace 4 from trace 1
"T1-T5 -> T1"	Subtracts trace 5 from trace 1
"T1-T6 -> T1"	Subtracts trace 6 from trace 1

To switch off the trace math, use the [Trace Math Off](#) button.

Remote command:

`CALCulate<n>:MATH[:EXPrESSion] [:DEFine]` on page 623

`CALCulate<n>:MATH:STATe` on page 625

Trace Math Off

Deactivates any previously selected trace math functions.

Remote command:

CALC:MATH:STAT OFF, see [CALCulate<n>:MATH:STATe](#) on page 625

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:POSition](#) on page 624

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"> • The unit is set to either W or dBm: the data is converted into W prior to subtraction, i.e. averaging is done in W. • The unit is set to either V, A, dBmV, dBμV, dBμA or dBpW: the data is converted into V prior to subtraction, i.e. subtraction is done in V. |
| "Log" | <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:MODE](#) on page 624

4.3.2.4 Spectrogram Settings

The individual settings available for spectrogram display are described here. For settings on color mapping, see ["Color Map Settings"](#) on page 340.

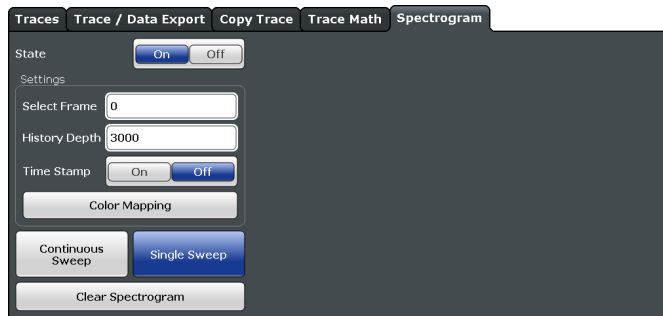
Settings concerning the frames and how they are handled during a sweep are provided as additional sweep settings for spectrogram display, see ["Spectrogram Frames"](#) on page 282.

Search functions for spectrogram markers are described in [Chapter 4.4.3, "Marker Search Settings and Positioning Functions"](#), on page 366.

- [General Spectrogram Settings](#).....338
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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.



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[History Depth](#).....338

[Timestamp](#).....339

[Color Mapping](#).....339

[Continuous Sweep/RUN CONT](#).....339

[Single Sweep/ RUN SINGLE](#).....339

[Clear Spectrogram](#).....340

State

Activates and deactivates the spectrogram result display

Remote command:

`CALCulate<n>:SPECTrogram[:STATe]` on page 631

Selecting a frame to display

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details see ["Time Frames"](#) on page 325.

Remote command:

`CALCulate<n>:SPECTrogram:FRAMe:SElect` on page 629

History Depth

Sets the number of frames that the R&S ESW stores in its memory.

The maximum possible 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 629

Timestamp

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 631

[CALCulate<n>:SPECTrogram:TSTamp:DATA?](#) on page 630

Color Mapping

Opens the "Color Map" dialog.

For details see ["Color Maps"](#) on page 327.

Continuous Sweep/RUN CONT

After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.

Furthermore, the RUN CONT key 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:

[INITiate<n>:CONTinuous](#) on page 409

Measurement mode: [INITiate<n>:CONTinuous](#) on page 409

Run measurement: [INITiate<n>\[:IMMediate\]](#) on page 407

Single Sweep/ RUN SINGLE

After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.

Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

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

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

Remote command:

Measurement mode: `INITiate<n>:CONTinuous` on page 409

Run measurement: `INITiate<n>[:IMMediate]` on page 407

`CALCulate<n>:SPECTrogram:CONT` on page 628

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 627

Color Map Settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

For more information on color maps see "Color Maps" on page 327.

For details on changing color mapping settings see Chapter 4.3.5.1, "How to Configure the Color Mapping", on page 345.

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.

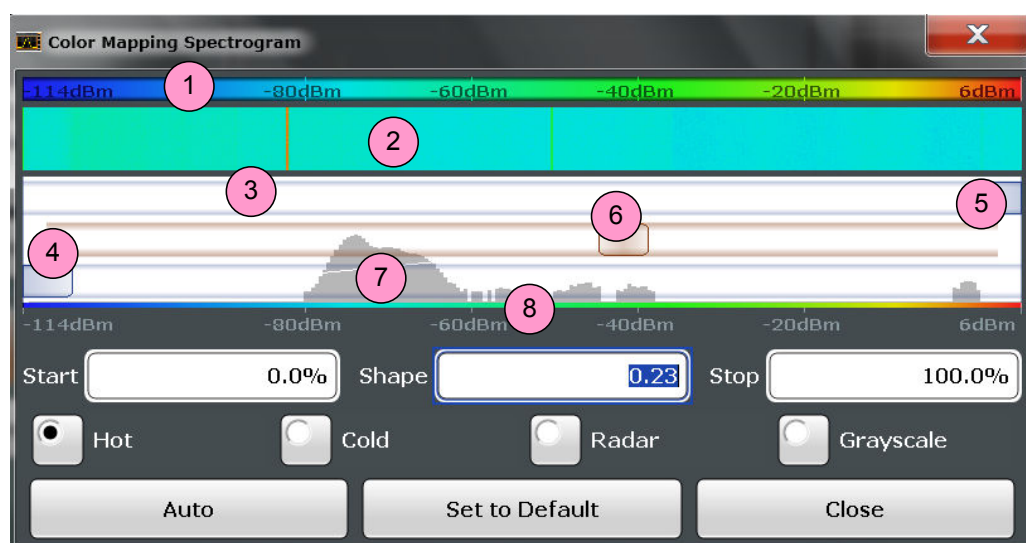


Figure 4-11: Color Mapping dialog box

- 1 = Color map: shows the current color distribution
- 2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
- 3 = Color curve pane: graphical representation of all settings available to customize the color scheme
- 4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
- 6 = Color curve slider: adjusts the focus of the color curve
- 7 = Histogram: shows the distribution of measured values
- 8 = Scale of the horizontal axis (value range)

Start / Stop

Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:

`DISPlay[:WINDow<n>]:SPECTrogram:COLor:LOWer` on page 632

`DISPlay[:WINDow<n>]:SPECTrogram:COLor:UPPer` on page 632

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 632

Hot/Cold/Radar/Grayscale

Sets the color scheme for the spectrogram.

Remote command:

`DISPlay[:WINDow<n>]:SPECTrogram:COLor[:STYLE]` on page 633

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 631

4.3.3 How to Configure a Standard Trace

Step-by-step instructions on configuring the trace settings are provided here.

Trace settings are configured in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Press the TRACE key and then select the "Trace Config" softkey.
- Select "Analysis" from the "Overview", then select the "Traces" tab.

1. For each trace, select the "Trace Mode" and "Trace Detector". Traces with the trace mode "Blank" are not displayed.
2. To configure several traces to predefined display modes in one step, press the button for the required function:
 - "Preset All Traces"
 - "Set Trace Mode Avg | Max | Min"
 - "Set Trace Mode Max | ClrWrite | Min"
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 the TRACE key and then the "Trace Copy" softkey.
 - Select "Analysis" from the "Overview", then select the "Trace Copy" tab.
2. Select the "Source" trace to be copied.
3. Select the "Copy to trace..." button for the trace to which the settings are to be applied.


The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next sweep.

4.3.4 How to Export Trace Data and Numerical Results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each sweep point the measured trace position and value are output. The file is stored with a `.DAT` extension. For details on the storage format see [Chapter 4.3.6, "Reference: ASCII File Export Format"](#), on page 347.

To export trace data and table results

Trace data can be exported either from the "Trace" menu, or from the "Save/Recall" menu.

1. Press the TRACE key, then select the "Trace Config" softkey and switch to the "Trace/Data Export" tab.
Or:
Select the  "Save" icon in the toolbar, then select the "Export" softkey.
2. Select the "Export Config" softkey to configure the export settings.

- a) Select "Export all Traces and all Table Results" to export all available measurement result data for the current application, or select a specific "Trace to Export".
 - b) Optionally, select the "Include Instrument Measurement Settings" option to insert additional information in the export file header.
 - c) If necessary, change the decimal separator to be used for the ASCII export file.
3. Select the "Export Trace to ASCII file" button.
 4. In the file selection dialog box, select the storage location and file name for the export file.
 5. Select "Save" to close the dialog box and export the data to the file.

4.3.5 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 4.3.2.4, "Spectrogram Settings"](#), on page 337.

The remote commands required to perform these tasks are described in [Chapter 5.9.2, "Remote Commands to Configure Traces"](#), on page 616.

The following tasks are described here:

- ["To display a spectrogram"](#) on page 343
- ["To remove the spectrogram display"](#) on page 344
- ["To set a marker in the spectrogram"](#) on page 344
- ["To configure a spectrogram"](#) on page 344
- ["To select a color scheme"](#) on page 345
- ["To set the value range graphically using the color range sliders"](#) on page 345
- ["To set the value range of the color map numerically"](#) on page 346
- ["To set the color curve shape graphically using the slider"](#) on page 347
- ["To set the color curve shape numerically"](#) on page 347

To display a spectrogram

1. In the "Overview", select "Display", then drag the evaluation type "Spectrogram" to the diagram area.
Alternatively:
 - a) Select the TRACE key and then the "Spectrogram Config" softkey.
 - b) Toggle "Spectrogram" to "ON".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using RUN SINGLE or RUN CONT.
The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific time frame:

- a) Stop the continuous measurement or wait until the single sweep is completed.
- b) Select the frame number in the diagram footer.
- c) Enter the required frame number in the edit dialog box.
Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

To remove the spectrogram display

1. Select the TRACE key and then the "Spectrogram Config" softkey.
2. Toggle "Spectrogram" to "OFF".

The standard spectrum display is restored.

To set a marker in the spectrogram

1. While a spectrogram is displayed, select the MARKER key.
2. Select a "Marker" softkey.
3. Enter the frequency or time (x-value) of the marker or delta marker.
4. Enter the frame number for which the marker is to be set, for example 0 for the current frame, or -2 for the second to last frame. Note that the frame number is always 0 or a negative value!

The marker is only visible in the spectrum diagram if it is defined for the currently selected frame. In the spectrogram result display all markers are visible that are positioned on a visible frame.

To configure a spectrogram

1. Configure the spectrogram frames:
 - a) Select the SWEEP key.
 - b) Select the "Sweep Config" softkey.
 - c) In the "Sweep/Average Count" field, define how many sweeps are to be analyzed to create a single frame.
 - d) In the "Frame Count" field, define how many frames are to be plotted during a single sweep measurement.
 - e) To include frames from previous sweeps in the analysis of the new frame (for "Max Hold", "Min Hold" and "Average" trace modes only), select "Continue Frame" = "ON".
2. Define how many frames are to be stored in total:
 - a) Select the TRACE key and then the "Spectrogram Config" softkey.
 - b) Select the "History Depth" softkey.
 - c) Enter the maximum number of frames to store.
3. Optionally, replace the frame number by a time stamp by toggling the "Timestamp" softkey to "On".

4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in [Chapter 4.3.5.1, "How to Configure the Color Mapping"](#), on page 345.

4.3.5.1 How to Configure the Color Mapping

The color display is highly configurable to adapt the spectrogram to your needs.

The settings for color mapping are defined in the "Color Mapping" dialog box. To display this dialog box, do one of the following:

- Select the color map in the window title bar of the Spectrogram result display.
- Select the "Color Mapping" softkey in the "Spectrogram" menu.

To select a color scheme

You can select which colors are assigned to the measured values.

- ▶ In the "Color Mapping" dialog box, select the option for the color scheme to be used.

Editing the value range of the color map

The distribution of the measured values is displayed as a histogram in the "Color Mapping" dialog box. To cover the entire measurement value range, make sure the first and last bar of the histogram are included.

To ignore noise in a spectrogram, for example, exclude the lower power levels from the histogram.



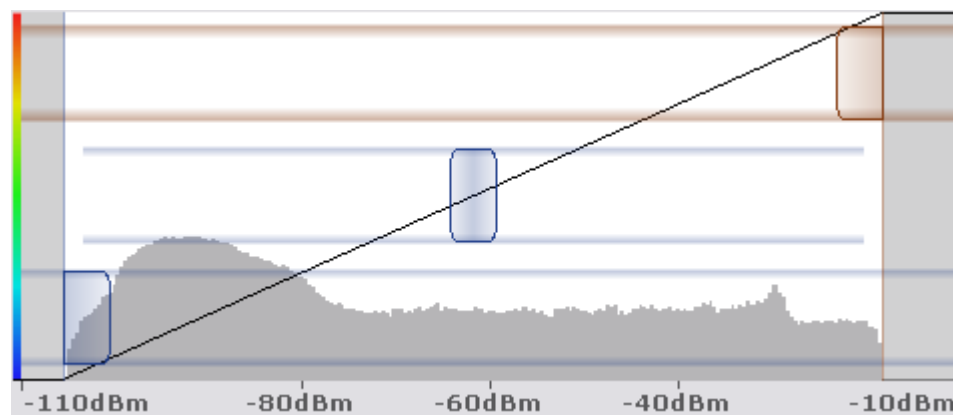
The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram, that means, the difference between the start and stop values must be at least 10%.

The value range of the color map can be set numerically or graphically.

To set the value range graphically using the color range sliders

1. Select and drag the bottom color curve slider (indicated by a gray box at the left of the color curve pane) to the lowest value you want to include in the color mapping.

2. Select and drag the top color curve slider (indicated by a gray box at the right of the color curve pane) to the highest value you want to include in the color mapping.



To set the value range of the color map numerically

1. In the "Start" field, enter the percentage from the left border of the histogram that marks the beginning of the value range.
2. In the "Stop" field, enter the percentage from the right border of the histogram that marks the end of the value range.

Example:

The color map starts at -110 dBm and ends at -10 dBm (that is: a range of 100 dB). In order to suppress the noise, you only want the color map to start at -90 dBm. Thus, you enter 10% in the "Start" field. The R&S 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.

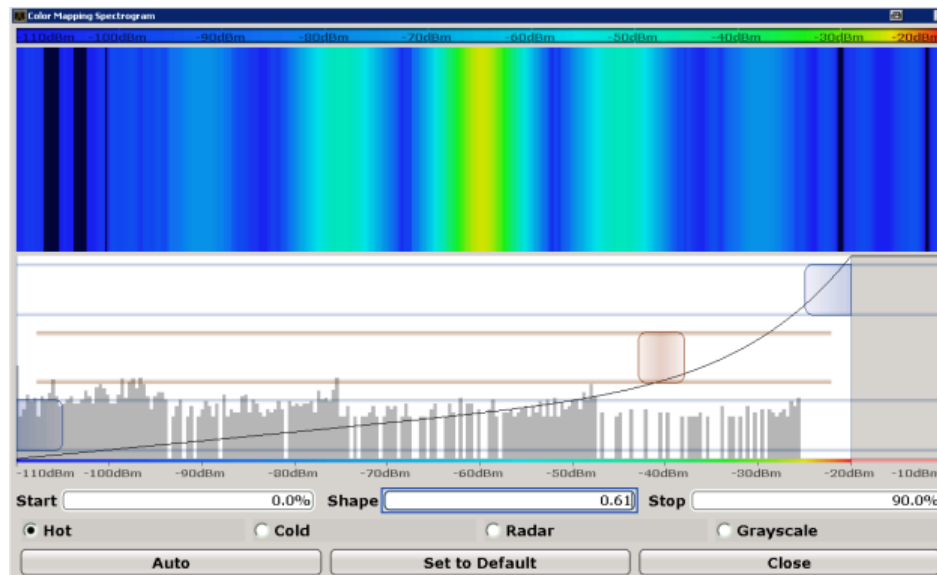
Editing the shape of the color curve

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

4.3.6 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 4.3.4, "How to Export Trace Data and Numerical Results"](#), on page 342).



For a description of the file formats for spectrum emission mask (SEM) measurement settings and results, see [Chapter 2.6.8, "Reference: SEM File Descriptions"](#), on page 136.

The file format for Spurious Emissions measurement results is described in [Chapter 2.7.6, "Reference: ASCII Export File Format \(Spurious\)"](#), on page 154.

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), followed by the measured data in one or several columns (depending on the measurement) which are also separated by a semicolon.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS-Excel. Different language versions of evaluation programs may require a different handling of the decimal point. Thus you can define the decimal separator to be used (decimal point or comma).

If the spectrogram display is selected when you select the "ASCII Trace Export" soft-key, 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 4-3: ASCII file format for trace export in the Spectrum application

File contents	Description
Header data	
Type;R&S ESW;	Instrument model
Version;1.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;	Operating mode
Preamplifier;OFF	Preamplifier status
Transducer; OFF	Transducer status
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Rf Att;20;dB	Input attenuation
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

File contents	Description
Ref Position;75;%	Position of reference level referred to diagram limits (0 % = lower edge)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Data section for individual window	
Window;1;Frequency Sweep	Window number and name
Trace 1;;	Selected trace
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASISPEAK
Values; 1001;	Number of measurement points
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 ..;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

4.3.7 Formats for Returned Values: ASCII Format and Binary Format

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

- ASCII Format (FORMat ASCII):

The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.

- Binary Format (FORMat REAL,32):
The data is stored as binary data (Definite Length Block Data according to IEEE 488.2), each measurement value being formatted in 32-Bit IEEE 754 Floating-Point-Format.

The schema of the result string is as follows:

#41024<value1><value2>...<value n> with

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



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

4.4 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.

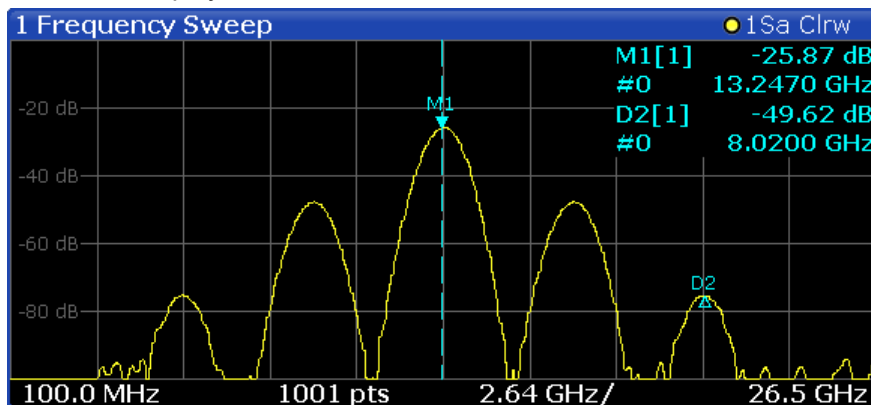
- [Basics on Markers and Marker Functions](#).....350
- [Marker Settings](#).....361
- [Marker Search Settings and Positioning Functions](#).....366
- [Marker Function Configuration](#).....372
- [How to Work With Markers](#).....382
- [Measurement Example: Measuring Harmonics Using Marker Functions](#).....385

4.4.1 Basics on Markers and Marker Functions

Some background knowledge on marker settings and functions is provided here for a better understanding of the required configuration settings.

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. R&S ESW provides 16 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- The easiest way to work with markers is using the touch screen. Simply drag the marker and drop it at the required position. When a marker label is selected, a vertical line is displayed which indicates the marker's current x-value.



- Alternatively, change the position of the selected marker using the rotary knob. By default, the marker is moved from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (General Marker Setting).
- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touch screen and hold your finger for about 2 seconds until the context menu is opened, then select the required entry.
- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To set individual markers very quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.

In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

- [Marker Types](#)..... 352
- [Activating Markers](#).....352
- [Marker Results](#)..... 352
- [Searching for Signal Peaks](#).....353
- [Performing a Highly Accurate Frequency Measurement \(Signal Count\)](#)..... 355
- [Defining a Fixed Reference Marker](#)..... 356

- [Measuring Noise Density](#)..... 356
- [Measuring Phase Noise](#)..... 357
- [Measuring Characteristic Bandwidths \(n dB Down Marker\)](#).....358
- [Measuring the Power in a Channel \(Band\)](#)..... 359
- [Demodulating Marker Values and Providing Audio Output](#).....360

4.4.1.1 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 can be assigned to individual markers. The availability of special marker functions depends on whether the measurement is performed in the frequency or time domain.

Temporary markers are used in addition to the markers and delta markers to analyze the measurement results for special marker functions. They disappear when the associated function is deactivated.

4.4.1.2 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.

4.4.1.3 Marker Results

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 (1 to 16)
- 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 [Chapter 4.4.1.9, "Measuring Characteristic Bandwidths \(n dB Down Marker\)"](#), on page 358.

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 4-4: 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

4.4.1.4 Searching for Signal Peaks

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, for example when a marker peak table is displayed, noise values may be detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

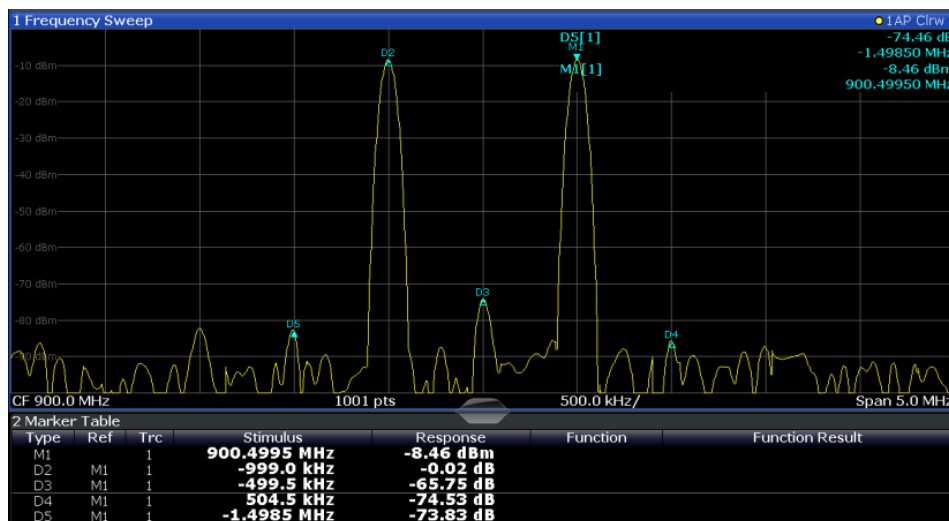


Figure 4-12: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	30 dB
2	29.85 dB
3	20 dB
4	10 dB
5	18 dB

In order to eliminate the smaller peaks M3, M4 and M5 in the example above, a peak excursion of at least 20 dB is required. In this case, the amplitude must rise at least 20 dB before falling again before a peak is detected.

Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

Automatic peak search

A peak search can be repeated automatically after each sweep in order to keep the maximum value as the reference point for a phase noise measurement. This is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

In the Spectrum application, a peak search can be repeated automatically after each sweep in order to keep the maximum value as the reference point for a phase noise measurement. This is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the maximum level can be determined by an initial peak search and then be used as a reference point for further measurement results.

4.4.1.5 Performing a Highly Accurate Frequency Measurement (Signal Count)

A normal marker determines the position of the point on the trace and indicates the signal frequency at this position. The trace, however, contains only a limited number of points. Depending on the selected span, each trace point may contain many measurement values. Thus, the frequency resolution of each trace point is limited (see also [Chapter 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274). Frequency resolution is further restricted by the RBW and sweep time settings.

In order to determine the frequency of a signal point accurately without changing the sweep settings, the R&S 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.

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 fre-

quency is determined with the desired resolution and then the sweep is allowed to continue.

Remote commands:

`CALCulate<n>:MARKer<m>:COUNT` on page 663

`CALCulate<n>:MARKer<m>:COUNT:RESolution` on page 665

4.4.1.6 Defining a Fixed Reference Marker

Access: "Overview" > "Analysis" > "Marker Functions" > "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.

Remote commands:

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed[:STATe]` on page 642

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPOINT:X` on page 641

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPOINT:Y` on page 641

4.4.1.7 Measuring Noise Density

Using the noise measurement marker function, the noise power density is measured at the position of the marker. In the time domain mode, all points of the trace are used to determine the noise power density. When measurements are performed in the frequency domain, two points to the right and left of the marker are used for the measurement to obtain a stable result.

Result display

Noise density is the noise referred to a bandwidth of 1 Hz. With logarithmic amplitude units (dBm, dBmV, dBm μ V, dB μ A), the noise power density is output in dBm/Hz, i.e. as level in 1 Hz bandwidth with reference to 1 mW. With linear amplitude units (V, A, W), the noise voltage density is analyzed in $\mu\text{V}/\sqrt{\text{Hz}}$, the noise current density in $\mu\text{A}/\sqrt{\text{Hz}}$ or 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 have to be made to obtain correct values:

- Detector: Sample or RMS
- Video bandwidth:
 - ≤ 0.1 resolution bandwidth with sample detector
 - ≥ 3 x resolution bandwidth with RMS detector
- Trace averaging:

In the default setting, the R&S ESW uses the sample detector for the noise function. With the sample detector, the trace can additionally be set to "Average" mode to stabilize the measured values. When the RMS detector is used, trace averaging should not be used since in this case it produces too low noise levels which cannot be corrected. Instead, the sweep time can be increased to obtain stable measurement results.

Correction factors

The R&S 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 a more stable noise display the adjacent (symmetric to the measurement frequency) points of the trace are averaged.
- For span > 0, the measured values are averaged versus time (after a sweep).



The R&S 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.

Remote commands:

`CALCulate<n>:MARKer<m>:FUNction:NOISe[:STATe]` on page 666

`CALCulate<n>:MARKer<m>:FUNction:NOISe:RESult?` on page 665

4.4.1.8 Measuring Phase Noise

Phase noise is unintentional modulation of a carrier; it creates frequencies next to the carrier frequency. A phase noise measurement consists of noise density measurements at defined offsets from the carrier; the results are given in relation to the carrier level (dBc). The phase noise marker function measures the noise power at the delta markers referred to 1 Hz bandwidth. Marker 1 is used as the reference for the phase noise measurement. By default, the current frequency and level of marker 1 are used as the fixed reference marker. However, a peak search can be started to use the current signal peak as the reference point, or a reference point can be defined manually.

Since the reference point is fixed, the reference level or the center frequency can be set so that the carrier is outside the displayed frequency range after phase noise measurement is started. Or a notch filter can be switched on to suppress the carrier.

Alternatively, the reference point can be determined automatically by a peak search after each sweep. This function can be used to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

The result of the phase noise measurement is the difference in level between the reference point and the noise power density. It is indicated as the function result of the phase noise marker 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 taken into account in the correction values used for the noise power measurement. To obtain stable results, two pixels on the right and the left of the delta marker position are taken for the measurement.

The procedure for determining the noise power is identical to the method used for the noise power measurement (see [Chapter 4.4.1.7, "Measuring Noise Density"](#), on page 356).

Remote commands:

`CALCulate<n>:MARKer<m>:FUNCTION:PNOise[:STATe]` on page 668

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise[:STATe]` on page 667

`CALCulate<n>:MARKer<m>:FUNCTION:PNOise:RESult?` on page 668

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:RESult?` on page 667

4.4.1.9 Measuring Characteristic Bandwidths (n dB Down Marker)

Access: "Overview" > "Analysis" > "Marker Functions" > "n dB Down"

When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. In order to measure this bandwidth, you could use several markers and delta markers and determine the bandwidth manually. However, using the n dB down marker function makes the task very simple and quick.

The n dB down marker function uses the current value of marker 1 as the reference point. It activates two temporary markers T1 and T2 located on the signal, whose level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but it can be changed.

If a positive offset is entered, the markers T1 and T2 are placed below the active reference point. If a negative value is entered (for example for notch filter measurements), the markers T1 and T2 are placed above the active reference point.

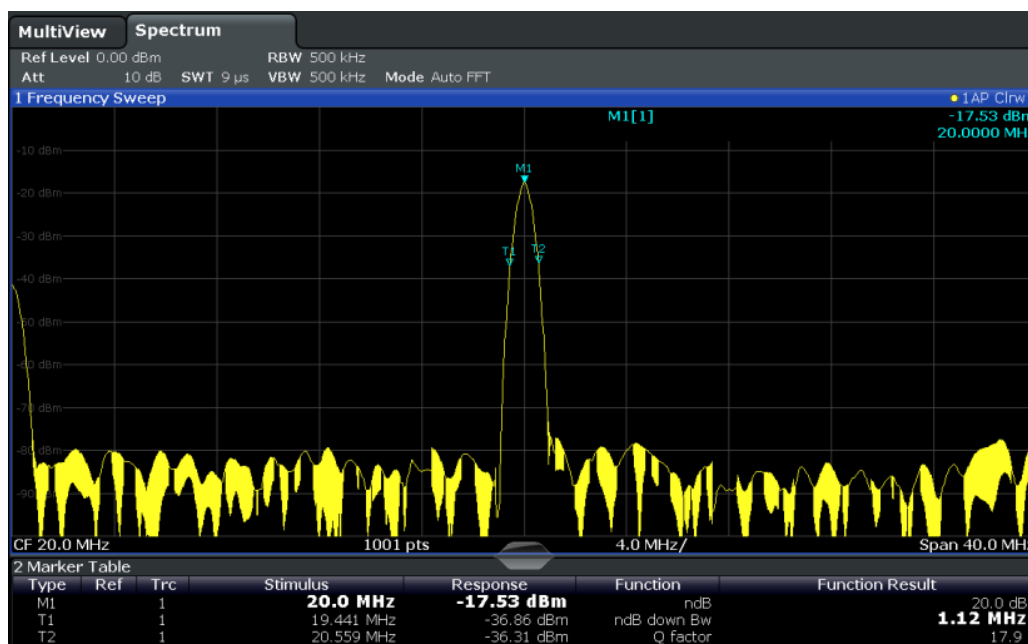


Figure 4-13: n dB down marker function

The following marker function results are displayed:

Table 4-5: n dB down marker function results

Label	Description
M1	Current position and level of marker 1
ndB	Offset value (n dB down)
ndB down Bw / PWid	Determined bandwidth or pulse width (zero span) at the offset
Q-factor	Quality factor of the determined bandwidth (characteristic of damping or resonance)
T1, T2	Current position and level of the temporary markers

If the required position for the temporary markers cannot be determined uniquely, for example due to noise, dashes are displayed as a result.

Remote commands:

`CALCulate<n>:MARKer<m>:FUNCTion:NDBDown:STATe` on page 671

`CALCulate<n>:MARKer<m>:FUNCTion:NDBDown:RESult?` on page 670

4.4.1.10 Measuring the Power in a Channel (Band)

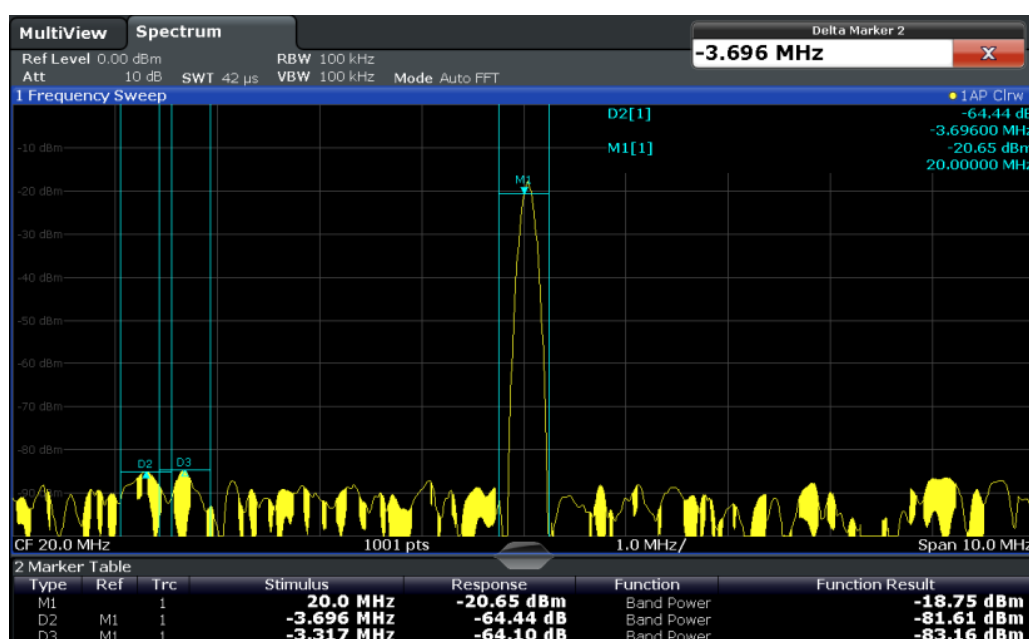
To determine the noise power in a transmission channel, you could use a noise marker and multiply the result with the channel bandwidth. However, the results would only be accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the marker table for each band power marker.



Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "-" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



All markers can be defined as band power markers, each with a different span. When a band power marker is activated, if no marker is active yet, marker 1 is activated. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are deactivated).

If the detector mode for the marker trace is set to "Auto", the RMS detector is used.

Remote commands:

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWER[:STATe]` on page 675

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWER:RESult?` on page 673

4.4.1.11 Demodulating Marker Values and Providing Audio Output

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.

This function is not available for Spectrum Emission Mask measurements.

The sweep stops at the frequency determined by marker 1 for the selected time and the RF signal is demodulated in a bandwidth that corresponds to the RBW. Alternatively, demodulation can be activated continuously, i.e. audio output occurs regardless of the marker position and the marker stop time. For measurements in the time domain (zero span), demodulation is always continuous.

Optionally, a 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 294) 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.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTion:DEModulation[:STATe]` on page 676

4.4.2 Marker Settings

Marker settings can be configured via the MARKER menu or in the "Marker" dialog box.

To display the "Marker" dialog box, do one of the following:

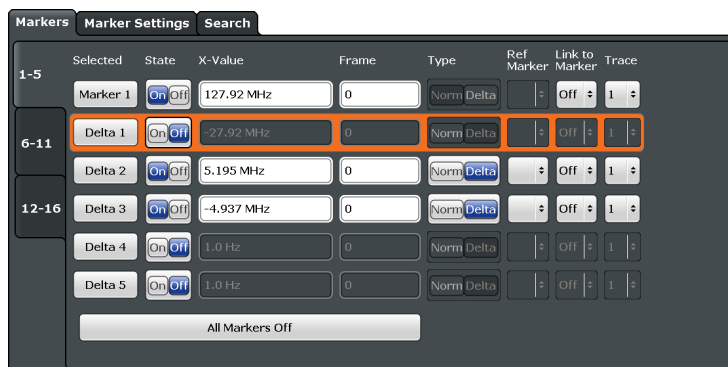
- Press the MKR key, then select the "Marker Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker" tab.

The remote commands required to define these settings are described in [Chapter 5.9.3, "Marker Usage"](#), on page 634.

- [Individual Marker Setup](#)..... 361
- [General Marker Settings](#)..... 364

4.4.2.1 Individual Marker Setup

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.



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

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Marker State..... 362

Marker Position (X-value)..... 362

Frame (Spectrogram only)..... 362

Marker Type..... 363

Reference Marker..... 363

Linking to Another Marker..... 363

Assigning the Marker to a Trace..... 364

Select Marker..... 364

All Markers Off..... 364

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 639

CALCulate<n>:DELTAmarker<m>[:STATe] on page 637

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 640

CALCulate<n>:DELTAmarker<m>:X on page 637

Frame (Spectrogram only)

Spectrogram frame the marker is assigned to.

Remote command:

[CALCulate<n>:MARKer<m>:SPECTrogram:FRAME](#) on page 639

[CALCulate<n>:DELTaMarker<m>:SPECTrogram:FRAME](#) on page 636

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 639

[CALCulate<n>:DELTaMarker<m>\[:STATe\]](#) on page 637

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 365), the reference point ("FXD") can also be selected instead of another marker.

Remote command:

[CALCulate<n>:DELTaMarker<m>:MREF](#) on page 636

Linking to Another Marker

Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:

[CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>](#) on page 638

[CALCulate<n>:DELTaMarker<m>:LINK:TO:MARKer<m>](#) on page 635

[CALCulate<n>:DELTaMarker<m>:LINK](#) on page 634

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 639

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 639

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 637

All Markers Off

Deactivates all markers in one step.

Remote command:

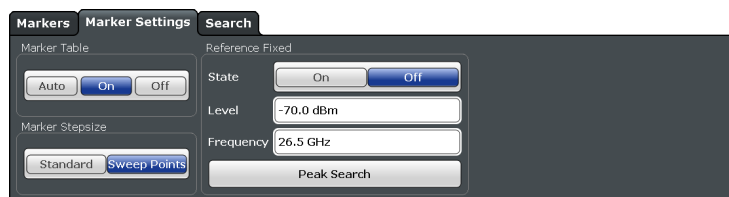
[CALCulate<n>:MARKer<m>:AOFF](#) on page 638

4.4.2.2 General Marker Settings

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

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

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



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Marker Table Display

Defines how the marker information is displayed.

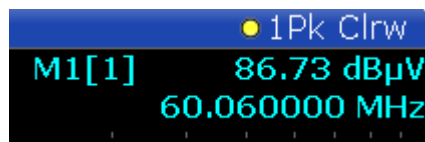
- "On" Displays the marker information in a table in a separate area beneath the diagram.
- "Off" Displays the marker information within the diagram area. No separate marker table is displayed.
- "Auto" (Default) Up to two markers are displayed in the diagram area. If more markers are active, the marker table is displayed automatically.

Remote command:

`DISPlay:MTABLE` on page 643

Marker Info

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



Remote command:

`DISPlay:MINFo[:STAT]` on page 643

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 642

Defining a Fixed Reference

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis.

When you set the "State" to "On", a vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value. The delta marker refers to the fixed reference marker.

If activated, the fixed reference marker ("FXD") can also be selected as a "Reference Marker" instead of another marker.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference marker.

Alternatively, a **Peak Search** can be performed to set the current maximum value of the trace assigned to marker 1 as the fixed reference marker.

Remote command:

- [CALCulate<n>:DELTamarker<m>:FUNction:FIXed\[:STATe\]](#) on page 642
- [CALCulate<n>:DELTamarker<m>:FUNction:FIXed:RPoint:Y](#) on page 641
- [CALCulate<n>:DELTamarker<m>:FUNction:FIXed:RPoint:X](#) on page 641
- [CALCulate<n>:DELTamarker<m>:FUNction:FIXed:RPoint:MAXimum\[:PEAK\]](#) on page 641

4.4.3 Marker Search Settings and Positioning Functions

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

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

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

For more information on searching for signal peaks see [Chapter 4.4.1.4, "Searching for Signal Peaks"](#), on page 353.

The remote commands required to define these settings are described in [Chapter 5.9.3.3, "Marker Search"](#), on page 644 and [Chapter 5.9.3.4, "Positioning Markers"](#), on page 647.

- [Marker Search Settings](#).....366
- [Marker Search Settings for Spectrograms](#).....369
- [Positioning Functions](#).....370

4.4.3.1 Marker Search Settings

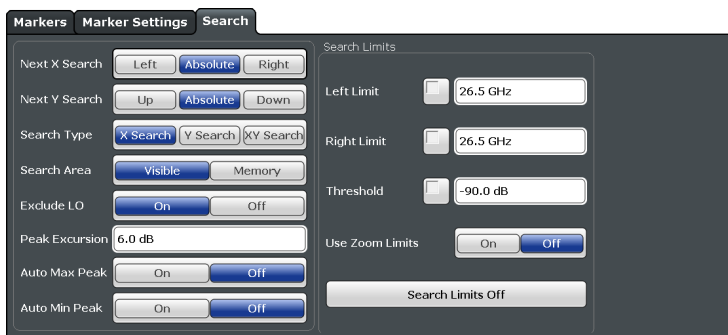
Markers are commonly used to determine peak values, i.e. maximum or minimum values, in the measured signal. Configuration settings allow you to influence the peak search results.



For Spectrograms, special marker settings are available, see [Chapter 4.4.3.2, "Marker Search Settings for Spectrograms"](#), on page 369.

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

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



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Search Mode for Next Peak

Selects the search mode for the next peak search.

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

Remote command:

Find a list of remote commands in [Chapter 5.9.3.4, "Positioning Markers"](#), on page 647.

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).
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 644

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see [Chapter 4.4.1.4, "Searching for Signal Peaks"](#), on page 353.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 644

Auto Max / 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 650

[CALCulate<n>:MARKer<m>:MINimum:AUTO](#) on page 651

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 354.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 646

[CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 645

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 645

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

Remote command:

[CALCulate<n>:THReshold](#) on page 646

Using Zoom Limits ← Search Limits

If activated, the peak search is restricted to the active zoom area defined for a single zoom (see ["Single Zoom"](#) on page 314).

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM\[:STATe\]](#) on page 646

Deactivating All Search Limits ← Search Limits

Deactivates the search range limits.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 646

[CALCulate<n>:THReshold:STATe](#) on page 647

4.4.3.2 Marker Search Settings for Spectrograms

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.

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

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

Functions for marker search in spectrograms described elsewhere:

- ["Exclude LO"](#) on page 367
- ["Peak Excursion"](#) on page 368
- ["Auto Max / Min Peak Search"](#) on page 368
- ["Search Limits \(Left / Right\)"](#) on page 97
- ["Search Threshold"](#) on page 368
- ["Using Zoom Limits"](#) on page 368
- ["Deactivating All Search Limits"](#) on page 97

Search Mode for Next Peak in X Direction	369
Search Mode for Next Peak in Y Direction	369
Marker Search Type	370
Marker Search Area	370

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 5.9.3.6, "Using Markers in Spectrograms"](#), on page 655.

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 5.9.3.6, "Using Markers in Spectrograms"](#), on page 655.

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 5.9.3.6, "Using Markers in Spectrograms"](#), on page 655.

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 656

[CALCulate<n>:DELTAmarker<m>:SPECTrogram:SARea](#) on page 660

4.4.3.3 Positioning Functions

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

These functions are available as softkeys in the "Marker To" menu, which is displayed when you press the MKR → key.

Peak Search.....	370
Search Next Peak.....	371
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Search Next Minimum.....	371
Center Frequency = Marker Frequency.....	371
Reference Level = Marker Level.....	371

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 651

[CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 648

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 650

[CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 651

[CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 650

[CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 648

[CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 648

[CALCulate<n>:DELTamarker<m>:MAXimum:LEFT](#) on page 647

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 653

[CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 649

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 652

[CALCulate<n>:MARKer<m>:MINimum:LEFT](#) on page 652

[CALCulate<n>:MARKer<m>:MINimum:RIGHT](#) on page 652

[CALCulate<n>:DELTamarker<m>:MINimum:NEXT](#) on page 649

[CALCulate<n>:DELTamarker<m>:MINimum:LEFT](#) on page 649

[CALCulate<n>:DELTamarker<m>:MINimum:RIGHT](#) on page 649

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 585

Reference Level = Marker Level

Sets the reference level to the selected marker level.

Remote command:

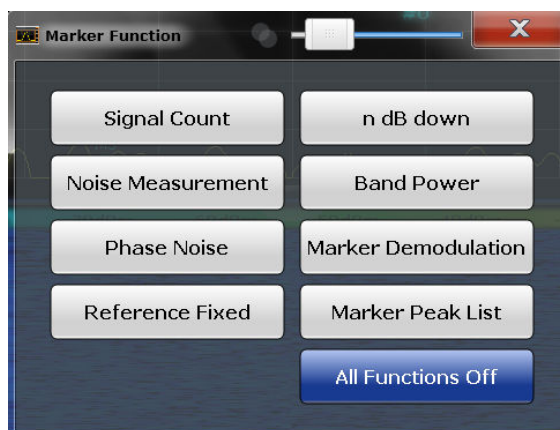
[CALCulate<n>:MARKer<m>:FUNCTION:REFERENCE](#) on page 588

4.4.4 Marker Function Configuration

Special marker functions can be selected via the "Marker Function" dialog box.

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

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



The remote commands required to define these settings are described in [Chapter 5.9.3.7, "Marker Functions"](#), on page 663.

• Precise Frequency (Signal Count) Marker	372
• Noise Measurement Marker	373
• Phase Noise Measurement Marker	375
• n dB Down Marker	376
• Reference Fixed	377
• Band Power Marker	377
• Marker Demodulation	379
• Marker Peak List Configuration	381
• Deactivating All Marker Functions	382

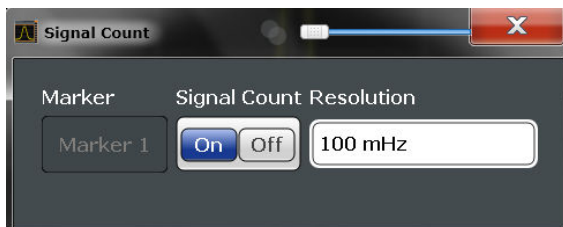
4.4.4.1 Precise Frequency (Signal Count) Marker

A special marker can be used to determine a particular frequency or time in a measured signal very accurately. Signal counters are configured in the "Signal Count Config" dialog box.

To display the "Signal Count Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.

- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.



For details see [Chapter 4.4.1.5, "Performing a Highly Accurate Frequency Measurement \(Signal Count\)"](#), on page 355. A measurement example is described in [Chapter 2.2.2.2, "Measuring the Signal Frequency Using the Signal Counter"](#), on page 23.



Signal counters are not available for measurements on I/Q-based data.

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Resolution	373

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 663

[CALCulate<n>:MARKer<m>:COUNT:FREQuency?](#) on page 664

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 665

4.4.4.2 Noise Measurement Marker

For each of the 16 markers noise measurement can be activated. Noise measurement markers are configured in the "Noise Measurement Config" dialog box, using the "Noise Measurement" function.

The individual marker settings correspond to those defined in the "Marker" dialog box (see [Chapter 4.4.2.1, "Individual Marker Setup"](#), on page 361). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Noise Measurement Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.

- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.



For details see [Chapter 4.4.1.7, "Measuring Noise Density"](#), on page 356.

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Marker Type	374
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Switching All Noise Measurements Off	375

Marker State

Activates or deactivates the marker in the diagram.

Remote command:

[CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 639

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 637

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 639

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 637

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 4.4.1.7, "Measuring Noise Density"](#), on page 356.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe\[:STATE\]](#) on page 666

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe:RESult?](#) on page 665

Switching All Noise Measurements Off

Deactivates noise measurement for all markers.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe\[:STATE\]](#) on page 666

4.4.4.3 Phase Noise Measurement Marker

Access: "Overview" > "Analysis" > "Marker Functions" > "Phase Noise" > "Phase Noise Config"

For each of the 16 markers phase noise measurement can be activated.

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.



For more information see [Chapter 4.4.1.8, "Measuring Phase Noise"](#), on page 357.

[Phase Noise Measurement State](#)..... 375

[Defining a Reference Point](#)..... 376

[Switching All Phase Noise Measurements Off](#)..... 376

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 667

[CALCulate<n>:DELTamarker<m>:FUNCTION:PNOise:RESult?](#) on page 667

Defining a Reference Point

Instead of using marker 1 as the reference marker, a fixed reference marker can be defined for phase noise measurement.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

Alternatively, a **Peak Search** can be performed to set the maximum value of the selected trace as the reference point.

If "Automatic Peak Search" is activated, a peak search is started automatically after each sweep and the result is used as the reference point.

Remote command:

- [CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPOINT:Y](#) on page 641
- [CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPOINT:X](#) on page 641
- [CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPOINT:MAXimum\[:PEAK\]](#) on page 641
- [CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:AUTO](#) on page 666

Switching All Phase Noise Measurements Off

Deactivates phase noise measurement for all markers.

Remote command:

- [CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise\[:STATE\]](#) on page 667

4.4.4.4 n dB Down Marker

Access: "Overview" > "Analysis" > "Marker Functions" > "n dB down" > "n dB Down Config"

Access: "Overview" > "Analysis" > "Marker Functions" > "n dB down" > "n dB down Config"

A special marker can be defined to determine a characteristic bandwidth or time span in a measured signal.



For details see [Chapter 4.4.1.9, "Measuring Characteristic Bandwidths \(n dB Down Marker\)"](#), on page 358.

[n dB down Marker State](#).....376

[n dB down Delta Value](#).....377

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 671
- [CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:RESULT?](#) on page 670

n dB down Delta Value

Defines the delta level from the reference marker 1 used to determine the bandwidth or time span.

Remote command:

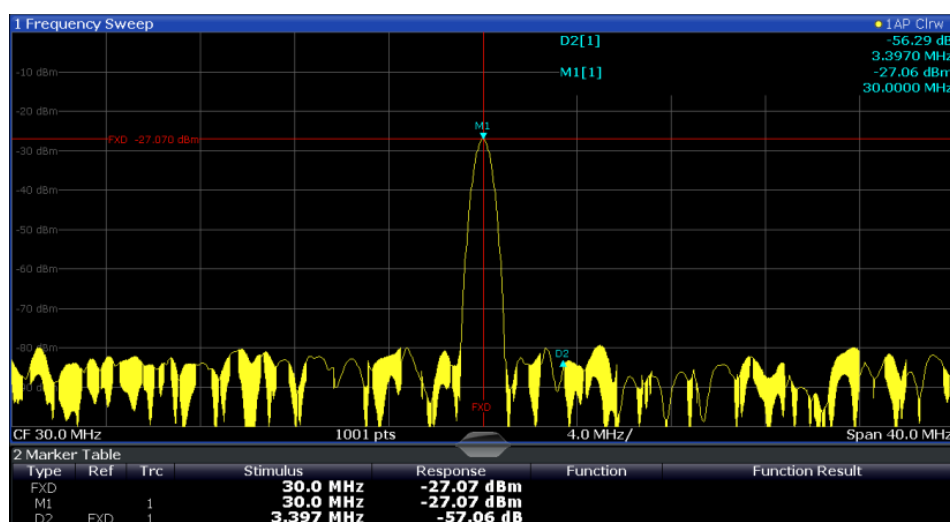
`CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:FREQuency?` on page 669

`CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:TIME?` on page 671

4.4.4.5 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.

For more information see [Chapter 4.4.1.6, "Defining a Fixed Reference Marker"](#), on page 356.

4.4.4.6 Band Power Marker

Access: "Overview" > "Analysis" > "Marker Functions" > "Band Power" > "Band Power Config"

For each of the 16 markers band power measurement can be activated.

The individual marker settings correspond to those defined in the "Marker" dialog box (see [Chapter 4.4.2.1, "Individual Marker Setup"](#), on page 361). 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.



For more information see [Chapter 4.4.1.10, "Measuring the Power in a Channel \(Band\)"](#), on page 359.

Band Power Measurement State	378
Span	378
Power Mode	378
Switching All Band Power Measurements Off	379

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 4.4.1.10, "Measuring the Power in a Channel \(Band\)"](#), on page 359.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:BPOWer\[:STATe\]](#) on page 675

[CALCulate<n>:DELTaMarker<m>:FUNCTION:BPOWer\[:STATe\]](#) on page 673

Span

Defines the span (band) around the marker for which the power is measured. The span is indicated by lines in the diagram.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:BPOWer:SPAN](#) on page 674

[CALCulate<n>:DELTaMarker<m>:FUNCTION:BPOWer:SPAN](#) on page 673

Power Mode

Defines the mode of the power measurement result.

"Power" The result is an absolute power level. The power unit depends on the [Unit](#) setting.

"Density" The result is a power level in relation to the bandwidth, displayed in dBm/Hz.

Remote command:

CALCulate<n>:MARKer<m>:FUNction:BPowEr:MODE on page 674

CALCulate<n>:DELTAmarker<m>:FUNction:BPowEr:MODE on page 672

Switching All Band Power Measurements Off

Deactivates band power measurement for all markers.

Remote command:

CALCulate<n>:MARKer<m>:FUNction:BPowEr[:STATe] on page 675

CALCulate<n>:DELTAmarker<m>:FUNction:BPowEr[:STATe] on page 673

4.4.4.7 Marker Demodulation

A special marker can be used to demodulate the signal at a particular position and send the result to the audio output. Marker Demodulation is configured in the "Marker Demod Config" dialog box, using the "Marker Demodulation" function.

To display the "Marker Demod Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Marker Demodulation" button. Select the "Marker Demod Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Marker Demodulation" button. Select the "Marker Demod Config" softkey.



Marker demodulation is unavailable

- for Spectrum Emission Mask measurements
- for measurements on I/Q-based data

For details see [Chapter 4.4.1.11, "Demodulating Marker Values and Providing Audio Output"](#), on page 360.

[Marker Demodulation State](#)..... 380

[Continuous Demodulation](#)..... 380

[Marker Stop Time](#)..... 380

Modulation.....	380
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Squelch level.....	380

Marker Demodulation State

Activates or deactivates the demodulation output.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation[:STATe]` on page 676

Continuous Demodulation

If activated, the signal is demodulated continuously (not only at the marker position) and sent to the audio output. This allows you to monitor the frequency range acoustically (assuming the sweep time is long enough).

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTinuous`
on page 675

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.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation:HOLDoff` on page 675

Modulation

Defines the demodulation mode for output (AM/FM). The default setting is AM.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation:SELect` on page 676

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 294) 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.

Remote command:

`[SENSe:]DEMod:SQUelch[:STATe]` on page 677

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 676

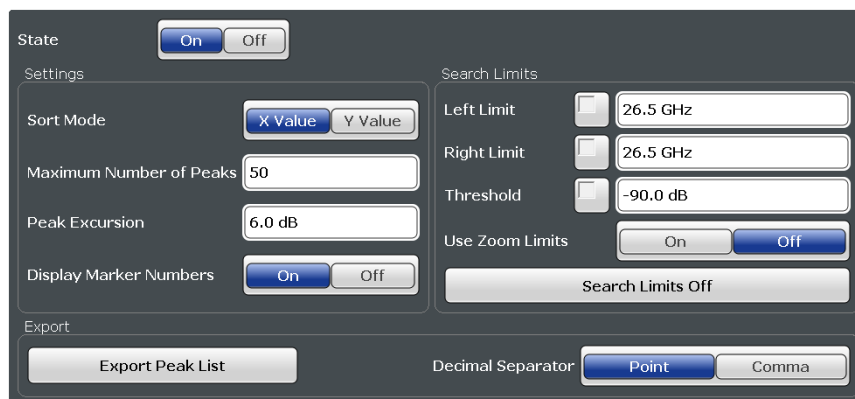
4.4.4.8 Marker Peak List Configuration

Access: "Overview" > "Analysis" > "Marker" > "Peak List"

The marker peak list provides an overview of all marker peaks in the measurement. You can define search and sort criteria to influence the results of the analysis. The general marker search settings also apply to the marker peak list.

For more information see [Chapter 4.4.1.4, "Searching for Signal Peaks"](#), on page 353 and [Chapter 4.4.3, "Marker Search Settings and Positioning Functions"](#), on page 366.

The individual marker settings correspond to those defined in the "Marker" dialog box (see [Chapter 4.4.2, "Marker Settings"](#), on page 361). 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.



Peak List State	381
Sort Mode	381
Maximum Number of Peaks	382
Peak Excursion	382
Displaying Marker Numbers	382
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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 679

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 679

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 679

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see [Chapter 4.4.1.4, "Searching for Signal Peaks"](#), on page 353.

Remote command:

`CALCulate<n>:MARKer<m>:PEXCursion` on page 644

Displaying Marker Numbers

By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks the marker numbers may decrease readability; in this case, deactivate the marker number display.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:ANNOtation:LABel[:STATe]` on page 677

Exporting the Peak List

The peak list can be exported to an ASCII file (.DAT) for analysis in an external application.

Remote command:

`MMEMory:STORe<n>:PEAK` on page 680

`FORMat:DEXPort:DSEParator` on page 626

4.4.4.9 Deactivating All Marker Functions

Access: "Overview" > "Analysis" > "Marker Functions" > "All Functions Off"

All special marker functions can be deactivated in one step.

4.4.5 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](#)..... 383
- [How to Use a Fixed Reference Marker](#)..... 383
- [How to Export a Peak List](#)..... 384
- [How to Output the Demodulated Signal Accoustically](#)..... 384

4.4.5.1 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 4.4, "Marker Usage"](#), on page 350.

The remote commands required to perform these tasks are described in [Chapter 5.9.3, "Marker Usage"](#), on page 634.

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing the PEAK SEARCH key.
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
 - a) Press the MKR -> key.
 - b) Select the "Next Peak" or "Next Min" key.
 - c) If necessary, change the search settings by selecting the "Search Config" softkey.
3. Center the display around the determined signal point by setting the marker value to the center frequency. Select the "Center = Mkr Freq" softkey.
4. Determine the precise frequency of the signal point:
 - a) Select the "Select Marker Function" softkey.
 - b) Select the "Signal Count" button.
 - c) Select the "Signal Count Resolution" softkey.
 - d) Select the resolution depending on how precise the result needs to be.

4.4.5.2 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 the MKR FUNC key, then select the "Reference Fixed" marker function.
 - In the "Marker" dialog box, in the "Reference Fixed" area of the "Marker Config" tab, set the "State" to "On".

A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.

2. To move the fixed reference marker, do one of the following:

- Change the "Level" and "Frequency" of the reference point in the "Marker Config" tab of the "Marker" dialog box, . By default, the current peak value of trace 1 is set.
- Set the fixed reference marker to the current peak value by selecting the "Peak Search" button in the "Marker Config" tab of the "Marker" dialog box.
- Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

How to Assign a Fixed Reference Marker to Delta Markers

1. In the "Marker" dialog box, select the horizontal "Markers" tab.
2. For the active delta marker that is to refer to the fixed reference marker, select "FXD" from the "Ref. Marker" list.

The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

4.4.5.3 How to Export a Peak List

You can save the results of a marker peak list to an ASCII file.

1. Press the MKR FUNCT key.
2. Select the "Marker Peak List" softkey.
3. Configure the peak search and list settings as described in [Chapter 4.4.4.8, "Marker Peak List Configuration"](#), on page 381.
4. Set the marker peak list "State" to "On".
5. Press the RUN SINGLE key to perform a single sweep measurement and create a marker peak list.
6. Select the "Marker Peak List" softkey to display the "Marker Peak List" dialog box again.
7. If necessary, change the decimal separator to be used for the ASCII export file.
8. Select the "Export Peak List" button.
9. In the file selection dialog box, select the storage location and file name for the export file.
10. Select "Save" to close the dialog box and export the peak list data to the file.

4.4.5.4 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.

⚠ CAUTION**Risk of hearing damage**

To protect your hearing, make sure that the volume setting is not too high before putting on the headphones.

1. Set marker 1 to the signal level you want to monitor.
2. Press the MKR FUNCT key.
3. Select the "Select Marker Function" softkey.
4. Select the "Marker Demodulation" button.
5. Select the "Marker Demod Config" softkey.
The marker function results are determined immediately according to the default settings.
6. Define how long you want to hear the output signal when the marker value is reached by entering the duration in the "Marker Stop Time" field.
Alternatively, the audio signal can be output continuously, regardless of the marker value; in this case, set "Continuous Demodulation" to "On".
7. Select the modulation type (AM/FM/PM) of the signal.
8. To avoid listening to noise during continuous output, set "Squelch" to "On" and define the signal level below which the signal is ignored ("Squelch level").
9. Set "Marker Demodulation" to "On".
10. Plug your headphones into the PHONES connector on the front panel of the R&S ESW.
11. Adjust the volume using the rotary knob next to the PHONES connector.
During the next or currently running measurement, when the sweep reaches the marker position, the demodulated signal is output as an audio signal via the headphones for the given duration. Or, depending on the configuration, the demodulated signal is continuously output via the headphones, if the signal level exceeds the squelch level.

4.4.6 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 2.10, "Harmonic Distortion Measurement"](#), on page 175).

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

Frequency:	128 MHz
Level:	- 25 dBm

Procedure:

1. Preset the R&S ESW.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.

The R&S ESW displays the reference signal with a span of 100 kHz and resolution bandwidth of 1 kHz.

4. Switch on the marker by pressing the MKR key.
The marker is positioned on the trace maximum.
5. Set the measured signal frequency and the measured level as reference values:
 - a) Press the MKR FUNC key
 - b) Press the "Reference Fixed" softkey.

The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.

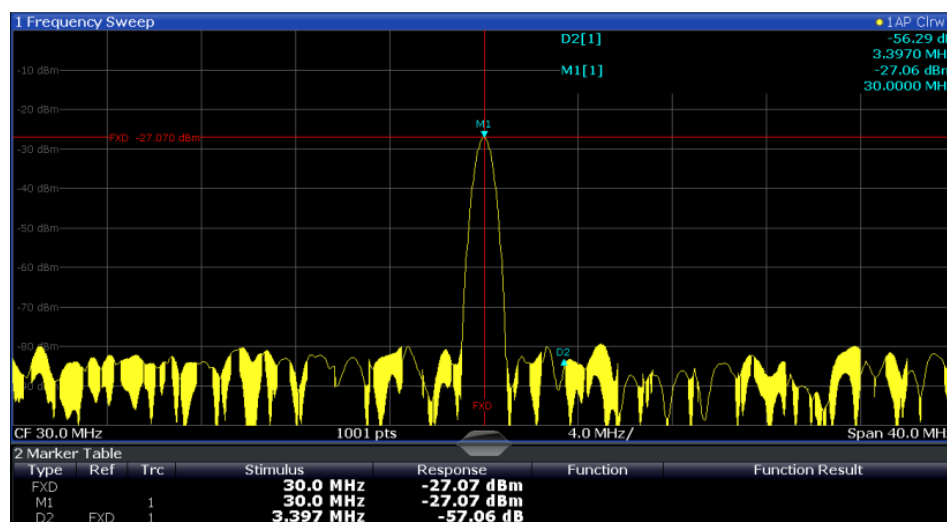


Figure 4-14: Fundamental wave and the frequency and level reference point

6. Make the step size for the center frequency correspond to the signal frequency: in the "Frequency" configuration dialog box, select "Center Frequency Stepsize = Marker".

The step size for the center frequency is now equal to the marker frequency.

7. Move the center frequency to the 2nd harmonic of the signal by pressing the UP (↑) key.

The center frequency is set to the 2nd harmonic.

8. Place the delta marker on the 2nd harmonic: in the "Marker To" menu, select the "Peak" softkey.

The delta marker moves to the maximum of the 2nd harmonic. The displayed level result is relative to the reference point level (= fundamental wave level).

The other harmonics are measured by repeating steps [step 7](#) and [step 8](#), with the center frequency being incremented or decremented in steps of 128 MHz using the UP or DOWN keys.

4.5 Display and Limit Lines

Display and limit lines help you analyze a measurement trace.

• Basics on Display Lines	387
• Basics on Limit Lines	388
• Settings and Functions for Display and Limit Lines	392
• How to Work with Display and Limit Lines	398

4.5.1 Basics on Display Lines

Display lines help you analyze a trace – as do markers. The function of a display line is comparable to that of a ruler that can be shifted on the trace in order to mark absolute values. They are used exclusively to visually mark relevant frequencies or points in time (zero span), as well as constant level values. It is not possible to check automatically whether the points are below or above the marked level values - use limit lines for that task (see [Chapter 4.5.2, "Basics on Limit Lines"](#), on page 388).

Two different types of display lines are provided:

- Two horizontal level lines for marking levels – Display Line 1 and 2
The level lines are continuous horizontal lines across the entire width of a diagram and can be shifted in y direction.
- Two vertical frequency or time lines for marking frequencies or points in time – Frequency/Time Line 1 and 2
The frequency or time lines are continuous vertical lines across the entire height of the diagram and can be shifted in x direction.

Lables

Each line is identified by one of the following abbreviations in the diagrams:

- D1: Display Line 1
- D2: Display Line 2
- F1: Frequency Line 1

- F2: Frequency Line 2
- T1: Time Line 1
- T2: Time Line 2

4.5.2 Basics on Limit Lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are allowed from a device under test (DUT). When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a time slot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The R&S 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.

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 4-15: 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.

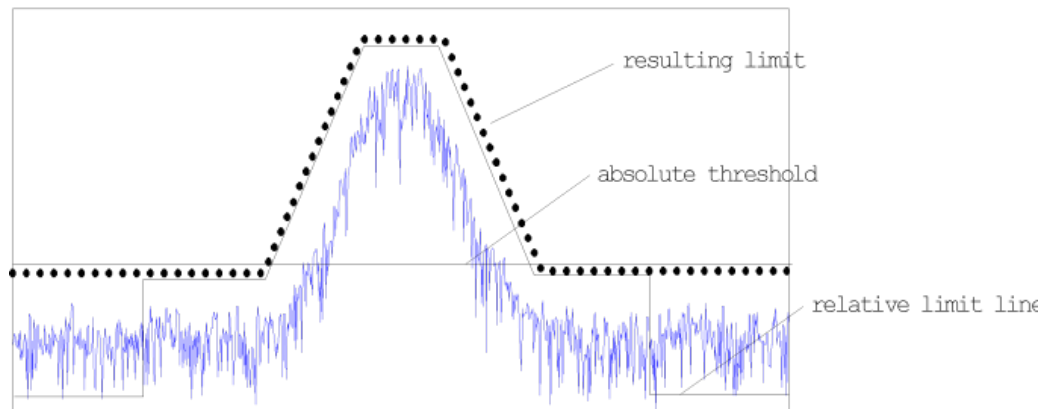
To check the signal for maximum levels you must define an **upper limit**, whereas to check the signal for minimum levels you must define a **lower limit**.

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.

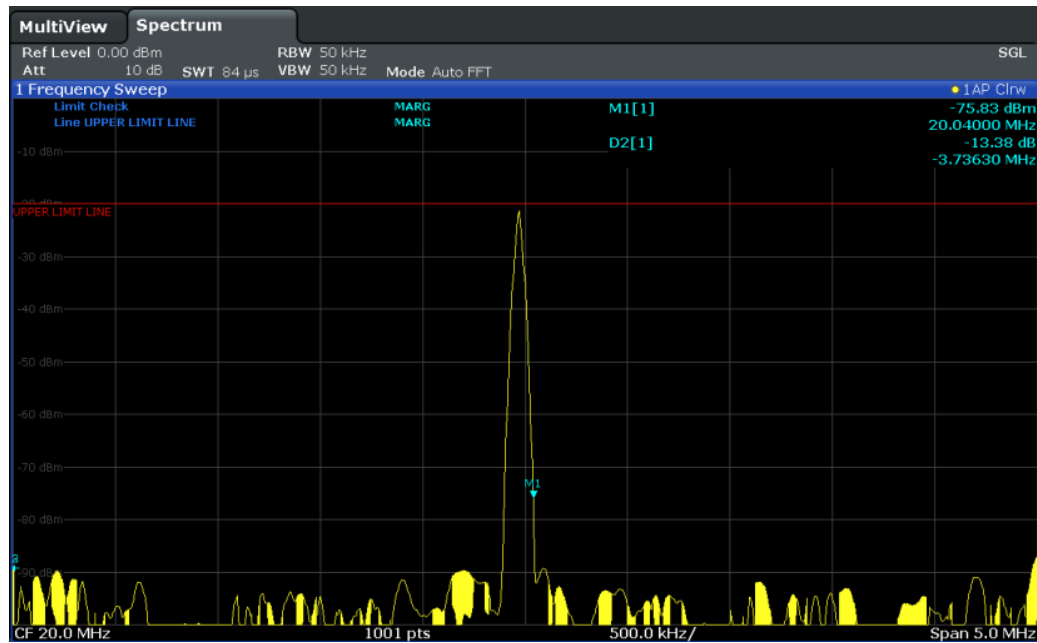


Figure 4-16: Margin violation for limit check

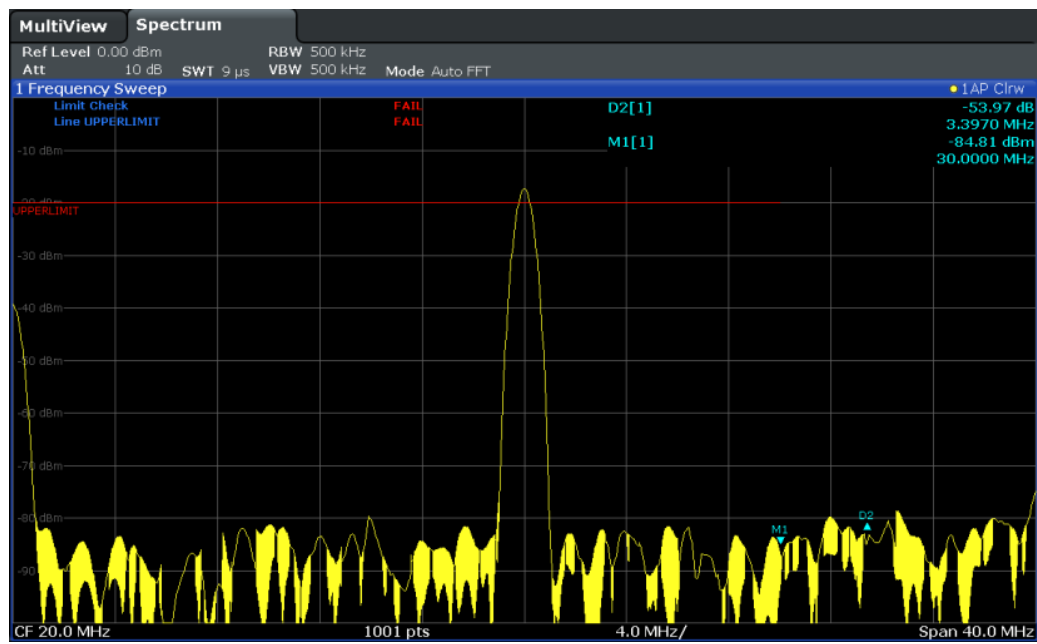


Figure 4-17: Limit violation for limit check



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".

4.5.3 Settings and Functions for Display and Limit Lines

For remote operation, see [Chapter 5.9.4, "Lines"](#), on page 681 .

- [Display Line Settings](#).....392
- [Limit Line Settings and Functions](#)..... 393

4.5.3.1 Display Line Settings

Access: "Overview" > "Analysis" > "Lines" > "Display Lines"

Two vertical and two horizontal lines can be defined in the display.



- [Vertical Line 1/2](#)..... 392
- [Horizontal Line 1/2](#)..... 392

Vertical Line 1/2

Activates a vertical display line (F1/F2 or T1/T2) in the diagram at the specified frequency or point in time, depending on the frequency span.

Remote command:

- [CALCulate<n>:FLINE<k>](#) on page 682
- [CALCulate<n>:FLINE<k>](#) on page 682
- [CALCulate<n>:TLINE<k>](#) on page 682
- [CALCulate<n>:TLINE<k>](#) on page 682

Horizontal Line 1/2

Activates a horizontal display line (D1/D2) in the diagram at the specified level.

Remote command:

- [CALCulate<n>:DLINE<k>](#) on page 681
- [CALCulate<n>:DLINE<k>](#) on page 681

4.5.3.2 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.



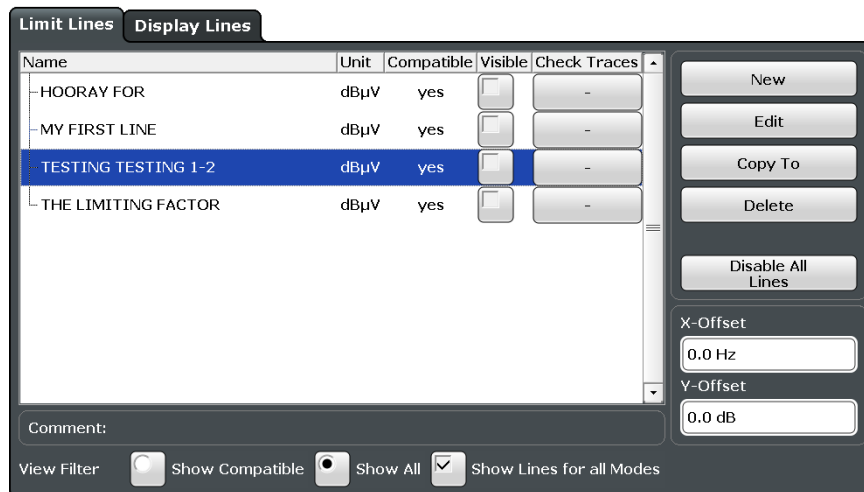
Stored limit line settings

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](#).....393
- [Limit Line Details](#).....395

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 395.

For more basic information on limit lines see [Chapter 4.5.2, "Basics on Limit Lines"](#), on page 388.

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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 388.

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<k>:LOWer:STATe` on page 690

`CALCulate<n>:LIMit<k>:UPPer:STATe` on page 695

`CALCulate<n>:LIMit<k>:ACTive?` on page 684

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<k>:TRACe<t>:CHECK` on page 692

Comment

An optional description of the limit line.

Included Lines in Overview (View Filter)

Defines which of the stored lines are included in the overview.

"Show compatible"	Only compatible lines Whether a line is compatible or not is indicated in the Compatibility setting.
"Show all"	All stored limit lines with the file extension <code>.LIN</code> in the <code>limits</code> subfolder of the main installation folder (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<k>:CONTrol:OFFSet](#) on page 686

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<k>:LOWer:OFFSet](#) on page 689

[CALCulate<n>:LIMit<k>:UPPer:OFFSet](#) on page 694

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<k>:COPY](#) on page 687

Delete Line

Delete the selected limit line configuration.

Remote command:

[CALCulate<n>:LIMit<k>:DELeTe](#) on page 687

Disable All Lines

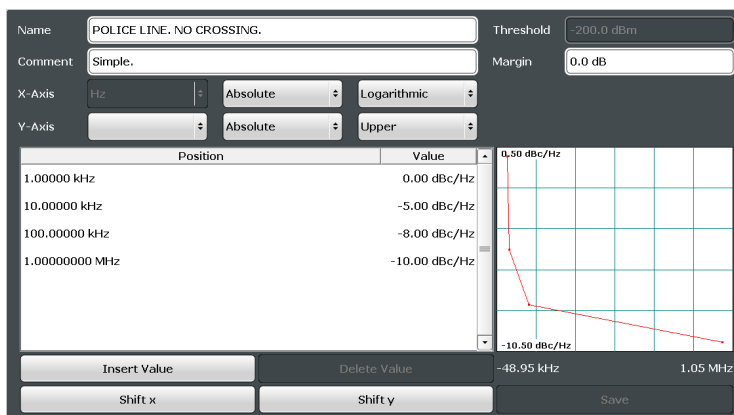
Disable all limit lines in one step.

Remote command:

[CALCulate<n>:LIMit<k>:STATe](#) on page 691

Limit Line Details

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines" > "New" / "Edit" / "Copy To"



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 Margin..... 396
 X-Axis..... 397
 Y-Axis..... 397
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 Shift x..... 398
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 Save..... 398

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<k>:NAME on page 691

Comment

Defines an optional comment for the limit line. The text may contain up to 40 characters.

Remote command:

CALCulate<n>:LIMit<k>:COMMeNt on page 684

Threshold

Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see "Thresholds" on page 389.

Remote command:

CALCulate<n>:LIMit<k>:LOWer:THReshold on page 690

CALCulate<n>:LIMit<k>:UPPer:THReshold on page 695

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 389.

Remote command:

[CALCulate<n>:LIMit<k>:LOWer:MARGin](#) on page 688

[CALCulate<n>:LIMit<k>:UPPer:MARGin](#) on page 693

X-Axis

Describes the horizontal axis on which the data points of the limit line are defined.

Includes the following settings:

- Domain:
 - "Hz": for frequency domain
 - "s": for time domain
- Scaling mode: absolute or relative (Hz/s/%) values
For relative values, the frequencies are referred to the currently set center frequency. In the zero span mode, the left boundary of the diagram is used as the reference.
- Scaling: linear or logarithmic

Remote command:

[CALCulate<n>:LIMit<k>:LOWer:SPACing](#) on page 690

[CALCulate<n>:LIMit<k>:UPPer:SPACing](#) on page 695

[CALCulate<n>:LIMit<k>:LOWer:MODE](#) on page 689

[CALCulate<n>:LIMit<k>:UPPer:MODE](#) on page 694

[CALCulate<n>:LIMit<k>:CONTrol:DOMain](#) on page 685

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<k>:UNIT](#) on page 692

[CALCulate<n>:LIMit<k>:LOWer:SPACing](#) on page 690

[CALCulate<n>:LIMit<k>:UPPer:SPACing](#) on page 695

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<k>:CONTrol\[:DATA\]](#) on page 685

[CALCulate<n>:LIMit<k>:LOWer\[:DATA\]](#) on page 688

[CALCulate<n>:LIMit<k>:UPPer\[:DATA\]](#) on page 693

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 395).

Remote command:

`CALCulate<n>:LIMit<k>:CONTRol:SHIFt` on page 686

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 395).

Remote command:

`CALCulate<n>:LIMit<k>:LOWer:SHIFt` on page 689

`CALCulate<n>:LIMit<k>:UPPer:SHIFt` on page 694

Save

Saves the currently edited limit line under the name defined in the "Name" field.

4.5.4 How to Work with Display and Limit Lines

Step-by-step instructions on configuring display and limit lines are provided here. For details on individual functions and settings see [Chapter 4.5.3, "Settings and Functions for Display and Limit Lines"](#), on page 392.

For remote operation, see [Chapter 5.9.4, "Lines"](#), on page 681.

4.5.4.1 Defining Display Lines

1. Display lines are configured in the "Lines Config" dialog box. To display this dialog box, press the LINES key and then "Lines Config".
2. Select the "Display Lines" tab.
3. To define a vertical line, select "Vertical Line 1" or 2 and enter the x-value at which the line is to be displayed.
To define a horizontal line, select "Horizontal Line 1" or 2 and enter the y-value at which the line is to be displayed.

4.5.4.2 Defining 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 2.6.4.2, "Limit Lines in SEM Measurements"](#), on page 106 and [Chapter 2.7.3.2, "Limit Lines in Spurious Measurements"](#), on page 146. It is strongly recommended that you define limits only via the "Sweep list" dialog for these measurements, not using the LINES key.

Any changes to the special limit lines are automatically overwritten when the sweep list settings are changed.

The following tasks are described here:

- ["How to find compatible limit lines"](#) on page 399
- ["How to activate and deactivate a limit check"](#) on page 399
- ["How to edit existing limit lines"](#) on page 399
- ["How to copy an existing limit line"](#) on page 400
- ["How to delete an existing limit line"](#) on page 400
- ["How to configure a new limit line"](#) on page 400
- ["How to move the limit line vertically or horizontally"](#) on page 401

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 check" for it.
To deactivate all limit lines at once, select the "Disable All Lines" button.
The limit checks for the deactivated limit lines are stopped and the results are removed 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 the "Edit" button.

3. Edit the line configuration as described in ["How to configure a new limit line"](#) on page 400.
4. Save the new configuration by selecting the "Save" button.
If the limit line is active, the edited limit line is displayed in the diagram.

How to copy an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Copy To" button.
3. Define a new name to create a new limit with the same configuration as the source line.
4. Edit the line configuration as described in ["How to configure a new limit line"](#) on page 400.
5. Save the new configuration by selecting the "Save" button.
The new limit line is displayed in the overview and can be activated.

How to delete an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Delete" button.
3. Confirm the message.
The limit line and the results of the limit check are deleted.

How to configure a new limit line

1. In the "Line Config" dialog box, select the "New" button.
The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.
3. Define the x-axis configuration:
 - Time domain or frequency domain
 - Absolute or relative limits
 - Linear or logarithmic scaling
4. Define the y-axis configuration:
 - Level unit
 - Absolute or relative limits
 - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:
 - a) Select "Insert Value".
 - b) Define the x-value ("Position") and y-value ("Value") of the first data point.

- c) Select "Insert Value" again and define the second data point.
 - d) Repeat this to insert all other data points.
To insert a data point before an existing one, select the data point and then "Insert Value".
To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
To delete a data point, select the entry and then "Delete Value".
6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
 7. Optionally, define a "Margin" at a fixed distance to the limit line.
The margin must be within the valid value range and is not displayed in the diagram or preview area.
 8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.
 9. Save the new configuration by selecting the "Save" button.
The new limit line is displayed in the overview and can be activated.

How to move the limit line vertically or horizontally

A configured limit line can easily be moved vertically or horizontally. Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally.

1. In the "Line Config" dialog box, select the limit line.
2. To shift the complete limit line parallel in the horizontal direction, select the "X-Offset" button and enter an offset value.
To shift the complete limit line parallel in the vertical direction, select the "Y-Offset" button and enter an offset value.
3. To shift the individual data points of a limit line by a fixed value (all at once):
 - a) Select the "Edit" button.
 - b) In the "Edit Limit Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
 - c) Save the shifted data points by selecting the "Save" button.

If activated, the limit line is shifted in the diagram.

5 Remote Control Commands for the Spectrum Application

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5.1 Introduction

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

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

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

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



Remote command examples

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

5.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
If not specified otherwise, commands can be used both for setting and for querying parameters.

If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.

- **Parameter usage**
If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
Parameters required only for setting are indicated as **Setting parameters**.
Parameters required only to refine a query are indicated as **Query parameters**.
Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S 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**
This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

5.1.2 Long and Short Form

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

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

Example:

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

5.1.3 Numeric Suffixes

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

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

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

Example:

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

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

5.1.4 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

5.1.5 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.

5.1.6 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

LAYout:ADD:WINDow Spectrum,LEFT,MTABLE

Parameters may have different forms of values.

• Numeric Values	405
• Boolean	406
• Character Data	406
• Character Strings	406
• Block Data	406

5.1.6.1 Numeric Values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

- INF/NINF
Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN

Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

5.1.6.2 Boolean

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

Querying boolean parameters

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

Example:

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

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

5.1.6.3 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 5.1.2, "Long and Short Form"](#), on page 403.

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

5.1.6.4 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'`

5.1.6.5 Block Data

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

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are

transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

5.2 Common Suffixes

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

Table 5-1: 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 measurement channel)
<t>	1..6	Trace
<k>	1..8	Limit line
<i>	1..3	Output (1, 2 or Phones)
<k>	1..8 (Limit line) 1 2 (Display line)	Line



Selecting windows in multiple measurement channels

Note that the suffix <n> always refers to a window in the currently selected measurement channel.

5.3 Configuring and Performing Measurements

5.3.1 Performing Measurements

Useful commands to perform measurements described elsewhere:

- `INITiate<n>:ESpectrum` on page 455
- `INITiate<n>:SPURious` on page 490

<code>INITiate<n>[:IMMediate]</code>	407
<code>INITiate<n>:CONMeas</code>	408
<code>INITiate<n>:CONTinuous</code>	409
<code>[SENSe:]SWEp:COUNT:CURRent?</code>	410

`INITiate<n>[:IMMediate]`

The command initiates a new sweep.

In case of 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:

<n> 1 | 2
 INITiate1 initiates a bargraph measurement.
 INITiate2 initiates a scan.

Example:

```
INIT2:CONT OFF
SWE:COUN 20
INIT2;*WAI
```

Starts a single scan (with a scan count = 20), and waits until the measurement is done.

Usage:

Event

Manual operation:

See ["Frequency Sweep"](#) on page 16

See ["Zero Span"](#) on page 16

See ["Single Sweep/ RUN SINGLE"](#) on page 281

See ["Continuous Sweep/RUN CONT"](#) on page 282

INITiate<n>:CONMeas

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

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

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: Event

Manual operation: See ["Continue Single Sweep"](#) on page 282

INITiate<n>:CONTinuous <State>

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

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

For details on synchronization refer to the R&S ESW User Manual, chapter "Command Sequence and Synchronization".

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

Suffix:

<n> 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

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 16
 See "Zero Span" on page 16
 See "Single Sweep/ RUN SINGLE" on page 281
 See "Continuous Sweep/RUN CONT" on page 282

[SENSe:]SWEep:COUNT:CURRent?

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

Example:

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

Usage: Query only

5.3.2 Configuring Power Measurements

The following commands work for several power measurements.

CALCulate<n>:MARKer<m>:FUNction:POWer:MODE.....	410
CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?.....	411
CALCulate<n>:MARKer<m>:FUNction:POWer:SELect.....	413
CALCulate<n>:MARKer<m>:FUNction:POWer[:STATe].....	414
[SENSe:]POWer:ACHannel:PRESet.....	414
[SENSe:]POWer:ACHannel:PRESet:RLEVel.....	414
[SENSe:]POWer:TRACe.....	415

CALCulate<n>:MARKer<m>:FUNction:POWer:MODE <Mode>

This command selects the trace display mode for power measurements.

Suffix:

<n> Window

<m> Marker

Parameters:

<Mode>

WRITE

The power is calculated from the current trace.

MAXHold

The power is calculated from the current trace and compared with the previous power value using a maximum algorithm.

Manual operation: See "Power Mode" on page 60

CALCulate<n>:MARKer<m>:FUNctioN:POWer<sb>:RESult? <Measurement>

This command queries the results of power measurements.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n>, <m>

irrelevant

<sb>

1 | 2 | 3 (4 | 5)

Sub block in a Multi-standard radio measurement;

MSR ACLR: 1 to 5

Multi-SEM: 1 to 3

for all other measurements: irrelevant

Query 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).

OBANdwidth | OBWidth

Occupied bandwidth.

Returns the occupied bandwidth in Hz.

Usage: Query only

Manual operation: See "Ch Power ACLR" on page 17
 See "C/N, C/No" on page 17
 See "OBW" on page 17
 See "Spectrum Emission Mask" on page 17
 See "C/N" on page 92
 See "C/N₀" on page 92

CALCulate<n>:MARKer<m>:FUNction:POWer:SElect <MeasType>

This command selects a power measurement and turns the measurement on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<MeasType>

ACPower | MCACpower

Adjacent channel leakage ratio (ACLR) aka 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 "Ch Power ACLR" on page 17
 See "C/N, C/No" on page 17
 See "OBW" on page 17
 See "C/N" on page 92
 See "C/N₀" on page 92

CALCulate<n>:MARKer<m>:FUNction:POWer[:STATe] <State>

This command turns a power measurement on and off.

Suffix:

<n>, <m> irrelevant

Parameters:

<State> ON | OFF

ON | 1

The power measurement selected with `CALCulate<n>:MARKer<m>:FUNction:POWer:SElect` is activated.

OFF | 0

A standard frequency sweep is activated.

*RST: OFF

Usage: Setting only

Manual operation: See "C/N" on page 92
See "C/N₀" on page 92

[SENSe:]POWer:ACHannel:PRESet <Measurement>

This command determines the ideal span, bandwidths and detector for the current power measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Parameters:

<Measurement> **ACPower | MCACpower**
ACLR measurement

CPOWer
channel power measurement

OBANdwidth | OBWidth
Occupied bandwidth measurement

CN
Carrier to noise ratio

CN0
Carrier to noise ration referenced to a 1 Hz bandwidth

Manual operation: See "Optimized Settings (Adjust Settings)" on page 60
See "Adjust Settings" on page 92
See "Adjust Settings" on page 97

[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.

Usage: Event

[SENSe:]POWer:TRACe <TraceNumber>

This command selects the trace channel power measurements are performed on.

For the measurement to work, the corresponding trace has to be active.

Parameters:

<TraceNumber> Range: 1 to 6
*RST: 1

Example: POW:TRAC 2
Assigns the measurement to trace 2.

Manual operation: See "[Selected Trace](#)" on page 59

5.3.3 Measuring the Channel Power and ACLR

- [Managing Measurement Configurations](#)..... 415
- [Configuring Channels](#)..... 417
- [Defining Weighting Filters](#)..... 421
- [Selecting the Reference Channel](#)..... 424
- [Checking Limits](#)..... 425
- [Defining General ACLR Characteristics](#)..... 430
- [Configuring Multi-Standard Radio \(MSR\) ACLR Measurements](#)..... 431
- [Performing an ACLR Measurement](#)..... 445
- [Analyzing Measurement Results](#)..... 445
- [Programming Examples for Channel Power Measurements](#)..... 446

5.3.3.1 Managing Measurement Configurations

- CALCulate<n>:MARKer<m>:FUNCTion:POWer:PRESet..... 415
- CALCulate<n>:MARKer<m>:FUNCTion:POWer:STANdard:CATalog?..... 416
- CALCulate<n>:MARKer<m>:FUNCTion:POWer:STANdard:DELeTe..... 416
- CALCulate<n>:MARKer<m>:FUNCTion:POWer:STANdard:SAVE..... 417

CALCulate<n>:MARKer<m>:FUNCTion:POWer:PRESet <Standard>

This command loads a measurement configuration.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

If the "Multi-Standard Radio" standard is selected (see ["Standard"](#) on page 56), different commands are required to configure ACLR measurements (see [Chapter 5.3.3.7, "Configuring Multi-Standard Radio \(MSR\) ACLR Measurements"](#), on page 431).

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Standard> For more information see [Chapter 2.3.9, "Reference: Predefined CP/ACLR Standards"](#), on page 88.

If you want to load a customized configuration, the parameter is a string containing the file name.

Manual operation: See ["Predefined Standards"](#) on page 56
See ["User-Defined Standards"](#) on page 56

CALCulate<n>:MARKer<m>:FUNction:POWer:STANdard:CATalog?

This command queries all files containing ACLR standards.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<Standards> List of standard files.

Usage: Query only

Manual operation: See ["User-Defined Standards"](#) on page 56

CALCulate<n>:MARKer<m>:FUNction:POWer:STANdard:DELeTe <Standard>

This command deletes a file containing an ACLR standard.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Standard> String containing the file name of the standard.

Usage: Event

Manual operation: See ["User-Defined Standards"](#) on page 56

CALCulate<n>:MARKer<m>:FUNCTION:POWer:STANdard:SAVE <Standard>

This command saves the current ACLR measurement configuration as a new ACLR standard.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Standard> String containing the file name. The file format is xml.

Manual operation: See "[User-Defined Standards](#)" on page 56

5.3.3.2 Configuring Channels

[SENSe:]POWer:ACHannel:ACPairs.....	417
[SENSe:]POWer:ACHannel:BANDwidth BWIDth:ACHannel.....	417
[SENSe:]POWer:ACHannel:BANDwidth BWIDth:ALTErnate<ch>.....	418
[SENSe:]POWer:ACHannel:BANDwidth BWIDth[:CHANnel<ch>].....	418
[SENSe:]POWer:ACHannel:NAME:ACHannel.....	419
[SENSe:]POWer:ACHannel:NAME:ALTErnate<ch>.....	419
[SENSe:]POWer:ACHannel:NAME:CHANnel<ch>.....	419
[SENSe:]POWer:ACHannel:SPACing[:ACHannel].....	420
[SENSe:]POWer:ACHannel:SPACing:ALTErnate<ch>.....	420
[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>.....	420
[SENSe:]POWer:ACHannel:TXCHannel:COUNt.....	421

[SENSe:]POWer:ACHannel:ACPairs <ChannelPairs>

This command defines the number of pairs of adjacent and alternate channels.

Parameters:

<ChannelPairs> Range: 0 to 12
*RST: 1

Manual operation: See "[Number of Channels \(Tx, ADJ\)](#)" on page 58
See "[Number of Adjacent Channels \(ADJ Count\)](#)" on page 74

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ACHannel <Bandwidth>

This command 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|BWIDth:UACHannel` command.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
 *RST: 14 kHz

Manual operation: See "[Channel Bandwidths](#)" on page 62
 See "[Adjacent Channel Bandwidths](#)" on page 75

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:ALTErnate<ch>` <Bandwidth>

This command 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|BWIDth: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 to 11
 Alternate channel number

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
 *RST: 14 kHz

Manual operation: See "[Channel Bandwidths](#)" on page 62
 See "[Adjacent Channel Bandwidths](#)" on page 75

`[SENSe:]POWer:ACHannel:BANDwidth|BWIDth[:CHANnel<ch>]` <Bandwidth>

This command defines the channel bandwidth of the transmission channels.

Steep-edged channel filters are available for fast ACLR measurements.

Suffix:

<ch> 1 to 18
 Tx channel number

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
 *RST: 14 kHz

Manual operation: See "Channel Bandwidths" on page 62
 See "Channel Bandwidth" on page 92
 See "Channel Bandwidth" on page 97

[SENSe:]POWer:ACHannel:NAME:ACHannel <Name>

This command 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>

This command 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 to 11
 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>

This command defines a name for a transmission channel.

Suffix:

<ch> 1 to 18
 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[:ACHannel] <Spacing>

This command defines the distance from transmission channel to adjacent channel.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first 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

Usage: SCPI confirmed

Manual operation: See ["Channel Spacings"](#) on page 62
 See ["Adjacent Channel Spacings"](#) on page 75

[SENSe:]POWer:ACHannel:SPACing:ALTErnate<ch> <Spacing>

This command defines the distance from transmission channel to alternate channels.

For MSR signals, this command defines the distance from the CF of the first Tx channel in the first 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 to 11
 Alternate channel number

Parameters:

<Spacing> Range: 100 Hz to 2000 MHz
 *RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...

Manual operation: See ["Channel Spacings"](#) on page 62
 See ["Adjacent Channel Spacings"](#) on page 75

[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch> <Spacing>

This command defines the distance between transmission channels.

If you set the channel spacing for a transmission channel, the R&S 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 to 18
Tx channel number

Parameters:

<Spacing> Range: 14 kHz to 2000 MHz
*RST: 20 kHz

Manual operation: See "[Channel Spacings](#)" on page 62

[SENSe:]POWer:ACHannel:TXChannel:COUNT <Number>

This command defines the number of transmission channels.

The command works for measurements in the frequency domain.

Parameters:

<Number> Range: 1 to 18
*RST: 1

Manual operation: See "[Number of Channels \(Tx, ADJ\)](#)" on page 58

5.3.3.3 Defining Weighting Filters

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel.....	421
[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL].....	422
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTErnate<ch>.....	422
[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch>.....	422
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel.....	422
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALL.....	423
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTErnate<ch>.....	423
[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch>.....	423

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel <Alpha>

This command 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 75

[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL] <Value>

This command defines the alpha value for the weighting filter for all channels.

Parameters:

<Value> <numeric value>
 *RST: 0.22

Example: POW:ACH:FILT:ALPH:ALL 0.35

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTErnate<ch> <Alpha>

This command defines the roll-off factor for the alternate channel weighting filter.

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 to 11
 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 75

[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> <Alpha>

This command defines the roll-off factor for the transmission channel weighting filter.

Suffix:

<ch> 1 to 18
 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[:STATe]:ACHannel <State>

This command 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
 *RST: OFF

Manual operation: See "Weighting Filters" on page 64
 See "Weighting Filters" on page 75

[SENSe:]POWer:ACHannel:FiLTer[:STATe]:ALL <State>

This command turns the weighting filters for all channels on and off.

Parameters:

<State> ON | OFF
 *RST: OFF

[SENSe:]POWer:ACHannel:FiLTer[:STATe]:ALTErnate<ch> <State>

This command turns the weighting filter for an alternate channel on and off.

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 to 11
 Alternate channel number

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See "Weighting Filters" on page 64
 See "Weighting Filters" on page 75

[SENSe:]POWer:ACHannel:FiLTer[:STATe]:CHANnel<ch> <State>

This command turns the weighting filter for a transmission channel on and off.

Suffix:

<ch> 1 to 18
 Tx channel number

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See "Weighting Filters" on page 64

5.3.3.4 Selecting the Reference Channel

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE.....	424
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO.....	424
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual.....	424

[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>

This command selects the reference channel for relative measurements.

You need at least one channel for the command to work.

Parameters:

<RefChannel>

MINimum

Transmission channel with the lowest power

MAXimum

Transmission channel with the highest power

LHIGhest

Lowest transmission channel for lower adjacent channels and highest transmission channel for upper adjacent channels

Example: POW:ACH:REF:TXCH:AUTO MAX

Selects the channel with the peak power as reference channel.

Manual operation: See "[Reference Channel](#)" on page 58

[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual <ChannelNumber>

This command defines a reference channel for relative ACLR measurements.

You need at least one channel for the command to work.

Note that this command is not available for MSR ACLR measurements (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer:PRESet](#) on page 415).

Parameters:

<ChannelNumber>

Range: 1 to 18

*RST: 1

Manual operation: See "[Reference Channel](#)" on page 58

5.3.3.5 Checking Limits



The results of the limit checks are also indicated in the `STATus:QUESTIONable:ACLR` status register.

For more information see the R&S ESW User Manual.

<code>CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute</code>	425
<code>CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute:STATe</code>	425
<code>CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]</code>	426
<code>CALCulate<n>:LIMit<k>:ACPower:ACHannel[:RELative]:STATe</code>	426
<code>CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?</code>	427
<code>CALCulate<n>:LIMit<k>:ACPower:ALternate<ch>:ABSolute</code>	427
<code>CALCulate<n>:LIMit<k>:ACPower:ALternate<ch>:ABSolute:STATe</code>	428
<code>CALCulate<n>:LIMit<k>:ACPower:ALternate<ch>[:RELative]</code>	428
<code>CALCulate<n>:LIMit<k>:ACPower:ALternate<ch>[:RELative]:STATe</code>	429
<code>CALCulate<n>:LIMit<k>:ACPower:ALternate<ch>:RESult?</code>	429
<code>CALCulate<n>:LIMit<k>:ACPower[:STATe]</code>	430

`CALCulate<n>:LIMit<k>:ACPower:ACHannel:ABSolute` <LowerLimit>, <UpperLimit>

This command defines the absolute limit of the adjacent channels.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

Suffix:

<n>, <k> irrelevant

Parameters:

<LowerLimit> The limit of the lower adjacent channel.
 Range: -200 dBm to 200 dBm
 *RST: -200 dBm

<UpperLimit> The limit of the upper adjacent channel.
 Range: -200 dBm to 200 dBm
 *RST: -200 dBm

Manual operation: See "[Limit Checking](#)" on page 63
 See "[Limit Checking](#)" on page 76

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

This command turns the absolute limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPower[:STATe]`.

Suffix:

<n>, <k> irrelevant

Parameters:

<State>	ON OFF
	Absolute limit check for lower adjacent channel
	*RST: OFF
<State>	ON OFF
	Absolute limit check for upper adjacent channel
	*RST: OFF

Manual operation: See "[Limit Checking](#)" on page 63
 See "[Limit Checking](#)" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ACHannel[:RELative] <LowerLimit>, <UpperLimit>

This command defines the relative limit of the adjacent channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

Suffix:

<n>	irrelevant
<k>	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 Checking](#)" on page 63
 See "[Limit Checking](#)" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ACHannel[:RELative]:STATe

This command turns the relative limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit<k>:ACPpower\[:STATe\]](#).

Suffix:

<n>, <k>	irrelevant
----------	------------

Parameters:

<State>	ON OFF
	Relative limit check for lower adjacent channel
	*RST: OFF
<State>	ON OFF
	Relative limit check for upper adjacent channel
	*RST: OFF

Manual operation: See "[Limit Checking](#)" on page 63
 See "[Limit Checking](#)" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ACHannel:RESult?

This command queries the state of the limit check for the adjacent channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n>, <k> irrelevant

Return values:

<LowerACH>, text value
 <UpperACH> The command returns two results. The first is the result for the lower, the second for the upper adjacent channel.

PASSED

Limit check has passed.

FAIL

Limit check has failed.

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

Manual operation: See "[Limit Checking](#)" on page 63
 See "[Limit Checking](#)" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ALTErnate<ch>:ABSolute <LowerLimit>, <UpperLimit>

This command defines the absolute limit of the alternate channels.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

Suffix:

<n>, <k> irrelevant

<ch> 1 to 11
Alternate channel number

Parameters:

<LowerLimit> The limit of the lower adjacent channel.
Range: -200 dBm to 200 dBm
*RST: -200 dBm

<UpperLimit> The limit of the upper adjacent channel.
Range: -200 dBm to 200 dBm
*RST: -200 dBm

Manual operation: See "[Limit Checking](#)" on page 63
See "[Limit Checking](#)" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ALTErnate<ch>:ABSolute:STATe

This command turns the absolute limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit<k>:ACPpower\[:STATe\]](#).

Suffix:

<n>, <k> irrelevant

<ch> 1 to 11
Alternate channel number

Parameters:

<State> ON | OFF
Absolute limit check for lower alternate channel
*RST: OFF

<State> ON | OFF
Absolute limit check for upper alternate channel
*RST: OFF

Manual operation: See "[Limit Checking](#)" on page 63
See "[Limit Checking](#)" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ALTErnate<ch>[:RELative] <LowerLimit>, <UpperLimit>

This command defines the relative limit of the alternate channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

Suffix:

<n>, <k> irrelevant

<ch> 1 to 11
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 Checking" on page 63
See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ALternate<ch>[:RELative]:STATe

This command turns the relative limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPpower[:STATe]`.

Suffix:

<n>, <k> irrelevant
<ch> 1 to 11
Alternate channel number

Parameters:

<State> ON | OFF
Relative limit check for lower alternate channel
*RST: OFF

<State> ON | OFF
Relative limit check for upper alternate channel
*RST: OFF

Manual operation: See "Limit Checking" on page 63
See "Limit Checking" on page 76

CALCulate<n>:LIMit<k>:ACPpower:ALternate<ch>:RESult?

This command queries the state of the limit check for the adjacent or alternate channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n>, <k> irrelevant

<ch>	1 to 11 Alternate channel number
Return values:	
<LowerChan>, <UpperChan>	text value The command returns two results. The first is the result for the lower, the second for the upper adjacent or alternate channel.
	PASSED Limit check has passed.
	FAIL Limit check has failed.
Example:	INIT:IMM;*WAI; CALC:LIM:ACP:ACH:RES? PASSED,PASSED
Usage:	Query only

CALCulate<n>:LIMit<k>:ACPpower[:STATe] <State>

This command turns the limit check for ACLR measurements on and off.

In addition, limits must be defined and activated individually for each channel (see [CALCulate<n>:LIMit<k>:ACPpower:ACHannel\[:RELative\]:STATe](#), [CALCulate<n>:LIMit<k>:ACPpower:ALternate<ch>\[:RELative\]:STATe](#), [CALCulate<n>:LIMit<k>:ACPpower:GAP<gap>:ABSolute:STATe](#), [CALCulate<n>:LIMit<k>:ACPpower:GAP<gap>:ACLR\[:RELative:\]STATe](#) and [CALCulate<n>:LIMit<k>:ACPpower:GAP<gap>\[:CACLR\]\[:RELative:\]STATe](#)).

Suffix:

<n>, <k> irrelevant

Parameters:

<State> ON | OFF
*RST: OFF

Manual operation: See "[Limit Checking](#)" on page 63
See "[Limit Checking](#)" on page 70
See "[Limit Checking](#)" on page 76
See "[Limit Checking](#)" on page 78

5.3.3.6 Defining General ACLR Characteristics

Useful commands to define general ACLR characteristics described elsewhere:

- [CALCulate<n>:MARKer<m>:FUNCTION:POWER:MODE](#) on page 410
- [\[SENSe:\]POWER:NCORrection](#) on page 587
- [\[SENSe:\]POWER:ACHannel:PRESet](#) on page 414
- [\[SENSe:\]POWER:ACHannel:PRESet:RLEVel](#) on page 414

- [\[SENSe:\]POWER:TRACe](#) on page 415

[\[SENSe:\]POWER:HSPeet](#)..... 431

[SENSe:]POWER:HSPeet <State>

This command 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
 *RST: OFF

Example: POW:HSP ON

Manual operation: See "[Fast ACLR](#)" on page 59

5.3.3.7 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.

Useful commands to perform MSR ACLR measurements described elsewhere:

- [CALCulate<n>:LIMit<k>:ACPower\[:STATe\]](#) on page 430
- [CALCulate<n>:MARKer<m>:FUNction:POWER:MODE](#) on page 410
- [CALCulate<n>:MARKer<m>:FUNction:POWER:PRESet](#) on page 415
- [CALCulate<n>:MARKer<m>:FUNction:POWER:RESult:PHZ](#) on page 445
- [\[SENSe:\]POWER:ACHannel:MODE](#) on page 446
- [\[SENSe:\]POWER:ACHannel:PRESet](#) on page 414
- [\[SENSe:\]POWER:ACHannel:REFerence:TXChannel:AUTO](#) on page 424
- [\[SENSe:\]POWER:NCORrection](#) on page 587
- [\[SENSe:\]POWER:TRACe](#) on page 415

[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute](#).....432
[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe](#).....432
[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR\[:RELative\]](#).....433
[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ACLR\[:RELative:\]STATe](#).....433
[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>\[:CACLR\]\[:RELative\]](#).....434
[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>\[:CACLR\]\[:RELative:\]STATe](#).....434
[CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:RESult?](#).....434
[\[SENSe:\]POWER:ACHannel:AGCHannels](#).....435
[\[SENSe:\]POWER:ACHannel:BANDwidth|BWIDth:GAP<gap>](#).....435
[\[SENSe:\]POWER:ACHannel:BANDwidth|BWIDth:UACHannel](#).....436
[\[SENSe:\]POWER:ACHannel:BANDwidth|BWIDth:UALTernate<ch>](#).....436

[SENSe:]POWer:ACHannel:FILTer:ALPHa:GAP<gap>.....	436
[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLOCK<sb>:CHANnel<ch>.....	437
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel.....	437
[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch>.....	437
[SENSe:]POWer:ACHannel:FILTer:STATe:GAP<gap>.....	438
[SENSe:]POWer:ACHannel:FILTer:STATe:SBLOCK<sb>:CHANnel<ch>.....	438
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UACHannel.....	438
[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch>.....	439
[SENSe:]POWer:ACHannel:GAP<gap>:MSIZe.....	439
[SENSe:]POWer:ACHannel:NAME:GAP<gap>.....	439
[SENSe:]POWer:ACHannel:NAME:UACHannel.....	440
[SENSe:]POWer:ACHannel:NAME:UALTernate<ch>.....	440
[SENSe:]POWer:ACHannel:SBCount.....	440
[SENSe:]POWer:ACHannel:SBLOCK<sb>:BANDwidth BWIDTH[:CHANnel<ch>].....	440
[SENSe:]POWer:ACHannel:SBLOCK<sb>:CENTer[:CHANnel<ch>].....	441
[SENSe:]POWer:ACHannel:SBLOCK<sb>:FREQuency:CENTer.....	441
[SENSe:]POWer:ACHannel:SBLOCK<sb>:NAME[:CHANnel<ch>].....	441
[SENSe:]POWer:ACHannel:SBLOCK<sb>:RFBWidth.....	442
[SENSe:]POWer:ACHannel:SBLOCK<sb>:TECHnology[:CHANnel<ch>].....	442
[SENSe:]POWer:ACHannel:SBLOCK<sb>:TXCHannel:COUNT.....	443
[SENSe:]POWer:ACHannel:SPACing:GAP<gap>.....	443
[SENSe:]POWer:ACHannel:SPACing:UACHannel.....	444
[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch>.....	444
[SENSe:]POWer:ACHannel:SSETup.....	444

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute <Limit>, <Reserved>

This command defines the absolute limit of the specified gap (CACLR) channel.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

Suffix:

<n>, <k>	irrelevant
<gap>	1 2 Gap (CACLR) channel number

Parameters:

<Limit>	Defines the absolute limit of the specified gap channel in dBm.
<Reserved>	Ignored.

Example: CALC:LIM:ACP:GAP2:ABS 44.2dBm,0

Manual operation: See "[Limit Checking](#)" on page 78

CALCulate<n>:LIMit<k>:ACPower:GAP<gap>:ABSolute:STATe <State>

This command turns the absolute limit check for the specified gap (CACLR) channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPowEr[:STATe]`.

Suffix:

<n>, <k> irrelevant
 <gap> 1 | 2
 Gap (CACLR) channel number

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See "Limit Checking" on page 78

CALCulate<n>:LIMit<k>:ACPowEr:GAP<gap>:ACLR[:RELative] <Limit>

This command 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 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>, <k> irrelevant
 <gap> 1 | 2
 Gap channel number

Parameters:

<Limit> Defines the relative limit for the ACLR power in the specified gap channel in dB.

Example: `CALC:LIM:ACP:GAP1:ACLR:REL 3dB`

Manual operation: See "Limit Checking" on page 78

CALCulate<n>:LIMit<k>:ACPowEr:GAP<gap>:ACLR[:RELative:]STATe <State>

This command turns the relative limit check for the ACLR power in the specified gap channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPowEr[:STATe]`.

Suffix:

<n>, <k> irrelevant
 <gap> 1 | 2
 Gap channel number

Parameters:

<State> ON | OFF
 *RST: OFF

Example: `CALC:LIM:ACP:GAP1:ACLR:REL:STAT ON`

Manual operation: See "[Limit Checking](#)" on page 78

CALCulate<n>:LIMit<k>:ACPpower:GAP<gap>[:CACLR][:RELative] <Limit>

This command defines the relative limit for the CACLR power in the specified gap channel. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S ESW uses the lower value for the limit check.

Suffix:

<n>, <k>	irrelevant
<gap>	1 2 Gap channel number

Parameters:

<Limit>	Defines the relative limit of the specified gap channel in dB.
---------	--

Example: `CALC:LIM:ACP:GAP1:REL 3dB`

Manual operation: See "[Limit Checking](#)" on page 78

CALCulate<n>:LIMit<k>:ACPpower:GAP<gap>[:CACLR][:RELative:]STATe <State>

This command turns the relative limit check for the CACLR power in the specified gap channel on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit<k>:ACPpower[:STATe]`.

Suffix:

<n>, <k>	irrelevant
<gap>	1 2 Gap channel number

Parameters:

<State>	ON OFF
*RST:	OFF

Example: `CALC:LIM:ACP:GAP1:REL:STAT ON`

Manual operation: See "[Limit Checking](#)" on page 78

CALCulate<n>:LIMit<k>:ACPpower:GAP<gap>:RESult?

This command queries the state of the limit check for *all* gap (CACLR) channels in an MSR ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

The results of the power limit checks are also indicated in the `STAT:QUES:ACPL` status registry.

Suffix:

<n>, <k> irrelevant
 <gap> 1 | 2
 irrelevant

Return values:

<LowerGap1>, The command returns the results for the four gap channels for
 <UpperGap1>, each gap (max. 4).
 <LowerGap2>, **PASSED**
 <UpperGap2> Limit check has passed.

FAIL

Limit check has failed.

NONE

No results available, e.g. because limit checking was deactivated

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:GAP2:RES?
PASSED,PASSED,
```

Usage:

Query only

Manual operation: See "[Limit Checking](#)" on page 78

[SENSe:]POWER:ACHannel:AGCHannels <State>

This command activates or deactivates gap channels in an MSR signal.

For more information see [Chapter 2.3.3.4, "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: ON

Manual operation: See "[Activate Gaps](#)" on page 77

[SENSe:]POWER:ACHannel:BANDwidth|BWIDth:GAP<gap> <Bandwidth>

This command defines the bandwidth of the specified MSR gap (CACLR) channel.

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNction:POWer:PRESet](#) on page 415).

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Bandwidth> numeric value in Hz
*RST: 3.84 MHz

Manual operation: See ["Gap Channel Bandwidths"](#) on page 78

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UACHannel <Bandwidth>

This command 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|BWIDth:ACHannel](#) command.

Steep-edged channel filters are available for fast ACLR measurements.

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See ["Adjacent Channel Bandwidths"](#) on page 75

[SENSe:]POWer:ACHannel:BANDwidth|BWIDth:UALTernate<ch> <Bandwidth>

This command 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|BWIDth:ALTernate<ch>](#) command.

Steep-edged channel filters are available for fast ACLR measurements.

Suffix:

<ch> 1 to 11
Alternate channel number

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
*RST: 14 kHz

Manual operation: See ["Adjacent Channel Bandwidths"](#) on page 75

[SENSe:]POWer:ACHannel:FILTer:ALPHA:GAP<gap> <Alpha>

This command defines the roll-off factor for the specified gap (CACLR) channel's weighting filter.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual operation: See "[Weighting Filters](#)" on page 78

[SENSe:]POWer:ACHannel:FILTer:ALPHa:SBLOCK<sb>:CHANnel<ch> <Alpha>

This command defines the roll-off factor for the specified transmission channel's weighting filter.

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual operation: See "[Weighting Filters](#)" on page 73

[SENSe:]POWer:ACHannel:FILTer:ALPHa:UACHannel <Alpha>

This command 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 75

[SENSe:]POWer:ACHannel:FILTer:ALPHa:UALTernate<ch> <Alpha>

This command 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:UALTernate<ch>](#) command.

Suffix:

<ch> 1 to 11
Alternate channel number

Parameters:

<Alpha> Roll-off factor
Range: 0 to 1
*RST: 0.22

Manual operation: See "[Weighting Filters](#)" on page 75

[SENSe:]POWer:ACHannel:FILTer:STATE:GAP<gap> <State>

This command turns the weighting filter for the specified gap (CACLR) channel on and off.

Suffix:

<gap> 1 | 2
Gap (CACLR) channel number

Parameters:

<State> ON | OFF
*RST: OFF

Manual operation: See "[Weighting Filters](#)" on page 78

[SENSe:]POWer:ACHannel:FILTer:STATE:SBLOCK<sb>:CHANnel<ch> <State>

This command turns the weighting filter for the specified transmission channel on and off.

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<State> ON | OFF
*RST: W-CDMA: ON, other technologies: OFF

Manual operation: See "[Weighting Filters](#)" on page 73

[SENSe:]POWer:ACHannel:FILTer[:STATE]:UACHannel <State>

This command 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
 *RST: OFF

Manual operation: See ["Weighting Filters"](#) on page 75

[SENSe:]POWer:ACHannel:FILTer[:STATe]:UALTernate<ch> <State>

This command 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 to 11
 Alternate channel number

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See ["Weighting Filters"](#) on page 75

[SENSe:]POWer:ACHannel:GAP<gap>: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

Example: POW:ACH:GAP2:MSIZ 5MHZ

Usage: SCPI confirmed

Manual operation: See ["Minimum gap size to show gap 1/2"](#) on page 77

[SENSe:]POWer:ACHannel:NAME:GAP<gap> <Name>

This command defines a name for the GAP channel.

Suffix:

<gap> 1 | 2
 Gap channel number

Parameters:

<Name> String containing the name of the channel
 *RST: Gap1, Gap2

[SENSe:]POWer:ACHannel:NAME:UACHannel <Name>

This command 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>

This command 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 to 11
 Alternate channel number

Parameters:

<Name> String containing the name of the channel
 *RST: ALT<1...11>

[SENSe:]POWer:ACHannel:SBCount <Number>

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

For more information see [Chapter 2.3.3.4, "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 68

[SENSe:]POWer:ACHannel:SBLock<sb>:BANDwidth|BWIDth[:CHANnel<ch>] <Bandwidth>

This command defines the bandwidth of the specified MSR Tx channel.

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNction:POWer:PRESet](#) on page 415).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Bandwidth> Bandwidth in Hz

Manual operation: See ["Tx Channel Bandwidth"](#) on page 73

[SENSe:]POWer:ACHannel:SBLOCK<sb>:CENTer[:CHANnel<ch>] <Frequency>

This command defines the (absolute) center frequency of the specified MSR Tx channel.

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

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer:PRESet](#) on page 415).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Frequency> absolute frequency in Hz

Manual operation: See ["Tx Center Frequency"](#) on page 72

[SENSe:]POWer:ACHannel:SBLOCK<sb>:FREQuency:CENTer <Frequency>

This command 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.

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNCTION:POWer:PRESet](#) on page 415).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

Parameters:

<Frequency> absolute frequency in Hz

Manual operation: See ["Sub Block Center Frequency"](#) on page 72

[SENSe:]POWer:ACHannel:SBLOCK<sb>:NAME[:CHANnel<ch>] <Name>

This command defines the name of the specified MSR Tx channel.

This command is for MSR signals only.

Suffix:

<sb> 1 | 2 | 3 | 4 | 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 'B:WCDMA'

Manual operation: See "[Tx Channel Definition](#)" on page 72

[SENSe:]POWer:ACHannel:SBLock<sb>:RFBWidth <Bandwidth>

This command defines the bandwidth of the individual MSR sub block. Note that sub block ranges also affect the position of the adjacent gap channels (CACLR).

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNction:POWer:PRESet](#) on page 415).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

Parameters:

<Bandwidth> Bandwidth in Hz

Manual operation: See "[RF Bandwidth](#)" on page 72

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

This command defines the technology used for transmission by the specified MSR Tx channel.

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNction:POWer:PRESet](#) on page 415).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
sub block number

<ch> 1 to 18
Tx channel number

Parameters:

<Standard> GSM | WCDMA | LTE_1_40 | LTE_3_00 | LTE_5_00 |
 LTE_10_00 | LTE_15_00 | LTE_20_00 | USER
 Technology used for transmission

GSM
 Transmission according to GSM standard

WCDMA
 Transmission according to 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

USER
 User-defined transmission; no automatic preconfiguration possi-
 ble

Manual operation: See "[Technology Used for Transmission](#)" on page 72

[SENSe:]POWer:ACHannel:SBLOCK<sb>:TXCHannel:COUNT <Number>

This command defines the number of transmission channels the specific sub block contains.

This command is for MSR signals only (see [CALCulate<n>:MARKer<m>:FUNction:POWer:PRESet](#) on page 415).

Suffix:

<sb> 1 | 2 | 3 | 4 | 5
 sub block number

Parameters:

<Number> Range: 1 to 18
 *RST: 1

Manual operation: See "[Number of Tx Channels \(Tx Count\)](#)" on page 72

[SENSe:]POWer:ACHannel:SPACing:GAP<gap> <Spacing>

This command defines the distance from sub block to the specified gap channel.

The channels in the upper gap are identical to those in the lower gap. Thus, in the R&S ESW MSR ACLR measurement, only 2 gap channels are configured.

The spacing for gap channels is defined in relation to the outer edges of the surrounding sub blocks, i.e.

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

(See also [Figure 2-24](#) and [Figure 2-25](#).)

Suffix:	
<gap>	1 2 Gap channel number
Parameters:	
<Spacing>	numeric value in Hz *RST: 2.5 MHz
Usage:	SCPI confirmed
Manual operation:	See " Gap Channel Spacings " on page 78

[SENSe:]POWer:ACHannel:SPACing:UACHannel <Spacing>

This command 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
Usage:	SCPI confirmed
Manual operation:	See " Adjacent Channel Spacings " on page 75

[SENSe:]POWer:ACHannel:SPACing:UALTernate<ch> <Spacing>

This command 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 to 11 Alternate channel number
Parameters:	
<Spacing>	Range: 100 Hz to 2000 MHz *RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...
Manual operation:	See " Adjacent Channel Spacings " on page 75

[SENSe:]POWer:ACHannel:SSETup <State>

This command defines whether adjacent channels are defined symmetrically or not.

For more information see [Chapter 2.3.3.4, "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: ON

Manual operation: See ["Symmetrical Adjacent Setup"](#) on page 70

5.3.3.8 Performing an ACLR Measurement

Useful commands to perform ACLR measurements described elsewhere:

- [CALCulate<n>:MARKer<m>:FUNCTION:POWER:SElect](#) on page 413
- [CALCulate<n>:MARKer<m>:FUNCTION:POWER\[:STATE\]](#) on page 414
- [INITiate<n>\[:IMMEDIATE\]](#) on page 407

5.3.3.9 Analyzing Measurement Results

Useful commands to analyze ACLR measurements described elsewhere:

- [CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?](#) on page 411
- [TRACe<n>\[:DATA\]](#) on page 617

[CALCulate<n>:MARKer<m>:FUNCTION:POWER:RESult:PHZ](#)..... 445

[\[SENSe:\]POWER:ACHannel:MODE](#)..... 446

CALCulate<n>:MARKer<m>:FUNCTION:POWER:RESult:PHZ <State>

This command selects the way 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

Parameters:

<State> ON | OFF
ON
 Channel power density in dBm/Hz
OFF
 Channel power in dBm
 *RST: OFF

Example:

CALC:MARK:FUNC:POW:RES:PHZ ON
 Output of results referred to the channel bandwidth.

Manual operation: See ["Channel Power Levels and Density \(Power Unit\)"](#) on page 59

[SENSe:]POWer:ACHannel:MODE <Mode>

This command 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**
 Shows the absolute power of all channels
RELative
 Shows the power of adjacent and alternate channels in relation to the transmission channel
 *RST: RELative

Manual operation: See ["Absolute and Relative Values \(ACLR Mode\)"](#) on page 59

5.3.3.10 Programming Examples for Channel Power Measurements

The following programming examples are meant to demonstrate the most important commands to perform channel power measurements in a remote environment.

- [Example: Configuring and Performing an ACLR Measurement](#).....446
- [Example: Configuring and Performing an MSR ACLR Measurement](#).....448

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-----
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.
```

```

CALC:MARK:FUNC:POW:SEL ACP
//Activates adjacent-channel power measurement.
CALC:MARK:FUNC:POW:PRES GSM
//Selects the user standard "GSM"

//-----Setting Up Channels-----
POW:ACH:TXCH:COUN 1
//Creates one transmission channel.
POW:ACH:NAME:CHAN1 'TX Channel'
//Names the first transmission channel 'TX Channel'.
POW:ACH:ACP 2
//Creates two adjacent channels - one adjacent channel and one alternate channel.
POW:ACH:NAME:ACH 'ABC'
//Names the adjacent channel 'ABC'
POW:ACH:NAME:ALT1 'XYZ'
//Names the first alternate channel 'XYZ'.
POW:ACH:BWID:CHAN1 30kHz
//Defines a bandwidth of 30 kHz for the transmission channel.
POW:ACH:BWID:ACH 30kHz
//Defines a bandwidth of 30 kHz for the adjacent channel.
POW:ACH:BWID:ALT1 30kHz
//Defines a bandwidth of 30 kHz for the first alternate channel.
POW:ACH:SPAC 33kHz
//Defines a distance of 33 kHz from the center of the transmission channel to the
//center of the adjacent channel.
//Also adjusts the distance to the alternate channels (66 kHz).
POW:ACH:SPAC:ALT1 100kHz
//Defines a distance of 100 kHz from the center of the transmission channel to the
//center of the first alternate channel.

//-----Selecting a Reference Channel--
POW:ACH:MODE REL
//Selects relative display of the channel power.
POW:ACH:REF:TXCH:MAN 1
//Defines transmission channel 1 as the reference channel.

//-----Saving the settings as a user standard-----
CALC:MARK:FUNC:POW:STAN:SAVE 'my_aclr_standard'
//Saves the user standard with the name "my_aclr_standard".
//Weighting filters can only be defined for user-defined standards.

//-----Defining Weighting Filters-----
POW:ACH:FILT:ALPH:CHAN1 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the first
//transmission channel.
POW:ACH:FILT:CHAN1 ON
//Turns the weighting filter for the first transmission channel on.
POW:ACH:FILT:ALPH:ACH 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the adjacent
//channel.

```

```

POW:ACH:FILT:ACH ON
//Turns the weighting filter for the adjacent channel on.
POW:ACH:FILT:ALPH:ALT1 0.35
//Defines a roll-off factor of 0.35 for the weighting filter of the first
//alternate channel.
POW:ACH:FILT:ALT1 ON
//Turns the weighting filter for the first alternate channel on.

//-----Working with Limits-----
CALC:LIM:ACP:ACH 30DB,30DB
//Defines a relative limit of 30 dB below the power of the reference channel
//for both adjacent channels.
CALC:LIM:ACP:ALT1 25DB,25DB
//Defines a relative limit of 25 dB below the power of the reference channel
//for the first alternate channels.
CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM
//Defines an absolute limit of -35 dBm for both adjacent channels.
CALC:LIM:ACP ON
//Turns the ACLR limit check on.
CALC:LIM:ACP:ACH:STAT ON
//Turns the relative limit check for adjacent channels on.
CALC:LIM:ACP:ACH:ABS:STAT ON
//Turns the absolute limit check for adjacent channels on.
CALC:LIM:ACP:ALT1:ABS:STAT ON
//Turns the absolute limit check for the first alternate channel on.

//-----Performing the Measurement-----
POW:ACH:PRES ACP;*WAI
//Determines the ideal ACLR measurement configuration.
POW:ACH:PRES:RLEV;*WAI
//Determines the ideal reference level for the measurement.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Limit Check-----
CALC:LIM:ACP:ACH:RES?
//Queries the results of the limit check for the adjacent channels.
CALC:LIM:ACP:ALT1:RES?
//Queries the results of the limit check for the first alternate channels.

//-----Retrieving Results-----
CALC:MARK:FUNC:POW:RES? ACP
//Returns the results for the ACLR measurement.

```

Example: Configuring and Performing an MSR ACLR Measurement

This example demonstrates how to configure and perform an ACLR measurement on a multi-standard radio signal in a remote environment.

```

//-----Preparing the instrument -----
//Reset the instrument

```

```
*RST

// Select ACLR measurement
:CALCulate:MARKer:FUNCTion:POWer:SElect ACPower

// Select MSR Standard :CALCulate:MARKer:FUNCTion:POWer:PRESet MSR

//Configure general measurement settings
:SENSe:FREQuency:CENTer 1.25GHz
:SENSe:FREQuency:SPAN 62.0MHz
:SENSe:POWer:ACHannel:SBCount 3

//----- Configuring 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:CHANnel12 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

```

5.3.4 Measuring the Carrier-to-Noise Ratio

Useful commands to perform C/N measurements described elsewhere:

- [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?](#) on page 411
- [CALCulate<n>:MARKer<m>:FUNction:POWer:SElect](#) on page 413
- [CALCulate<n>:MARKer<m>:FUNction:POWer\[:STATe\]](#) on page 414
- [\[SENSe:\]POWer:ACHannel:BANDwidth|BWIDth\[:CHANnel<ch>\]](#) on page 418
- [\[SENSe:\]POWer:ACHannel:PRESet](#) on page 414

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: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.
```

5.3.5 Measuring the Occupied Bandwidth

- [Configuring the Measurement](#).....451
- [Programming Example: OBW Measurement](#).....452

5.3.5.1 Configuring the Measurement

Useful commands to configure the channel described elsewhere:

- [\[SENSe:\]POWer:ACHannel:BANDwidth|BWIDth\[:CHANnel<ch>\]](#) on page 418

- [SENSe:]POWer:ACHannel:PRESet on page 414
- [SENSe:]POWer:ACHannel:PRESet:RLEVel on page 414

Useful commands to define search limits described elsewhere:

- CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 645
- CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT on page 645
- CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 646

Useful commands to perform the measurement described elsewhere:

- CALCulate<n>:MARKer<m>:FUNction:POWer:SElect on page 413
- CALCulate<n>:MARKer<m>:FUNction:POWer[:STATe] on page 414

Useful commands to retrieve results described elsewhere:

- CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult? on page 411

[SENSe:]POWer:BANDwidth|BWIDth.....452

[SENSe:]POWer:BANDwidth|BWIDth <Percentage>

This command selects the percentage of the total power that defines the occupied bandwidth.

Parameters:

<Percentage>	Range:	10 PCT to 99.9 PCT
	*RST:	99 PCT

Example: POW:BWID 95PCT

Manual operation: See "% Power Bandwidth" on page 96

5.3.5.2 Programming Example: OBW Measurement

This programming example demonstrates the measurement example described in [Chapter 2.5.5, "Measurement Example"](#), on page 98 in a remote environment.

```
//-----Configuring the Measurement-----
*RST
//Resets the instrument
FREQ:CENt 800MHz
//Sets the center frequency to 800 MHz.
DISP:TRAC:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
CALC:MARK:FUNC:POW:SEL OBW
//Activates occupied bandwidth measurement.
POW:BWID 99PCT
//Sets the percentage of power to 99%.
POW:ACH:BAND 21kHz
//Sets the channel bandwidth to 21 kHz.
POW:ACH:PREs OBW
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PREs:RLEV
```



```
//Determines the ideal reference level for the measurement.
DET APE
//Sets the trace detector to positive peak.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:MARK:FUNC:POW:RES? OBW
//Returns the occupied bandwidth.
```

5.3.6 Measuring with Spectrum Emission Masks

- [Managing Measurement Configurations](#)..... 453
- [Controlling the Measurement](#)..... 455
- [Configuring Multi SEM Measurements](#)..... 455
- [Configuring Sweep Lists](#)..... 457
- [Configuring the Reference Range](#)..... 471
- [Configuring Power Classes](#)..... 473
- [Configuring MSR SEM Measurements](#)..... 478
- [Configuring the List Evaluation](#)..... 484
- [Performing SEM Measurements](#)..... 486
- [Retrieving Results](#)..... 486
- [Example: SEM Measurement](#)..... 486

5.3.6.1 Managing Measurement Configurations

- [CALCulate<n>:LIMit<k>:ESPectrum<sb>:RESTore](#)..... 453
- [\[SENSe:\]ESPectrum<sb>:PRESet\[:STANdard\]](#)..... 454
- [\[SENSe:\]ESPectrum<sb>:PRESet:RESTore](#)..... 454
- [\[SENSe:\]ESPectrum<sb>:PRESet:STORE](#)..... 454

CALCulate<n>:LIMit<k>:ESPectrum<sb>:RESTore

This command restores the predefined limit lines for the selected Spectrum Emission Mask standard.

All modifications made to the predefined limit lines are lost and the factory-set values are restored.

Suffix:

<n>, <k>, <sb> irrelevant

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>

This command loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is C:\r_s\instr\sem_std.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Standard> String containing the file name.
If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

Return values:

<Standard> The query returns the name of the currently loaded standard.

Manual operation: See ["Standard / MSR Settings"](#) on page 121
See ["Load Standard"](#) on page 128

[SENSe:]ESpectrum<sb>:PRESet:RESTore

This command restores the default configurations of predefined SEM standards.

Note that the command will overwrite customized standards that have the same name as predefined standards.

Suffix:

<sb> 1 | 2 | 3

Usage: Event

Manual operation: See ["Restore Standard Files"](#) on page 129

[SENSe:]ESpectrum<sb>:PRESet:STORe <Standard>

This command saves the current SEM measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is C:\r_s\instr\sem_std.

Suffix:

<sb> 1 | 2 | 3

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 129

5.3.6.2 Controlling the Measurement

INITiate<n>:ESpectrum	455
[SENSe:]SWEep:MODE.....	455

INITiate<n>:ESpectrum

This command initiates a Spectrum Emission Mask measurement.

Suffix:

<n> irrelevant

Usage: Event

[SENSe:]SWEep:MODE <Mode>

This command selects the spurious emission and spectrum emission mask measurements.

You can select other measurements with

- [CALCulate<n>:MARKer<m>:FUNCTION:POWER\[:STATE\]](#)

Parameters:

<Mode>

AUTO
Turns on basic spectrum measurements.

ESpectrum
Turns on spectrum emission mask measurements.

LIST
Turns on spurious emission measurements.

*RST: AUTO

Usage: SCPI confirmed

Manual operation: See "[Spectrum Emission Mask](#)" on page 17
See "[Spurious Emissions](#)" on page 18

5.3.6.3 Configuring Multi SEM Measurements

[SENSe:]ESpectrum<sb>:RANGe<range>:MLCalc.....	455
[SENSe:]ESpectrum<sb>:SBCENTER.....	456
[SENSe:]ESpectrum<sb>:SBCOUNT.....	456

[SENSe:]ESpectrum<sb>:RANGe<range>: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 111.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<Function> **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 119

[SENSe:]ESpectrum<sb>:SBCENTER <Frequency>

This command defines the center frequency of the selected sub block in a Multi-SEM measurement.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

Return values:

<Frequency> Frequency within the currently defined global span (see
[\[SENSe:\]FREQUENCY:SPAN](#) on page 584 and [\[SENSe:\]FREQUENCY:CENTER](#) on page 582).

Range: 1 to 3

*RST: 1

Example: ESP2:SBCENTER 1GHZ

Manual operation: See "[Sub Block Center Frequency](#)" on page 121

[SENSe:]ESpectrum<sb>:SBCOUNT <Sub blocks>

This command defines the number of sub blocks in the SEM measurement. (<sb> is irrelevant)

Return values:

<Sub blocks> Number of sub blocks in the SEM measurement.

Range: 1 to 3

*RST: 1

Example: ESP:SBCOUNT 2

Manual operation: See "[Sub Block Count](#)" on page 120

5.3.6.4 Configuring Sweep Lists

Useful commands to configure sweep lists described elsewhere:

- `CALCulate<n>:LIMit<k>:ESpectrum<sb>:PClass<PClass>:LIMit[:STATE]` on page 475

<code>[SENSe:]ESpectrum<sb>:HighSPeed</code>	457
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:BANDwidth[:RESolution]</code>	458
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:BANDwidth:VIDeo</code>	458
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:COUNT?</code>	458
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:DELete</code>	459
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:FILTer:TYPE</code>	459
<code>[SENSe:]ESpectrum<sb>:RANGe<range>[:FREquency]:START</code>	460
<code>[SENSe:]ESpectrum<sb>:RANGe<range>[:FREquency]:STOP</code>	461
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:ATTenuation</code>	461
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO</code>	462
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:GAIN:LNA:STATE</code>	462
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:GAIN:STATE</code>	462
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:INSert</code>	463
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:START</code>	463
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP</code>	464
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START</code>	464
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START:ABS</code>	465
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START:FUNCTion</code>	466
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP</code>	466
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute</code>	467
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCTion</code>	468
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:STATE</code>	468
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:MLCalc</code>	469
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:POINts:MIN[:VALue]</code>	469
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:RLEVel</code>	470
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:SWEep:TIME</code>	470
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:SWEep:TIME:AUTO</code>	471
<code>[SENSe:]ESpectrum<sb>:RANGe<range>:TRANsducer</code>	471

`[SENSe:]ESpectrum<sb>:HighSPeed <State>`

This command turns high speed mode for SEM measurements on and off.

For more information including restrictions see [Chapter 2.6.4.3, "Fast SEM Measurements"](#), on page 108.

Suffix:

`<sb>` 1 | 2 | 3
Sub block in a Multi-SEM measurement

Parameters:

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

Example: `ESP:HSP ON`

Manual operation: See "Fast SEM" on page 116

[SENSe:]ESpectrum<sb>:RANGe<range>:BANDwidth[:RESolution] <RBW>

This command defines the resolution bandwidth for a SEM range.

In case of high speed measurements, the resolution bandwidth has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1...30
Selects the measurement range.

Parameters:

<RBW> Resolution bandwidth.
Refer to the data sheet for available resolution bandwidths.
*RST: 30.0 kHz
Default unit: Hz

Manual operation: See "RBW" on page 116

[SENSe:]ESpectrum<sb>:RANGe<range>:BANDwidth:VIDeo <VBW>

This command defines the video bandwidth for a SEM range.

In case of high speed measurements, the video bandwidth has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1...30
Selects the measurement range.

Parameters:

<VBW> Video bandwidth.
Refer to the data sheet for available video bandwidths.
*RST: 10.0 MHz
Default unit: Hz

Manual operation: See "VBW" on page 116

[SENSe:]ESpectrum<sb>:RANGe<range>:COUNT? <Ranges>

This command queries the number of ranges in the sweep list (<range> is irrelevant).

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

Return values:

<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]ESpectrum<sb>:RANGe<range>:DELete

This command removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<sb> 1 | 2 | 3
 Sub block in a Multi-SEM measurement

<range> 1...30
 Selects the measurement range.

Usage: Event

Manual operation: See "[Delete Range](#)" on page 119

[SENSe:]ESpectrum<sb>:RANGe<range>: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 | 2 | 3
 Sub block in a Multi-SEM measurement

<range> 1...30
 Selects the measurement range.

Parameters:

<FilterType>

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

Manual operation: See "[Filter Type](#)" on page 116**[SENSe:]ESpectrum<sb>:RANGe<range>[:FREQUENCY]:START <Frequency>**

This command defines the start frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S 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 2.6.4.1, "Ranges and Range Settings"](#), on page 104.**Suffix:**

<sb>

1 | 2 | 3

Sub block in a Multi-SEM measurement

<range>

1...30

Selects the measurement range.

Parameters:

<Frequency>

Numeric value. Note that the minimum frequency range of a SEM range is 20 Hz.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)

Default unit: Hz

Manual operation: See "[Range Start / Range Stop](#)" on page 115

[SENSe:]ESpectrum<sb>:RANGe<range>[:FREQUENCY]:STOP <Frequency>

This command defines the stop frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S 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 2.6.4.1, "Ranges and Range Settings"](#), on page 104.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1...30
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Manual operation: See "[Range Start / Range Stop](#)" on page 115

[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:ATTenuation <Attenuation>

This command defines the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1...20
Selects the measurement range.

Parameters:

<Attenuation> Numeric value.
Refer to the data sheet for the attenuation range.
*RST: 10 dB
Default unit: dB

Manual operation: See "[RF Attenuator](#)" on page 117

[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:ATTenuation:AUTO <State>

This command turns automatic selection of the input attenuation for a SEM range on and off.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
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 117

[SENSe:]ESpectrum<sb>:RANGe<range>: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 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 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 117

[SENSe:]ESpectrum<sb>:RANGe<range>:INPut:GAIN:STATe <State>

This command turns the preamplifier for a SEM range on and off.

In case of high speed measurements, the state of the preamplifier has to be identical for all ranges.

Note that it is not possible to turn on the preamplifier and the [optional low noise preamplifier](#) at the same time.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<State> ON | OFF
*RST: OFF

Manual operation: See "[Preamp](#)" on page 117

[SENSe:]ESpectrum<sb>:RANGe<range>:INSert <Mode>

This command inserts a new SEM range and updates the range numbers accordingly.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the SEM range.

Parameters:

<Mode> **AFTer**
Inserts a range after the selected range.

BEFore
Inserts a range before the selected range.

Manual operation: See "[Insert before/after Range](#)" on page 119

**[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STARt
<Level>**

This command defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.
 Range: -400 to 400
 *RST: -13
 Default unit: dBm

Example:

SENSe:ESpectrum:RANGe:LIMit:ABSolute:START -10
 For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "[Abs Limit Start/Stop <n>](#)" on page 118

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:ABSolute:STOP
 <Level>

This command defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 | 2 | 3
 Sub block in a Multi-SEM measurement

<range> 1..30
 Selects the measurement range.

<PClass> 1..4
 Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.
 Range: -400 to 400
 *RST: -13
 Default unit: dBm

Example:

SENSe:ESpectrum:RANGe:LIMit:ABSolute:STOP -15
 For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "[Abs Limit Start/Stop <n>](#)" on page 118

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START <Limit>

This command defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit regardless of the limit check mode.

Suffix:

<sb> 1 | 2 | 3
 Sub block in a Multi-SEM measurement

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the start frequency of a SEM range.
Range: -400 to 400
*RST: -50
Default unit: dBc

Example: SENS:ESP:RANG:LIM:REL:STAR -10

Manual operation: See "Rel Limit Start/Stop <n>" on page 118

**[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:ABS
<Limit>**

This command defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "Relative limit line functions" on page 107.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see [SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STARt:FUNCTION on page 466).
Range: -400 to 400
*RST: -13
Default unit: dBm

Example: SENSe:ESpectrum:RANGe:LIMit:RELative:STARt:
ABSolute -10

For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "Rel Limit Start/Stop <n>" on page 118

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START:FUNCTION <Function>

This command enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<sb>	1 2 3 Sub block in a Multi-SEM measurement
<range>	1..30 Selects the SEM range.
<PClass>	1..4 Power class for which the limit is defined.

Parameters:

<Function> Defines the function to be used to determine the relative limit line start value

MAX

The maximum of the relative *and* the absolute level is used as the limit start value. Use the `[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START` and `[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START:ABS` commands to define these values.

OFF

No function is used, the relative limit line is defined by a fixed relative start value. Use the `[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:START` command to define this value.

*RST: OFF

Example:

```
SENSe:ESpectrum:RANGe:LIMit:RELative:START:
FUNCTION MAX
```

For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "[Rel Limit Start/Stop <n>](#)" on page 118

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP <Limit>

This command defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit anytime and regardless of the limit check mode.

Suffix:

<sb>	1 2 3 Sub block in a Multi-SEM measurement
<range>	1..30 Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the stop frequency of a SEM range.
Range: -400 to 400
*RST: -50
Default unit: dBc

Example:

SENSe:ESpectrum:RANGe:LIMit:RELative:STOP -15
For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "[Rel Limit Start/Stop <n>](#)" on page 118

**[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:
ABSolute <Limit>**

This command defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "[Relative limit line functions](#)" on page 107.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the SEM range.

<PClass> 1..4
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see [\[SENSe:\]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:FUNCTION](#) on page 468).
Range: -400 to 400
*RST: -13
Default unit: dBm

Example:

SENSe:ESpectrum:RANGe:LIMit:RELative:STOP:
ABSolute -15

For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "[Rel Limit Start/Stop <n>](#)" on page 118

**[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:
FUNction <Function>**

This command enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<sb>	1 2 3 Sub block in a Multi-SEM measurement
<range>	1..30 Selects the SEM range.
<PClass>	1..4 Power class for which the limit is defined.

Parameters:

<Function> Defines the function to be used to determine the relative limit line stop value

MAX

The maximum of the relative *and* the absolute level is used as the limit stop value. Use the `[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP` and `[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP:ABSolute` commands to define these values.

OFF

No function is used, the relative limit line is defined by a fixed relative stop value. Use the `[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:RELative:STOP` command to define this value.

*RST: OFF

Example:

```
SENSe:ESpectrum:RANGe:LIMit:RELative:STOP:  
FUNction MAX
```

For a detailed example see [Chapter 5.3.6.11, "Example: SEM Measurement"](#), on page 486.

Manual operation: See "[Rel Limit Start/Stop <n>](#)" on page 118

[SENSe:]ESpectrum<sb>:RANGe<range>:LIMit<PClass>:STATe <State>

This command selects the limit check mode for *all* SEM ranges (<range> is irrelevant).

Suffix:

<sb>	1 2 3 Sub block in a Multi-SEM measurement
<PClass>	1..4 Power class for which the limit is defined.

Parameters:

<State> ABSolute | RELative | AND | OR

ABSolute

Checks only the absolute limits defined.

RELative

Checks only the relative limits. Relative limits are defined as relative to the measured power in the reference range.

AND

Combines the absolute and relative limit. The limit check fails when both limits are violated.

OR

Combines the absolute and relative limit. The limit check fails when one of the limits is violated.

*RST: RELative

Manual operation: See "[Limit Check <n>](#)" on page 118

[SENSe:]ESpectrum<sb>:RANGe<range>: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 111.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<Function> **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 119

[SENSe:]ESpectrum<sb>:RANGe<range>:POINts:MIN[:VALue] <SweepPoint>

Defines the minimum number of sweep points for the range.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<SweepPoints> Minimum number of sweep points per range
Range: 1 to 32001
*RST: 1

Example: SENSE1:ESpectrum:RANGe3:POINTs:MIN:VALue 400

Manual operation: See "[Minimum Sweep Points](#)" on page 119

[SENSe:]ESpectrum<sb>:RANGe<range>:RLEVel <RefLevel>

This command defines the reference level for a SEM range.

In case of high speed measurements, the reference level has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.
*RST: 0 dBm

Manual operation: See "[Ref. Level](#)" on page 117

[SENSe:]ESpectrum<sb>:RANGe<range>:SWEep:TIME <SweepTime>

This command defines the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Manual operation: See "[Sweep Time](#)" on page 117

[SENSe:]ESpectrum<sb>:RANGe<range>:SWEep:TIME:AUTO <State>

This command turns automatic selection of the sweep time for a SEM range on and off.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
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 116

[SENSe:]ESpectrum<sb>:RANGe<range>:TRANsducer <Transducer>

This command selects a transducer factor for a SEM range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:

<sb> 1 | 2 | 3
Sub block in a Multi-SEM measurement

<range> 1..30
Selects the measurement range.

Parameters:

<Transducer> String containing the transducer file name, including the path information.

Manual operation: See "[Transd. Factor](#)" on page 117

5.3.6.5 Configuring the Reference Range

[SENSe:]ESpectrum<sb>:BWID.....	472
[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHa.....	472
[SENSe:]ESpectrum<sb>:FILTer[:RRC][::STATE].....	472
[SENSe:]ESpectrum<sb>:RRANGe?.....	472
[SENSe:]ESpectrum<sb>:RTYPE.....	473

[SENSe:]ESpectrum<sb>:BWID <Bandwidth>

This command defines the channel bandwidth of the reference range.

The bandwidth is available if the power reference is the channel power.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Bandwidth> minimum span ≤ value ≤ span of reference range
*RST: 3.84 MHz

Manual operation: See ["Tx Bandwidth"](#) on page 122

[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHA <Alpha>

This command defines the roll-off factor for the RRC filter.

The RRC filter is available if the power reference is the channel power.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Alpha> Range: 0 to 1
*RST: 0.22

Manual operation: See ["Alpha"](#) on page 122

[SENSe:]ESpectrum<sb>:FILTer[:RRC][:STATE] <State>

This command turns the RRC filter in the reference range on and off.

The RRC filter is available if the power reference is the channel power.

Suffix:

<sb> 1 | 2 | 3

Parameters:

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

Manual operation: See ["RRC Filter State"](#) on page 122

[SENSe:]ESpectrum<sb>:RRANge? <RefRange>

This command queries the reference range.

Suffix:

<sb> 1 | 2 | 3

Return values:

<RefRange> Number of the current reference range.
Range: 1 to 30

Usage: Query only

[SENSe:]ESpectrum<sb>:RTYPE <Type>

This command defines the type of the power reference.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Type>

PEAK

Measures the highest peak within the reference range.

CPOWer

Measures the channel power within the reference range (integral bandwidth method).

*RST: CPOWer

Manual operation: See "Power Reference Type" on page 122

5.3.6.6 Configuring Power Classes

CALCulate<n>:LIMit<k>:ESpectrum<sb>:LIMits.....	473
CALCulate<n>:LIMit<k>:ESpectrum<sb>:MODE.....	474
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass:COUNT.....	475
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:LIMit[:STATe].....	475
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:MAXimum.....	476
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:MINimum.....	476
CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>[:EXCLusive].....	477
CALCulate<n>:LIMit<k>:ESpectrum<sb>:VALue.....	477

CALCulate<n>:LIMit<k>: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<k>:ESpectrum<sb>:PCLass:COUNT](#) on page 475.

Suffix:

<n>, <k> irrelevant

<sb> 1 | 2 | 3

Setting parameters:

<Max1> Defines the value range for power class 1 as -200 to <Max1>.

Only available for `CALC:LIM:ESP:PCL:COUNT >=2`

If only 2 power classes are defined, the value range for power class 2 is defined as <Max1> to 200.

Range: -199 to + 199

- <Max2>** Defines the value range for power class 2 as <Max1> to <Max2>.
 Only available for `CALC:LIM:ESP:PCL:COUNT >=3`
 If only 3 power classes are defined, the value range for power class 3 is defined as <Max2> to 200.
 Range: -199 to + 199, <Max2> must be higher than <Max1>
- <Max3>** Defines the value range for power class 3 as <Max2> to <Max3>.
 The value range for power class 4 is defined as <Max3> to 200.
 Only available for `CALC:LIM:ESP:PCL:COUNT = 4`
 Range: -199 to + 199, <Max3> must be higher than <Max2>

Return values:

<RangeLimits> As a result of the query, the range limits including the beginning of the first power class (-200) and the end of the last power class (+200) are indicated.

Example:

```
CALC:LIM:ESP:LIM -50,50,70
Defines the following power classes:
<-200, -50>
<-50, 50>
<50, 70>
<70, 200>
Query:
CALC:LIM:ESP:LIM?
Response:
-200,-50,50,70,200
```

CALCulate<n>:LIMit<k>: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>, <k> irrelevant
 <sb> 1 | 2 | 3

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<k>:ESpectrum<sb>:`

`PCLass<PClass>[:EXCLusive]` command.

*RST: AUTO

Example:

`CALC:LIM:ESP:MODE AUTO`

Activates automatic selection of the limit line.

CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass:COUNT <NoPowerClasses>

This command sets the number of power classes to be defined.

This command must be executed before any new power class values can be defined using `CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:MAXimum` and `CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:MINimum`.

Suffix:

<n>, <k> irrelevant

<sb> 1 | 2 | 3

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 124

CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>:LIMit[:STATe] <State>

This command selects the limit check mode for each power class.

Suffix:

<n>, <k> irrelevant

<sb> 1 | 2 | 3

<PClass> 1...4
power class

Parameters:

<State>

ABSolute

Evaluates only limit lines with absolute power values

RELative

Evaluates only limit lines with relative power values

AND

Evaluates limit lines with relative and absolute power values. A negative result is returned if both limits fail.

OR

Evaluates limit lines with relative and absolute power values. A negative result is returned if at least one limit failed.

*RST: REL

Example:

CALC:LIM:ESP:PCL:LIM ABS

Manual operation: See "Used Power Classes" on page 123**CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<PClass>:MAXimum <Level>**

This command defines the upper limit of a particular power class.

Note:

- The last power class always has an upper limit of 200 dBm.
- The upper limit of a power class must always be the same as the lower limit of the subsequent power class.
- The power class must already exist (see [CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass:COUNT](#) on page 475).

Suffix:

<n>, <k> irrelevant

<sb> 1 | 2 | 3

<PClass> 1...4
power class**Parameters:**

<Level> Range: -199.9 dBm to 200 dBm

Example:

CALC:LIM:ESP:PCL1:MAX -40 dBm

Sets the maximum power value of the first power class to -40 dBm.

Manual operation: See "PMin/PMax" on page 123**CALCulate<n>:LIMit<k>:ESPectrum<sb>:PCLass<PClass>:MINimum <Level>**

This command defines the lower limit of a particular power class.

Note:

- The first power class always has a lower limit of -200 dBm.

- The lower limit of a power class must always be the same as the upper limit of the previous power class.
- The power class must already exist (see [CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass:COUNT](#) on page 475).

Suffix:

<n>, <k>	irrelevant
<sb>	1 2 3
<PClass>	1...4 power class

Parameters:

<Level> Range: -200 dBm to 199.9 dBm

Example:

CALC:LIM:ESP:PCL2:MIN -40 dBm

Sets the minimum power value of the second power class to -40 dBm.

Manual operation: See "[PMin/PMax](#)" on page 123

CALCulate<n>:LIMit<k>:ESpectrum<sb>:PCLass<PClass>[:EXCLusive] <State>

This command selects the power class used by the measurement if [CALCulate<n>:LIMit<k>:ESpectrum<sb>:MODE](#) is set to manual.

Note that:

- You can only use power classes for which limits are defined.

Suffix:

<n>, <k>	irrelevant
<sb>	1 2 3
<PClass>	1...4 power class

Parameters:

<State> ON | OFF
*RST: OFF

Example:

CALC:LIM:ESP:PCL1 ON

Activates the first defined power class.

Manual operation: See "[Used Power Classes](#)" on page 123

CALCulate<n>:LIMit<k>:ESpectrum<sb>:VALue <Power>

This command activates the manual limit line selection as and specifies the expected power as a value. Depending on the entered value, the associated predefined limit lines is selected.

This command has the same effect as a combination of the `CALC:LIM:ESP:MODE MAN` and the `CALCulate<n>:LIMit<k>:ESpectrum<sb>:PClass<PClass>[: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>, <k> irrelevant

<sb> 1 | 2 | 3

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.

5.3.6.7 Configuring MSR SEM Measurements

<code>[SENSe:]ESpectrum<sb>:MSR:APPLY</code>	478
<code>[SENSe:]ESpectrum<sb>:MSR:BAND</code>	479
<code>[SENSe:]ESpectrum<sb>:MSR:BCATegory</code>	479
<code>[SENSe:]ESpectrum<sb>:MSR:CLAS</code>	480
<code>[SENSe:]ESpectrum<sb>:MSR:GSM:CARR</code>	481
<code>[SENSe:]ESpectrum<sb>:MSR:GSM:CPResent</code>	482
<code>[SENSe:]ESpectrum<sb>:MSR:LTE:CPResent</code>	482
<code>[SENSe:]ESpectrum<sb>:MSR:MPOWER</code>	483
<code>[SENSe:]ESpectrum<sb>:MSR:RFBWidth</code>	483

`[SENSe:]ESpectrum<sb>:MSR:APPLY`

This command configures the SEM sweep list according to the MSR settings defined by previous commands.

Suffix:

<sb> 1 | 2 | 3

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
```

Usage: Event

Manual operation: See "[Apply to SEM](#)" on page 127

[SENSe:]ESpectrum<sb>:MSR:BAND <Range>

Defines the frequency range of the bands used by the base station.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Range> **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 126

[SENSe:]ESpectrum<sb>:MSR:BCATegory <Category>

This command defines the band category for MSR measurements, i.e. the combination of available carriers to measure.

Suffix:

<sb> 1 | 2 | 3

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 125

[SENSe:]ESpectrum<sb>:MSR:CLAS <Class>

Defines the class of the base station according to its sending range.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Class> **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 125

[SENSe:]ESpectrum<sb>:MSR:GSM:CARR <Power>

Defines the power of the GSM carrier (if available, see [\[SENSe:\]ESpectrum<sb>:MSR:GSM:CPResent](#) on page 482).

This command is only available for band category 2 (see [\[SENSe:\]ESpectrum<sb>:MSR:BCATegory](#) on page 479).

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Power> numeric value
 Range: 0 dBm to 100 dBm
 *RST: 39.0 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 126

[SENSe:]ESpectrum<sb>:MSR:GSM:CPResent <State>

This command defines whether a GSM/Edge carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

This command is only available for band category 2 (see [SENSe:]ESpectrum<sb>:MSR:BCATegory on page 479).

Suffix:

<sb> 1 | 2 | 3

Parameters:

<State> ON | OFF
*RST: OFF

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 126

[SENSe:]ESpectrum<sb>:MSR:LTE:CPResent <State>

This command defines whether an LTE FDD 1.4 MHz or 3 MHz carrier is located at the edge of the specified RF bandwidth. In this case, the specification demands specific limits for the SEM ranges.

This command is only available for band category 2 (see [SENSe:]ESpectrum<sb>:MSR:BCATegory on page 479).

Suffix:

<sb> 1 | 2 | 3

Parameters:

<State> ON | OFF
*RST: OFF

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 126

[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:CLAS](#) on page 480).

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Power> Range: 0 dBm to 100 dBm
Increment: 1 dB

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 126

[SENSe:]ESpectrum<sb>:MSR:RFBWidth <Bandwidth>

This command defines the RF bandwidth of the base station for MSR measurements.

Suffix:

<sb> 1 | 2 | 3

Parameters:

<Bandwidth> Bandwidth in Hz
*RST: 10.0 MHz

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 126

5.3.6.8 Configuring the List Evaluation

CALCulate<n>:ESpectrum:PSEarch:AUTO.....	484
CALCulate<n>:ESpectrum:PEAKsearch:AUTO.....	484
CALCulate<n>:ESpectrum:PSEarch[:IMMEDIATE].....	484
CALCulate<n>:ESpectrum:PEAKsearch[:IMMEDIATE].....	484
CALCulate<n>:ESpectrum:PSEarch:MARGIN.....	485
CALCulate<n>:ESpectrum:PEAKsearch:MARGIN.....	485
CALCulate<n>:ESpectrum:PSEarch:PSHOW.....	485
CALCulate<n>:ESpectrum:PEAKsearch:PSHOW.....	485
MMEMory:STORe<n>:LIST.....	485

CALCulate<n>:ESpectrum:PSEarch:AUTO <State>
CALCulate<n>:ESpectrum:PEAKsearch:AUTO <State>

This command turns the list evaluation on and off.

Suffix:

<n> [Window](#)
 <m> [Marker](#)

Parameters:

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

Example: CALC:ESP:PSE:AUTO OFF
 Deactivates the list evaluation.

Manual operation: See "[List Evaluation \(Result Summary\) State](#)" on page 130
 See "[List Evaluation State](#)" on page 152

CALCulate<n>:ESpectrum:PSEarch[:IMMEDIATE]
CALCulate<n>:ESpectrum:PEAKsearch[:IMMEDIATE]

This command initiates a list evaluation.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)
Usage: Event

CALCulate<n>:ESPectrum:PSEarch:MARGin <Threshold>
CALCulate<n>:ESPectrum:PEAKsearch:MARGin <Threshold>

This command defines the threshold of the list evaluation.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)

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 130
 See "[Margin](#)" on page 152

CALCulate<n>:ESPectrum:PSEarch:PSHow <State>
CALCulate<n>:ESPectrum:PEAKsearch:PSHow <State>

This command turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)

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

Example: `CALC:ESP:PSE:PSH ON`
 Marks all peaks with blue squares.

Manual operation: See "[Show Peaks](#)" on page 130
 See "[Show Peaks](#)" on page 152

MMEMory:STORe<n>:LIST <FileName>

This command 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 full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S ESW User Manual.

Suffix:

<n> [Window](#)

Parameters:

<FileName> String containing the path and name of the target file.

Example:

```
M MEM: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 130

See ["Saving the Evaluation List"](#) on page 153

5.3.6.9 Performing SEM Measurements

Useful commands to perform SEM measurements described elsewhere:

- [INITiate<n>:ESpectrum](#) on page 455
- [INITiate<n>\[:IMMediate\]](#) on page 407
- [\[SENSe:\]SWEep:MODE](#) on page 455

5.3.6.10 Retrieving Results

Useful commands to retrieve results described elsewhere:

- [CALCulate<n>:LIMit<k>:FAIL?](#) on page 687
- [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?](#) on page 411
- [TRACe<n>\[:DATA\]](#) on page 617
- [TRACe<n>\[:DATA\]:MEMory?](#) on page 617
- [TRACe<n>\[:DATA\]:X?](#) on page 618

5.3.6.11 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-----
*RST
//Resets the instrument
SWE:MODE ESP
//Activates SEM Measurement

INIT:CONT OFF
//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

//----- Managing Measurement Configurations-----
ESP:PRES 'WCDMA\3GPP\UL\3GPP_UL.xml'
//Loads the 3GPP configuration stored in the file '3GPP_UL.xml'

//----- Defining the Reference Range-----
ESP:RRAN?
//Queries the current reference range.
ESP:RTYP CPOW
//Selects the channel power as the power reference.
ESP:BWID 4 MHZ
//Defines a channel bandwidth of 4 MHz for the power reference.
ESP:FILT:RRC ON
ESP:FILT:ALPH 0.5
//Uses an RRC filter with a roll-off factor of 0.5 when measuring
//the reference power.

//----- Configuring Power Classes-----
CALC:LIM:ESP:PCL:COUN 3
//Defines 3 power classes.
CALC:LIM:ESP:LIM -100,0
//Defines the value ranges of the three power classes as [dBm]:
//power class 1: -200 to -100
//power class 2: -100 to 0
//power class 3: 0 to 200
CALC:LIM:ESP:PCL1:LIM ABS
//Defines an absolute limit check for class 1.
CALC:LIM:ESP:PCL2:LIM REL
//Defines a relative limit check for class 2.
CALC:LIM:ESP:MODE MAN
//Defines a manual selection of the power class.
CALC:LIM:ESP:PCL2 ON
//Activates the use of the second power class for the entire measurement.

//----- Configuring a Sweep List-----
ESP:RANG2:INS AFT
//Inserts a range after range 2.

```

```

ESP:RANG1:INS BEF
//Inserts a range before range 1.
ESP:RANG:COUNT?
//Returns the number of measurement ranges in the sweep list (currently 11).
ESP:RANG5:DEL

//Deletes the 11th range.
ESP:RANG1:STOP -10000000

//Defines a stop frequency of -9 MHz for range 1.
ESP:RANG2:STAR -9000000
//Defines a start frequency of -10 MHz for range 2.

ESP:HSP OFF
//Switches off Fast SEM mode so the ranges can be configured individually.

ESP:RANG2:BAND:RES 1000000
//Defines a resolution bandwidth of 1 MHz for range 2.

ESP:RANG2:FILT:TYPE RRC
//Selects an RRC filter for range 2.
ESP:RANG2:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 2.
ESP:RANG2:SWE:TIME 1
//Defines a sweep time of 1 second for range 2.
ESP:RANG2:RLEV 0
//Defines a reference level of 0 dBm for range 2.
ESP:RANG2:INP:ATT 10
//Defines an input attenuation of 10 dB for range 2.

// Create a transducer that can be used.
// It has to cover the corresponding frequency range

SENSE1:CORREction:TRANSDUCER:SElect 'Transducer'
SENSE1:CORREction:TRANSDUCER:UNIT 'DB'
SENSE1:CORREction:TRANSDUCER:COMment 'Test Transducer'
// Frequency Span 0 MHz bis 20 Ghz
SENSE1:CORREction:TRANSDUCER:DATA 0e6,5, 20e9,3

ESP:RANG2:TRAN 'Transducer'
//Includes a transducer called 'transducer' for range 2.

//----- Configuring the limit check-----

ESP:RANG:LIM1:STAT AND
//Checks the absolute and relative limits for all ranges in power class 1 and
//fails if both limits are violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant. They are

```

```

//defined here to demonstrate the use of the MAX function for relative limits.
ESP:RANG2:LIM1:REL:STAR:FUNC MAX
//Enables the use of maximum function for relative limit start. If the value
//exceeds the larger of the absolute (-13 dBm) and relative (-10 dBc) start
//values, the check fails.
ESP:RANG2:LIM1:REL:STAR -10
ESP:RANG2:LIM1:REL:STAR:ABS -13
ESP:RANG2:LIM1:REL:STOP:FUNC MAX
ESP:RANG2:LIM1:REL:STOP -10
ESP:RANG2:LIM1:REL:STOP:ABS -13

ESP:RANG:LIM2:STAT OR
//Checks the absolute and relative limits for all ranges in power class 2 and
//fails if either limit is violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant.
ESP:RANG2:LIM2:ABS:STAR 10
ESP:RANG2:LIM2:ABS:STOP 10
//Defines an absolute limit of 10 dBm for the entire range 2 for power class 2.
ESP:RANG2:LIM2:REL:STAR -20
ESP:RANG2:LIM2:REL:STOP -20
//Defines a relative limit of -20 dBc for the entire range 2 for power class 2.

//----- Configuring List Evaluation-----
CALC:ESP:PSE:AUTO ON
//Activates list evaluation, i.e. the peak is determined for each range
//after each sweep.
CALC:ESP:PSE:MARG 10dB
//Defines a peak threshold of 10 dB.

//----- Managing Measurement Configurations-----

ESP:PRES:STOR 'WCDMA\3GPP\UL\3GPP_UL_User.xml'
//Saves the current configuration in a new file named '3GPP_UL_User'
//in the same directory so the standard is not overwritten.

//----- Performing the measurement-----
INIT:ESP
//One sweep

//----- Checking the Results-----
CALC:LIM:FAIL?
//Queries the result of the limit check for all ranges.
TRAC:DATA? LIST
//Returns the peak for each range of the SEM measurement as a list.

```

5.3.7 Measuring Spurious Emissions

- [Initializing the Measurement](#)..... 490
- [Configuring Sweep Lists](#)..... 490
- [Configuring the List Evaluation](#)..... 498
- [Performing Spurious Emission Measurements](#)..... 500
- [Retrieving Results](#)..... 500
- [Programming Example: Spurious Emissions Measurement](#)..... 501

5.3.7.1 Initializing the Measurement

Note that you have to initialize the measurement before you can configure the sweep list or the list evaluation.

[INITiate<n>:SPURious](#)..... 490

INITiate<n>:SPURious

This command initiates a Spurious Emission measurement.

Suffix:

<n> irrelevant

Usage: Event

5.3.7.2 Configuring Sweep Lists



In remote operation, it is not possible to configure the sweep list while a sweep is running.

Useful commands to configure sweep lists described elsewhere:

- [\[SENSe:\] SWEep:MODE](#) on page 455

[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution]	491
[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo	491
[SENSe:]LIST:RANGe<range>:BREak	491
[SENSe:]LIST:RANGe<range>:COUNT?	492
[SENSe:]LIST:RANGe<range>:DELeTe	492
[SENSe:]LIST:RANGe<range>:DETEctor	492
[SENSe:]LIST:RANGe<range>:FILTer:TYPE	492
[SENSe:]LIST:RANGe<range>[:FREQuency]:STARt	493
[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP	494
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation	494
[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO	494
[SENSe:]LIST:RANGe<range>:INPut:GAIN:LNA:STATe	495
[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe	495
[SENSe:]LIST:RANGe<range>:LIMit:STARt	495
[SENSe:]LIST:RANGe<range>:LIMit:STATe	496
[SENSe:]LIST:RANGe<range>:LIMit:STOP	496

[SENSe:]LIST:RANGe<range>:POINts[:VALue].....	496
[SENSe:]LIST:RANGe<range>:RLEVel.....	497
[SENSe:]LIST:RANGe<range>:SWEep:TIME.....	497
[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO.....	497
[SENSe:]LIST:RANGe<range>:TRANsducer.....	497

[SENSe:]LIST:RANGe<range>:BANDwidth[:RESolution] <RBW>

This command defines the resolution bandwidth for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<RBW> Resolution bandwidth.
Refer to the data sheet for available resolution bandwidths.
Default unit: Hz

Manual operation: See "[RBW](#)" on page 149

[SENSe:]LIST:RANGe<range>:BANDwidth:VIDeo <VBW>

This command defines the video bandwidth for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<VBW> Video bandwidth.
Refer to the data sheet for available video bandwidths.
Default unit: Hz

Manual operation: See "[VBW](#)" on page 149

[SENSe:]LIST:RANGe<range>:BREak <State>

This command controls the sweep (for all ranges, <range> is irrelevant).

Parameters:

<State> **ON**
The R&S ESW stops after measuring one range.
To continue with the next range, you have to use
[INITiate<n>:CONMeas](#).

OFF
The R&S ESW sweeps all ranges in one go.
*RST: OFF

Manual operation: See "[Stop After Sweep](#)" on page 150

[SENSe:]LIST:RANGe<range>:COUNT?

This command queries the number of ranges in the sweep list (<range> is irrelevant).

Return values:

<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]LIST:RANGe<range>:DELeTe

This command removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<range> 1..30
Selects the measurement range.

Usage: Event

[SENSe:]LIST:RANGe<range>:DETEctor <Detector>

This command selects the detector for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Detector> **NEGative**
minimum peak detector

POSitive
peak detector

SAMPIe
sample detector

RMS
RMS detector

AVERage
average detector

 *RST: RMS

Manual operation: See "[Detector](#)" on page 149

[SENSe:]LIST:RANGe<range>:FILTer:TYPE <FilterType>

This command selects the filter type for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<FilterType>

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

Manual operation: See "Filter Type" on page 148

[SENSe:]LIST:RANGe<range>[:FREQuency]:START <Frequency>

This command defines the start frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S 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

For more information see [Chapter 2.7, "Spurious Emissions Measurement"](#), on page 143.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Frequency>

Numeric value.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)

Default unit: Hz

Manual operation: See "Range Start / Range Stop" on page 148

[SENSe:]LIST:RANGe<range>[:FREQuency]:STOP <Frequency>

This command defines the stop frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S 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

For more information see [Chapter 2.7, "Spurious Emissions Measurement"](#), on page 143 .

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Manual operation: See ["Range Start / Range Stop"](#) on page 148

[SENSe:]LIST:RANGe<range>:INPut:ATTenuation <Attenuation>

This command defines the input attenuation for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Attenuation> Numeric value.
Refer to the data sheet for the attenuation range.
*RST: 10 dB
Default unit: dB

Manual operation: See ["RF Attenuator"](#) on page 150

[SENSe:]LIST:RANGe<range>:INPut:ATTenuation:AUTO <State>

This command turns automatic selection of the input attenuation for a spurious emission measurement range on and off.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

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

Manual operation: See "[RF Att. Mode](#)" on page 150

[SENSe:]LIST:RANGe<range>:INPut:GAIN:LNA:STATe <State>

This command turns the optional low noise amplifier (LNA) for a spurious emission measurement range on and off.

Note that it is not possible to turn on the [preamplifier](#) and the low noise preamplifier at the same time.

Suffix:

<range> 1..30
 Selects the measurement range.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

```
LIST:RANG2:INP:GAIN:LNA:STAT ON
```

Turns on the optional low noise amplifier in the second range.

Manual operation: See "[Preamp](#)" on page 150

[SENSe:]LIST:RANGe<range>:INPut:GAIN:STATe <State>

This command 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:

<range> 1..30
 Selects the measurement range.

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See "[Preamp](#)" on page 150

[SENSe:]LIST:RANGe<range>:LIMit:STARt <Level>

This command defines an absolute limit for a spurious emission measurement range.

Suffix:

<range> 1..30
 Selects the measurement range.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.
 Range: -400 to 400
 *RST: 13
 Default unit: dBm

Manual operation: See ["Abs Limit Start/Stop"](#) on page 151

[SENSe:]LIST:RANGe<range>:LIMit:STATe

This command turns the limit check for all spurious emission measurement ranges on and off (<range> is irrelevant).

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See ["Limit Check"](#) on page 151

[SENSe:]LIST:RANGe<range>:LIMit:STOP <Level>

This command defines an absolute limit for a spurious emission measurement range.

Suffix:

<range> 1..30
 Selects the measurement range.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.
 Range: -400 to 400
 *RST: 13
 Default unit: dBm

Manual operation: See ["Abs Limit Start/Stop"](#) on page 151

[SENSe:]LIST:RANGe<range>:POINts[:VALue] <Points>

This command defines the number of sweep points in a spurious emission measurement range.

Suffix:

<range> 1..30
 Selects the measurement range.

Parameters:

<Points> For more information on sweep points see [Chapter 3.6.1.8, "How Much Data is Measured: Sweep Points and Sweep Count"](#), on page 274.
 *RST: 1001

Manual operation: See ["Sweep Points"](#) on page 150

[SENSe:]LIST:RANGe<range>:RLEVel <RefLevel>

This command defines the reference level for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.

*RST: 0 dBm

Manual operation: See "[Ref. Level](#)" on page 149

[SENSe:]LIST:RANGe<range>:SWEep:TIME <SweepTime>

This command defines the sweep time for a spurious emission measurement range.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Manual operation: See "[Sweep Time](#)" on page 149

[SENSe:]LIST:RANGe<range>:SWEep:TIME:AUTO <State>

This command turns automatic selection of the sweep time for a spurious emission measurement range on and off.

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

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

Manual operation: See "[Sweep Time Mode](#)" on page 149

[SENSe:]LIST:RANGe<range>:TRANsdruceR <Transducer>

This command selects a transducer factor for a spurious emission measurement range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:

<range> 1..30
Selects the measurement range.

Parameters:

<Transducer> String containing the transducer file name, including the path information.

Manual operation: See "Transducer" on page 150

5.3.7.3 Configuring the List Evaluation

Useful commands to configure list evaluation described elsewhere:

- `MMEMoRY:STORe<n>:LIST` on page 485

<code>CALCulate<n>:PSEarch:AUTO</code>	498
<code>CALCulate<n>:PEAKsearch:AUTO</code>	498
<code>CALCulate<n>:PSEarch:DEtails</code>	498
<code>CALCulate<n>:ESpectrum:PEAKsearch:DEtails</code>	498
<code>CALCulate<n>:PSEarch:MARGin</code>	499
<code>CALCulate<n>:PEAKsearch:MARGin</code>	499
<code>CALCulate<n>:PSEarch:PSHow</code>	499
<code>CALCulate<n>:PEAKsearch:PSHow</code>	499
<code>CALCulate<n>:PSEarch:SUBRanges</code>	500
<code>CALCulate<n>:PEAKsearch:SUBRanges</code>	500

CALCulate<n>:PSEarch:AUTO <State>

CALCulate<n>:PEAKsearch:AUTO <State>

This command 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.

CALCulate<n>:PSEarch:DEtails <State>

CALCulate<n>:ESpectrum:PEAKsearch:DEtails <State>

This command 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 500).
OFF | 0
 Includes only one peak per range.
 *RST: OFF

Example:

CALC:ESP:PSE:DET ON
 CALC:PSE:SUBR 10
 Includes up to 10 peaks per range in the list.

Usage: Event

Manual operation: See "[Details](#)" on page 152

CALCulate<n>:PSEarch:MARGin <Threshold>
CALCulate<n>:PEAKsearch:MARGin <Threshold>

This command defines the threshold of the list evaluation.

Suffix:

<n> [Window](#)

Parameters:

<Margin> Range: -200 to 200
 *RST: 200
 Default unit: dB

Example:

CALC:PSE:MARG 100
 Sets the threshold to 100 dB.

CALCulate<n>:PSEarch:PSHow <State>
CALCulate<n>:PEAKsearch:PSHow <State>

This command turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:PSE:PSH ON
 Marks all peaks with blue squares.

CALCulate<n>:PSEarch:SUBRanges <NumberPeaks>

CALCulate<n>:PEAKsearch:SUBRanges <NumberPeaks>

This command defines the number of peaks included in the peak list.

After this number of peaks has been found, the R&S 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 153

5.3.7.4 Performing Spurious Emission Measurements

Useful commands to perform the measurement described elsewhere:

- [\[SENSe:\]SWEep:MODE](#) on page 455
- [INITiate<n>\[:IMMediate\]](#) on page 407

5.3.7.5 Retrieving Results

Useful commands to retrieve results described elsewhere:

- [CALCulate<n>:LIMit<k>:FAIL?](#) on page 687
- [TRACe<n>\[:DATA\]](#) on page 617
- [TRACe<n>\[:DATA\]:MEMory?](#) on page 617
- [TRACe<n>\[:DATA\]:X?](#) on page 618

[MMEMory:STORe<n>:SPURious](#)..... 500

MMEMory:STORe<n>:SPURious <FileName>

This command exports the marker peak list available for spurious emission measurements 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 full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S ESW User Manual.

Suffix:	
<n>	irrelevant
Parameters:	
<FileName>	String containing the path and name of the target file.
Example:	MMEM:STOR:SPUR 'test' Saves the current marker peak list in the file test.dat.
Usage:	Event

5.3.7.6 Programming Example: Spurious Emissions Measurement

In the following example, the Spurious Emissions measurement is configured by defining ranges and parameters to create the following sweep list.

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.
```

5.3.8 Analyzing Statistics

- [Activating Statistical Measurements](#)..... 503
- [Configuring Statistical Measurements](#).....504
- [Using Gate Ranges for Statistical Measurements](#)..... 504
- [Scaling the Diagram](#).....506
- [Performing a Statistical Measurement](#)..... 509
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- [Programming Example: Measuring Statistics](#)..... 511

5.3.8.1 Activating Statistical Measurements

- [CALCulate<n>:STATistics:APD\[:STATe\]](#)..... 503
- [CALCulate<n>:STATistics:CCDF\[:STATe\]](#)..... 503

CALCulate<n>:STATistics:APD[:STATe] <State>

This command turns the APD measurement on and off.

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:STAT:APD ON
 Switches on the APD measurement.

Manual operation: See "[APD](#)" on page 18

CALCulate<n>:STATistics:CCDF[:STATe] <State>

This command turns the CCDF on and off.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:STAT:CCDF ON
 Switches on the CCDF measurement.

Manual operation: See "[CCDF](#)" on page 18

5.3.8.2 Configuring Statistical Measurements

Useful commands to configure statistical measurements described elsewhere:

- [SENSe:]BANDwidth[:RESolution] on page 594

CALCulate<n>:MARKer<m>:Y:PERCent.....	504
CALCulate<n>:STATistics:NSAMples.....	504

CALCulate<n>:MARKer<m>:Y:PERCent <Probability>

This command sets a marker to a particular probability value. You can query the corresponding level with CALCulate<n>:MARKer<m>:X.

Using the command turns delta markers into normal markers.

This command is available for CCDF measurements.

Suffix:

<n> Window

<m> Marker

Parameters:

<Probability> Range: 0 % to 100 %

Example:

CALC1:MARK:Y:PERC 95PCT

Positions marker 1 to a probability of 95 %.

Manual operation: See "Percent Marker (CCDF only)" on page 162

CALCulate<n>:STATistics:NSAMples <Samples>

This command defines the number of samples included in the analysis of statistical measurement functions.

Suffix:

<n> Window

Parameters:

<Samples> Range: Min: 100, Max: depends on the RBW filter
*RST: 100000

Example:

CALC:STAT:NSAM 500

Sets the number of measurement points to be acquired to 500.

Manual operation: See "Number of Samples" on page 163

5.3.8.3 Using Gate Ranges for Statistical Measurements

[SENSe:]SWEep:EGATe:TRACe<t>:COMMENT.....	505
[SENSe:]SWEep:EGATe:TRACe:PERiod.....	505
[SENSe:]SWEep:EGATe:TRACe<t>:STARt<range>.....	505
[SENSe:]SWEep:EGATe:TRACe<t>:STOP<range>.....	506
[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<range>].....	506

[SENSe:]SWEep:EGATe:TRACe<t>:COMMeNt <Comment>

This command 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 164

[SENSe:]SWEep:EGATe:TRACe:PERiod <Length>

This command defines the length of the gate for all traces.

The gate length applies to all traces.

Parameters:

<Length> Range: 100 ns to 1000 s
*RST: 2 ms

Example:

SWE:EGAT:TRAC1:PER 5ms
Defines the period for gated triggering to 5 ms.

Manual operation: See "[Period](#)" on page 164

[SENSe:]SWEep:EGATe:TRACe<t>:STARt<range> <Time>

This command defines the start time for a gate range.

Suffix:

<t> [Trace](#)

<range> 1...3
gate range

Parameters:

<Time> The value range depends on the gate period you have set for the selected trace with [\[SENSe:\]SWEep:EGATe:TRACe:PERiod](#). The following rules apply:

- the start time may not be higher than the length of the gate
- the start time may not be lower than the stop time of the gate range of a lower order

The reset values depend on the gate range.

- for gate range 1, the start time is 0 ms
- for gate range 3, the start time is 2 ms
- for gate range 5, the start time is 4 ms

Example:

SWE:EGAT:TRAC1:STAR1 3ms
Sets the Starting point for range 1 on trace 1 at 3 ms.

Manual operation: See "Range <x> Start/Stop" on page 164

[SENSe:]SWEep:EGATe:TRACe<t>:STOP<range> <Time>

This command defines the stop time for a gate range.

Suffix:

<t>	Trace
<range>	1...3 gate range

Parameters:

<Time>	The value range depends on the gate period you have set for the selected trace with [SENSe:]SWEep:EGATe:TRACe:PERiod. The following rules apply: <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> • for gate range 1, the stop time is 1 ms • for gate range 3, the stop time is 3 ms • for gate range 5, the stop time is 5 ms
--------	---

Example: SWE:EGAT:TRAC1:STOP1 5ms
Sets the stopping point for range 1 on trace 1 at 5 ms.

Manual operation: See "Range <x> Start/Stop" on page 164

[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<range>] <State>

This command includes or excludes a gate range for a particular trace.

Suffix:

<t>	Trace
<range>	1...3 gate range

Parameters:

<State>	ON OFF
*RST:	OFF

Example: SWE:EGAT:TRAC1:STAT1 ON
Activates gate range 1 for trace 1.

Manual operation: See "Gated Trigger" on page 163
See "Range <x> Use" on page 164

5.3.8.4 Scaling the Diagram

CALCulate<n>:STATistics:PRESet.....	507
CALCulate<n>:STATistics:SCALE:AUTO ONCE.....	507
CALCulate<n>:STATistics:SCALE:X:RANGE.....	508

CALCulate<n>:STATistics:SCALe:X:RLEVel.....	508
CALCulate<n>:STATistics:SCALe:Y:LOWer.....	508
CALCulate<n>:STATistics:SCALe:Y:UNIT.....	509
CALCulate<n>:STATistics:SCALe:Y:UPPer.....	509

CALCulate<n>:STATistics:PRESet

This command resets the scale of the diagram (x- and y-axis).

- Reference level (x-axis)
0.0 dBm
- Display range (x-axis) for APD measurements
100 dB
- Display range (x-axis) for CCDF measurements
20 dB
- Upper limit of the y-axis
1.0
- Lower limit of the y-axis
1E-6

Suffix:

<n> [Window](#)

Example:

CALC:STAT:PRES
Resets the scaling for statistical functions

Usage:

Event

Manual operation: See "[Default Settings](#)" on page 166

CALCulate<n>:STATistics:SCALe:AUTO ONCE

This command initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get valid results, you have to perform a complete sweep with synchronization to the end of the auto range process. This is only possible in single sweep mode.

Suffix:

<n> [Window](#)

Parameters:

ONCE

Example:

CALC:STAT:SCAL:AUTO ONCE;*WAI
Adapts the level setting for statistical measurements.

Usage:

Event

Manual operation: See "[Adjust Settings](#)" on page 163

CALCulate<n>:STATistics:SCALE:X:RANGe <Range>

This command defines the display range of the x-axis for statistical measurements.

The effects are identical to `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALE]`.

Suffix:

<n> [Window](#)

Parameters:

<Range> Range: 1 dB to 200 dB
 *RST: 100 dB

Example: `CALC:STAT:SCAL:X:RANG 20dB`

Manual operation: See "[Range](#)" on page 166

CALCulate<n>:STATistics:SCALE:X:RLEVel <RefLevel>

This command sets the reference level for statistical measurements. The effects are identical to `DISPlay[:WINDow<n>]:TRACe<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

Example: `CALC:STAT:SCAL:X:RLEV -60dBm`

Manual operation: See "[Ref Level](#)" on page 166

CALCulate<n>:STATistics:SCALE:Y:LOWer <Magnitude>

This command 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 166

CALCulate<n>:STATistics:SCALE:Y:UNIT <Unit>

This command 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 166

CALCulate<n>:STATistics:SCALE:Y:UPPer <Magnitude>

This command 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 166

5.3.8.5 Performing a Statistical Measurement

Useful commands to perform statistical measurements described elsewhere:

- [INITiate<n>\[:IMMediate\]](#) on page 407

5.3.8.6 Retrieving Results

Useful commands to retrieve results described elsewhere:

- [CALCulate<n>:MARKer<m>:X](#) on page 640

[CALCulate<n>:STATistics:CCDF:X<t>?](#)..... 509

[CALCulate<n>:STATistics:RESult<t>?](#)..... 510

CALCulate<n>:STATistics:CCDF:X<t>? <Probability>

This command 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

Example:

```
CALC:STAT:CCDF:X1? P10
```

Returns the level values that are over 10 % above the mean value.

Usage:

Query only

Manual operation:

See "[CCDF](#)" on page 18

CALCulate<n>:STATistics:RESult<t>? <ResultType>

This command queries the results of a CCDF or ADP measurement for a specific trace.

Suffix:

<n> irrelevant

<t> [Trace](#)

Parameters:

<ResultType>	MEAN Average (=RMS) power in dBm measured during the measurement time.
	PEAK Peak power in dBm measured during the measurement time.
	CFACTOR Determined crest factor (= ratio of peak power to average power) in dB.
	ALL Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example:

```
CALC:STAT:RES2? ALL
```

Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage:

Query only

Manual operation:

See "[APD](#)" on page 18

See "[CCDF](#)" on page 18

5.3.8.7 Programming Example: Measuring Statistics

This example demonstrates how to determine statistical values for a measurement in a remote environment using the gated statistics example described in [Chapter 2.8.4, "APD and CCDF Basics - Gated Triggering"](#), on page 160.

```
//-----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

```

5.3.9 Measuring the Time Domain Power

- [Configuring the Measurement](#).....512
- [Performing Time Domain Power Measurements](#)..... 515
- [Retrieving Measurement Results](#).....515
- [Programming Example: Time Domain Power](#).....520

5.3.9.1 Configuring the Measurement

Useful commands to configure the measurement described elsewhere:

- [CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 645
- [CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 645
- [CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 646

CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:AOff	512
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:AVERage	513
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:PHOLd	513
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery[:STATe]	514
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:MEAN[:STATe]	514
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:PPEak[:STATe]	514
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:RMS[:STATe]	515
CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:SDEViation[:STATe]	515

CALCulate<n>:MARKer<m>:FUNCTion:SUMMery:AOff

This command turns all time domain power evaluation modes off.

Suffix:

<n>	Window
<m>	Marker

Usage: Event

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:AVERage <State>

This command switches on or off averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with [\[SENSe:\]AVERage<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:

<State> ON | OFF
*RST: OFF

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:SUMM:AVER ON
Switches on the calculation of average.
AVER:COUN 200
Sets the measurement counter to 200.
INIT;*WAI
Starts a sweep and waits for the end.
```

CALCulate<n>:MARKer<m>:FUNCtion:SUMMary:PHOLd <State>

This command switches on or off the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF
*RST: OFF

CALCulate<n>:MARKer<m>:FUNction:SUMMary[:STATe] <State>

This command turns time domain power measurements on and off. This measurement 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

*RST: OFF

Manual operation: See ["Time Domain Power"](#) on page 18

CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN[:STATe] <State>

This command turns the evaluation to determine the mean time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See ["Results"](#) on page 172

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak[:STATe] <State>

This command turns the evaluation to determine the positive peak time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See ["Results"](#) on page 172

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS[:STATe] <State>

This command turns the evaluation to determine the RMS time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See ["Results"](#) on page 172

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEVIation[:STATe] <State>

This command turns the evaluation to determine the standard deviation of the time domain power on and off.

The R&S ESW performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

5.3.9.2 Performing Time Domain Power Measurements

Useful commands to perform time domain power measurements described elsewhere:

- [INITiate<n>\[:IMMEDIATE\]](#) on page 407

5.3.9.3 Retrieving Measurement Results

- [Mean Power](#).....515
- [Peak Power](#).....517
- [RMS Power](#).....518
- [Standard Deviation](#).....519

Mean Power

[CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN:AVERAge:RESult?](#).....516

[CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN:PHOLd:RESult?](#).....516

[CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN:RESult?](#).....516

CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN:AVERage:RESult?

This command queries the average mean time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:AVERage](#) on page 513.

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?

This command queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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?

This command queries the mean time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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 172

Peak Power

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:AVERage:RESult?	517
CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:PHOLd:RESult?	517
CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:RESult?	517

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:AVERage:RESult?

This command queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:AVERage](#) on page 513.

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:

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:PHOLd:RESult?

This command queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:RESult?

This command queries the positive peak time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only

Manual operation: See "[Results](#)" on page 172

RMS Power

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:AVERAGE:RESULT?](#)..... 518

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:PHOLD:RESULT?](#)..... 518

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:RESULT?](#)..... 519

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:AVERAGE:RESULT?

This command queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERAGE](#) on page 513.

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?

This command queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLD](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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?

This command queries the RMS of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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 172

Standard Deviation

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:AVERage:RESult?.....	519
CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:PHOLd:RESult?.....	520
CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:RESult?.....	520

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:AVERage:RESult?

This command queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:AVERage](#) on page 513.

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?

This command queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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?

This command queries the standard deviation of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

5.3.9.4 Programming Example: Time Domain Power

This programming example demonstrates the measurement example described in [Chapter 2.9.6, "Measurement Example"](#), on page 174 in a remote environment.

```
//-----Configuring the Measurement-----
*RST
//Resets the instrument

INIT:CONT OFF
//Turns on single sweep mode.

FREQ:CENT 1.8GHz
//Sets the center frequency to 1.8 GHz.

BAND:RES 100kHz
```

```

//Sets the bandwidth to 100 kHz.

SWE:TIME 10ms
//Sets the sweep time to 640 µs.

FREQ:SPAN 0
//Sets the instrument to zero span.

CALC:MARK:FUNC:SUMM:STAT ON
//Turns on time domain power measurements.

CALC:MARK:FUNC:SUMM:MEAN ON
CALC:MARK:FUNC:SUMM:PPE ON
CALC:MARK:FUNC:SUMM:RMS ON
//Turns the 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 µs.

//-----Performing the Measurement-----

INIT;*WAI
//Initiates the measurement and waits until the measurement is finished.

//-----Retrieving the Results-----
CALC:MARK:FUNC:SUMM:MEAN:RES?
CALC:MARK:FUNC:SUMM:PPE:RES?
CALC:MARK:FUNC:SUMM:RMS:RES?
//Queries the mean, peak and RMS time domain power.

```

5.3.10 Measuring the Harmonic Distortion

- [Activating the Measurement](#).....521
- [Configuring the Measurement](#).....522
- [Performing the Measurement](#).....523
- [Retrieving Results](#).....524
- [Example: Measuring the Harmonic Distortion](#).....524

5.3.10.1 Activating the Measurement

[CALCulate<n>:MARKer<m>:FUNCtion:HARMonics\[:STATe\]](#)..... 522

CALCulate<n>:MARKer<m>:FUNction:HARMonics[:STATe] <State>

This command turns the harmonic distortion measurement on and off.

Note the following:

- If you perform the measurement in the frequency domain, the search range for the frequency of the first harmonic, whose power is determined, is defined by the last span.
- If you perform the measurement in the time domain, the current center frequency is used as the frequency of the first harmonic. Thus, the frequency search is bypassed. The first harmonic frequency is set by a specific center frequency in zero span before the harmonic measurement is started.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

CALC:MARK:FUNC:HARM ON

Activates the harmonic distortion measurement.

Manual operation: See "[Harmonic Distortion](#)" on page 19

5.3.10.2 Configuring the Measurement

Useful commands to configure the measurements described elsewhere:

- [CALCulate<n>:MARKer<m>:FUNction:CENTer](#) on page 585
- [\[SENSe:\]SWEep:TIME:AUTO](#) on page 602

[CALCulate<n>:MARKer<m>:FUNction:HARMonics:BANDwidth:AUTO](#)..... 522

[CALCulate<n>:MARKer<m>:FUNction:HARMonics:NHARmonics](#)..... 523

[CALCulate<n>:MARKer<m>:FUNction:HARMonics:PRESet](#)..... 523

CALCulate<n>:MARKer<m>:FUNction:HARMonics:BANDwidth:AUTO <State>

This command selects the resolution bandwidth of the harmonic in respect to the bandwidth of the first harmonic.

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 180

CALCulate<n>:MARKer<m>:FUNction:HARMonics:NHARmonics <NoHarmonics>

This command 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 "[No. of Harmonics](#)" on page 179

CALCulate<n>:MARKer<m>:FUNction:HARMonics:PRESet

This command initiates a measurement to determine the ideal configuration for the harmonic distortion measurement.

The method depends on the span.

- Frequency domain (span > 0)
 Frequency and level of the first harmonic are determined and used for the measurement list.
- Time domain (span = 0)
 The level of the first harmonic is determined. The frequency remains unchanged.

Suffix:

<n> [Window](#)
 <m> [Marker](#)

Usage: Event

Manual operation: See "[Adjust Settings](#)" on page 180

5.3.10.3 Performing the Measurement

Useful commands to perform the measurement described elsewhere:

- [INITiate<n>\[:IMMEDIATE\]](#) on page 407

5.3.10.4 Retrieving Results

CALCulate<n>:MARKer<m>:FUNCTion:HARMonics:DISTortion?.....	524
CALCulate<n>:MARKer<m>:FUNCTion:HARMonics:LIST?.....	524

CALCulate<n>:MARKer<m>:FUNCTion:HARMonics:DISTortion? TOTal

This command queries the total harmonic distortion of the signal.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> Window

<m> Marker

Return values:

<Result> <Distortion_%>,<Distortion_dB>
 Pair of values, one showing the THD in %, one in dB.

Usage: Query only

Manual operation: See "[Harmonic Distortion](#)" on page 19

CALCulate<n>:MARKer<m>:FUNCTion:HARMonics:LIST?

This command queries the position of the harmonics.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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.

Usage: Query only

Manual operation: See "[Harmonic Distortion](#)" on page 19

5.3.10.5 Example: Measuring the Harmonic Distortion

```
//-----Configuring the Measurement-----
*RST
//Resets the instrument.
```



```

INIT:CONT OFF
//Turns on single sweep mode.

CALC:MARK:FUNC:HARM ON
//Turns on the harmonic distortion measurement.
CALC:MARK:FUNC:HARM:NHAR 3
//Defines three harmonics to be found.

CALC:MARK:FUNC:HARM:BAND:AUTO OFF
//Turns off automatic bandwidth selection.
CALC:MARK:FUNC:HARM:PRES
//Determines the ideal configuration.

//-----Performing the Measurement-----

INIT;*WAI
//Initiates the measurement and finishes the sweep.

//-----Retrieving the Results-----
CALC:MARK:FUNC:HARM:LIST?
//Queries the position of the harmonics.
CALC:MARK:FUNC:HARM:DIST? TOT
//Queries the total harmonic distortion.

```

5.3.11 Measuring the Third Order Intercept Point

- [Determining the TOI](#).....525
- [Programming Example: Measuring the TOI](#).....527

5.3.11.1 Determining the TOI

Useful commands to perform TOI measurements described elsewhere:

- [CALCulate<n>:DELTaMarker<m>:X](#) on page 637
- [CALCulate<n>:DELTaMarker<m>:X:RELative?](#) on page 653
- [CALCulate<n>:DELTaMarker<m>:Y?](#) on page 654
- [CALCulate<n>:MARKer<m>:X](#) on page 640
- [CALCulate<n>:MARKer<m>:Y?](#) on page 654

[CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?](#)..... 525

[CALCulate<n>:MARKer<m>:FUNCTION:TOI:SEARChsignal ONCE](#)..... 526

[CALCulate<n>:MARKer<m>:FUNCTION:TOI\[:STATE\]](#)..... 526

CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?

This command queries the results for the third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<TOI> Third order intercept point.

Example:

```
INIT:CONT OFF
```

Switches to single sweep mode.

```
CALC:MARK:FUNC:TOI ON
```

Switches the intercept measurement.

```
INIT;*WAI
```

Starts a sweep and waits for the end.

```
CALC:MARK:FUNC:TOI:RES?
```

Outputs the measured value.

Usage: Query only

Manual operation: See "[TOI](#)" on page 19

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:

<n>, <m> irrelevant

Parameters:

ONCE

Example:

```
CALC:MARK:FUNC:TOI:SEAR ONCE
```

Executes the search for 2 signals and their intermodulation product at the currently available trace.

Usage: Event

Manual operation: See "[Search Signals](#)" on page 187

CALCulate<n>:MARKer<m>:FUNCTION:TOI[:STATe] <State>

This command initiates a measurement to determine the third intercept point.

A two-tone signal with equal carrier levels is expected at the RF input of the instrument. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can be modified separately afterwards with the [CALCulate<n>:DELTAmarker<m>:X](#) command.

The third-order intercept is calculated from the level spacing between the normal markers and the delta markers.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

CALC:MARK:FUNC:TOI ON

Switches on the measurement of the third-order intercept.

Manual operation: See ["TOI"](#) on page 19

5.3.11.2 Programming Example: Measuring the TOI

This example demonstrates how to determine the TOI in a remote environment.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
CALC:MARK:FUNC:TOI ON
//Activate TOI measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:TOI:SEAR ONCE
//Initiates a search for signals in the current trace.

//-----Retrieving Results-----
CALC:MARK:FUNC:TOI:RES?
//Returns the TOI.
```

5.3.12 Measuring the AM Modulation Depth

- [Configuring and Performing the Measurement](#)..... 527
- [Example: Measuring the AM Modulation Depth](#)..... 529

5.3.12.1 Configuring and Performing the Measurement

Useful commands to perform AM modulation depth measurements described elsewhere:

- [CALCulate<n>:DELTamarker<m>:X](#) on page 637
- [CALCulate<n>:DELTamarker<m>:X:RELative?](#) on page 653

- `CALCulate<n>:MARKer<m>:X` on page 640

<code>CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult?</code>	528
<code>CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:SEARChsignal ONCE</code>	528
<code>CALCulate<n>:MARKer<m>:FUNCTION:MDEPth[:STATe]</code>	528

`CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult?`

This command queries the results of the AM modulation depth measurement..

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

`<n>` [Window](#)

`<m>` [Marker](#)

Return values:

`<ModulationDepth>` Modulation depth in %.

Usage: Query only

Manual operation: See "[AM Mod Depth](#)" on page 19

`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>` [Window](#)

`<m>` [Marker](#)

Parameters:

ONCE

Example:

`CALC:MARK:FUNC:MDEP:SEAR ONCE`

Executes the search of an AM modulated signal at the currently available trace.

Usage: Event

Manual operation: See "[Search Signals](#)" on page 192

`CALCulate<n>:MARKer<m>:FUNCTION:MDEPth[:STATe] <State>`

This command turns the AM Modulation Depth measurement on and off.

To work correctly, the measurement requires an AM modulated signal.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<State> ON | OFF

*RST: OFF

Manual operation: See "[AM Mod Depth](#)" on page 19**5.3.12.2 Example: Measuring the AM Modulation Depth**

This example demonstrates how to determine the AM modulation depth in a remote environment. Note that without a real input signal this measurement will not return useful results.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
FREQ:CENT 100MHz
//Set center frequency
FREQ:SPAN 10KHz
// Set span
CALC:MARK:FUNC:MDEP ON
//Activate AM modulation depth measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT:IMM
// Perform a single measurement
CALC:MARK:FUNC:MDEP:SEAR ONCE
//Initiates a search for signals in the current trace.

//-----Retrieving Results-----
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results.

//If the results are not accurate, change the position of the
//the temporary markers manually.

//----Changing the position of the temp markers----
CALC:MARK:X 100MHZ
//Positions the reference marker on 100 MHz.
CALC:DELT2:X 5KHZ
//Positions delta marker 2 and 3 at a distance of 5 kHz to the reference marker.
CALC:DELT3:X 1KHZ
//Corrects the position of delta marker 3 by 1 kHz.
```

```
CALC:MARK:FUNC:MDEP:RES?  
//Queries the measurement results for the repositioned markers.
```

5.3.13 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.



Noise cancellation in list evaluations

Noise cancellation is also available in zero span and thus also for list evaluations. See "[Noise Cancellation](#)" on page 58 for details.

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.

5.3.13.1 Performing List Evaluations

All remote control commands specific to list evaluations (which are available via remote control only) are described here.

Useful commands for list evaluation described elsewhere:

- [\[SENSe:\]POWer:NCORrection](#) on page 587

Remote commands exclusive to list evaluation

[SENSe:]LIST:POWer:RESult?	531
[SENSe:]LIST:POWer[:SEQuence]	531
[SENSe:]LIST:POWer:SET	532
[SENSe:]LIST:POWer:STATe	533

[SENSe:]LIST:POWer:RESult?

This command queries the results of the list evaluation.

This command may be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PowerLevel> Power level for each frequency included in the measurement. The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with [SENSe:]LIST:POWer:SET. The result is a list of floating point values separated by commas. The unit depends on CALCulate<n>:UNIT:POWer.

Usage: Query only

[SENSe:]LIST:POWer[:SEQuence] <Frequency>, <RefLevel>, <RFAttenuation>, <FilterType>, <RBW>, <VBW>, <MeasTime>, <TriggerLevel>

This command configures and initiates the List Evaluation measurement.

The list can contain up to 200 entries (frequencies). You can define a different instrument setup for each frequency that is in the list.

If you synchronize the measurement with *OPC, the R&S 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.
 Range: 0 to Fmax
 Default unit: Hz

<RefLevel> Defines the reference level for a list entry.
 Range: -130 to 30
 Increment: 0.01
 Default unit: dBm

<RFAttenuation>	Defines the RF attenuation for a list entry. Range: 0 to 70 Increment: 1 Default unit: dB
<FilterType>	Selects the filter type for a list entry. For more information see [SENSe:]BANDwidth[:RESolution]:TYPE .
<RBW>	Defines the resolution bandwidth for a list entry.
<VBW>	Defines the video bandwidth for a list entry.
<MeasTime>	Defines the measurement time for a list entry. Range: 1 µs to 16000 s
<TriggerLevel>	The trigger level must be 0.
Return values:	
<PowerLevel>	Power level for each frequency included in the measurement. The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with [SENSe:]LIST:POWer:SET . The result is a list of floating point values separated by commas. The unit depends on CALCulate<n>:UNIT:POWer .

[SENSe:]LIST:POWer:SET <PeakPower>, <RMSPower>, <AVGPower>, <TriggerSource>, <TriggerSlope>, <TriggerOffset>, <GateLength>

This command defines global List Evaluation parameters.

These parameters are valid for every frequency you want to measure.

The state of the first three parameters (<PeakPower>, <RMSPower> and <AVGPower>) define the number of results for each frequency in the list.

Note that you have to set the trigger level *after* sending this command.

Parameters:

<PeakPower>	ON OFF 0 1 Turns peak power evaluation on and off. *RST: 1
<RMSPower>	ON OFF 0 1 Turns RMS power evaluation on and off. *RST: 0
<AVGPower>	ON OFF 0 1 Turns average power evaluation on and off. *RST: 0
<TriggerSource>	Selects a trigger source.
<TriggerSlope>	NEGative POSitive Selects the trigger slop.

- <TriggerOffset> Defines the trigger delay.
 Range: negative measurement time to 30 s
 *RST: 0
 Default unit: s
- <GateLength> Defines the gate length for gated measurements.
 Setting 0 seconds turns gated measurements off.
 To perform gated measurements, the trigger source must be different from IMMEDIATE.
 Range: 31.25 ns to 30 s
 *RST: 0 s

[SENSe:]LIST:POWer:STATe <State>

This command turns the List Evaluation off.

Parameters:

<State> OFF
 *RST: OFF

5.3.13.2 Example: Performing List Evaluation

The following example shows a list evaluation with the following configuration.

No	Freq [MHz]	Ref Level [dBm]	RF Attenuation [dB]	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

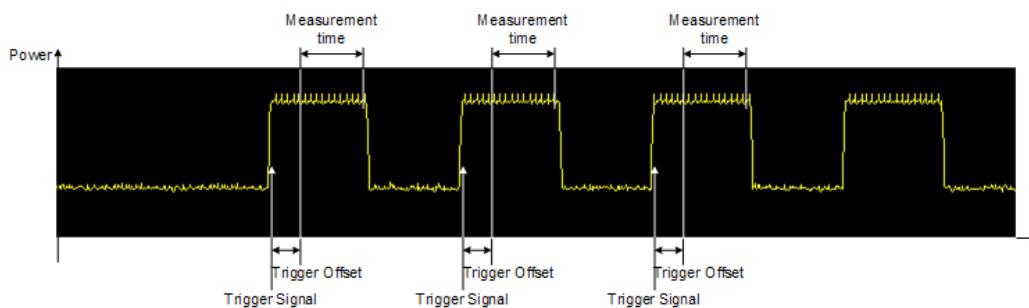
```

5.3.14 Measuring the Pulse Power

All remote control commands specific to measuring the mean or peak pulse power (e.g. bursts in various telecommunications standards) are described here. This measurement is available via remote control only.

The Pulse Power measurement is a gated measurement that determines the power over a particular number of pulses. The measurement is controlled by an external trigger or the video signal. A separate trigger event is required for each burst included in the measurement. In case of an external trigger source, the trigger level corresponds to the TTL level. In case of a video signal, you can define any threshold.

The figure below shows the relations between the available trigger settings.



The measurement is always on trace 1, either with the peak detector to determine the peak power or the RMS detector to determine the RMS power. Overall, you can configure the measurement independent of the instrument setup with the commands listed below only, which results in faster measurements.



The Pulse Power measurement is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S 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.

5.3.14.1 Performing Pulse Power Measurements

The following commands control pulse power measurements.

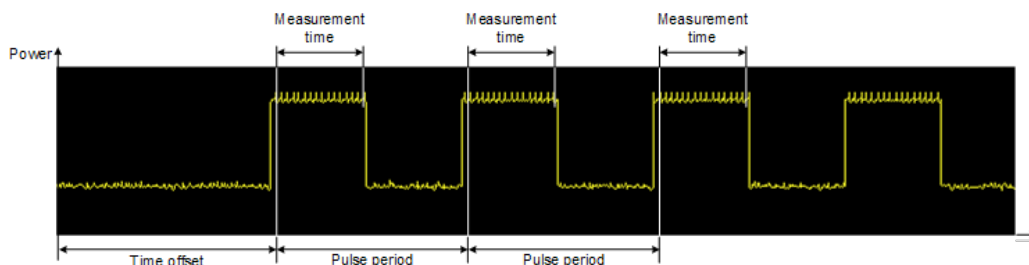
CALCulate<n>:MARKer<m>:FUNction:MSUMmary.....	535
[SENSe:]MPOWer:FtYpe.....	536
[SENSe:]MPOWer:RESult[:LIST]?.....	536
[SENSe:]MPOWer[:SEQuence].....	537
[SENSe:]MPOWer:RESult:MIN?.....	538

CALCulate<n>:MARKer<m>:FUNction:MSUMmary

<TimeOffset>,<MeasTime>,<PulsePeriod>,<#OfPulses>

This command configures power measurements on pulses in the time domain.

To evaluate the pulse power, the R&S 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
<#OfPulses>	Defines the number of pulses to measure.
Example:	<code>CALC:MARK:FUNC:MSUM 50US,450US,576.9US,8</code> Evaluates data that contains 8 pulses during a measurement time of 450 μ s and a pulse period of 576.9 μ s. The evaluation starts with an offset of 50 μ s.

[SENSe:]MPOWer:FTYPE <FilterType>

This command selects the filter type for pulse power measurements.

Parameters:

<FilterType>	<p>CFILter Channel filters Available in the Spectrum application.</p> <p>NORMal 3 dB Gaussian filters Available in the Spectrum application.</p> <p>P5 5-pole filters Available for FFT sweeps in the Spectrum application.</p> <p>RRC RRC filters</p> <p>CISPr PULSe 6 dB CISPR filter Return value for query is always <code>PULS</code>.</p> <p>MIL 6 dB MIL standard filter</p> <p>*RST: Depends on application</p>
--------------	--

[SENSe:]MPOWer:RESult[:LIST]?

This command queries the results of the pulse power measurement.

This command may be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower>	List of pulse powers. The number of values depends on the number of pulses you have been measuring. The unit is dBm.
--------------	--

Usage: Query only

[SENSe:]MPOWer[:SEquence] <Frequency>, <RBW>, <MeasTime>, <TriggerSource>, <TriggerLevel>, <TriggerOffset>, <Detector>, <#OfPulses>

This command configures and initiates the pulse power measurement.

The R&S 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. Range: 0 to Fmax Default unit: Hz
<RBW>	Defines the resolution bandwidth.
<MeasTime>	Defines the measurement time. Range: 1 µs to 30 s
<TriggerSource>	Selects a trigger source.
<TriggerLevel>	Defines a trigger level. The trigger level is available for the video trigger. In that case, the level is a percentage of the diagram height. In case of an external trigger, the R&S ESW uses a fix TTL level. Range: 0 to 100 Default unit: PCT
<TriggerOffset>	Defines the trigger delay. Range: 0 s to 30 s *RST: 0 s Default unit: s
<Detector>	Selects the detector and therefore the way the measurement is evaluated. MEAN Calculates the RMS pulse power. PEAK Calculates the peak pulse power.

<#OfPulses> Defines the number of pulses included in the measurement.
Range: 1 to 32001

Return values:

<PowerLevel> Pulse power level.
The result is a list of floating point values separated by commas.
The unit is dBm.

[SENSe:]MPOWer:RESult:MIN?

This command queries the lowest pulse power that has been measured during a pulse power measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> Lowest power level of the pulse power measurement.
The unit is dBm.

Usage: Query only

5.3.14.2 Example: Performing a Pulse Power Measurement

The following example shows a pulse power measurement.

```

-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
MPOW:FTYP NORM
//Selects a Gaussian filter for the measurement.
MPOW 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20;
*OPC
//Configures and initiates a measurement on 20 pulses with synchronization to the end.
//Analyzer produces a service request
//On service request:
MPOW:RES?
//Returns the results of the measurements (20 power levels).
MPOW:RES:MIN?
//Returns the lowest of the 20 power level that have been measured.

-----Initiliazing the measurement and querying results simultaneously-----
MPOW? 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20
//Configures, initiates and queries the results of the measurement.
//Result example:
-105.225059509,-105.656074524,-105.423065186,-104.374649048,-103.059822083,-101.29511261,
-99.96534729,-99.7452468872,-99.6610794067,-100.327224731,-100.96686554,-101.450386047,
-102.150642395,-103.240142822,-105.95476532,-110.583129883,-115.7760849,-126.279388428,
-124.620399475,-116.97366333

```

5.3.15 Remote Commands for EMI Measurements

The following commands are required to perform EMI measurements in a remote environment.

The following tasks specific to the EMI application are described here:

- [Activating EMI Measurement](#)..... 539
- [Configuring EMI Markers](#)..... 539
- [Configuring the EMI Final Test](#).....541
- [Configuring EMI Limit Lines](#)..... 542
- [Controlling LISN](#)..... 542
- [Retrieving EMI Results](#)..... 543
- [Evaluating the Results](#)..... 546
- [Programming Example: EMI Measurement](#)..... 546

5.3.15.1 Activating EMI Measurement

EMI measurement must be activated explicitly.

[CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:STATe](#)..... 539

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**

Manual operation: See "EMI" on page 19

5.3.15.2 Configuring EMI Markers

The commands required to configure EMI markers are described here.

Useful commands for configuring EMI markers described elsewhere:

- [CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 639
- [CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 637
- [CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 639
- [CALCulate<n>:DELTamarker<m>\[:STATe\]](#) on page 637
- [CALCulate<n>:DELTamarker<m>:MREF](#) on page 636
- [CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>](#) on page 638
- [CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m>](#) on page 635
- [CALCulate<n>:DELTamarker<m>:LINK](#) on page 634
- [CALCulate<n>:MARKer<m>:TRACe](#) on page 639

Remote commands exclusive to configuring EMI markers

CALCulate<n>:DELTaMarker<m>:FUNctIon:FMEaSurement:DETEctor	540
CALCulate<n>:MARKer<m>:FUNctIon:FMEaSurement:DETEctor	540

CALCulate<n>:DELTaMarker<m>:FUNctIon:FMEaSurement:DETEctor <Detector>

This command 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
quasi-peak detector

*RST: OFF

Manual operation: See "[Final Test Detector](#)" on page 206

CALCulate<n>:MARKer<m>:FUNctIon:FMEaSurement:DETEctor <Detector>

This command 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 quasi-peak detector
	*RST: OFF

Manual operation: See "Final Test Detector" on page 206

5.3.15.3 Configuring the EMI Final Test

The commands required to configure the EMI final test are described here.

Useful commands for configuring EMI final tests described elsewhere:

- [SENSe:]BANDwidth[:RESolution]:TYPE on page 595
- [SENSe:]BANDwidth[:RESolution] on page 594
- DISPlay[:WINDow<n>]:TRACe:X:SPACing on page 587

Remote commands exclusive to configuring EMI final tests

CALCulate<n>:MARKer<m>:FUNction:FMEasurement:PEAKsearch:AUTO.....	541
CALCulate<n>:MARKer<m>:FUNction:FMEasurement:PEAKsearch:AUTO.....	541
CALCulate<n>:MARKer<m>:FUNction:FMEasurement:DWELL.....	542

CALCulate<n>:MARKer<m>:FUNction:FMEasurement:PEAKsearch:AUTO
<State>

CALCulate<n>:MARKer<m>:FUNction:FMEasurement:PEAKsearch:AUTO
<State>

This command turns an automatic peak search on and off. If enabled, the search is performed automatically after each sweep.

Suffix:

<n>, <k> 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 208

CALCulate<n>:MARKer<m>:FUNction:FMEasurement:DWELI <Time>

This command defines the dwell time during the final measurement.

Suffix:

<n>, <m> irrelevant

Parameters:

<Time> Range: min value to max value
 *RST: 1 s
 Default unit: seconds

Manual operation: See ["Dwell Time"](#) on page 208

5.3.15.4 Configuring EMI Limit Lines

The commands required to define limit lines for EMI measurements are described in [Chapter 5.9.4, "Lines"](#), on page 681.

5.3.15.5 Controlling LISN

The commands required to control a LISN are described here.

INPut:LISN:PHASe	542
INPut:LISN:FILTER:HPASs[:STATe]	542
INPut:LISN:TYPE	543

INPut:LISN:PHASe <Phase>

This command selects the phase of the LISN you want to measure.

Parameters:

<Phase> **L1**
 L2
 L3
 N
 *RST: L1

Example: INP:LISN:PHAS N
 Selects the N phase.

Manual operation: See ["Phase"](#) on page 210

INPut:LISN:FILTER:HPASs[:STATe] <State>

This command turns the 150 kHz highpass filter for the ENV216 network on and off.

Parameters:

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

Example:

INP:LISN:HPAS ON
 Turns the filter on.

Manual operation: See "[150 kHz Highpass Filter](#)" on page 210

INPut:LISN:TYPE <LISNType>

This command selects the type of network.

Parameters:

<LISNType> **TWOPhase**
 2-Phase networks
FOURphase
 4-Phase networks
ESH3z5
ESH2z5
ENV4200
ENV216
 *RST: ---

Example:

INP:LISN:TYPE ESH3z5
 Selects the ESH3z5 network.

Manual operation: See "[LISN Type](#)" on page 210

5.3.15.6 Retrieving EMI Results

The commands required to retrieve EMI measurement results are described here.

Useful commands for retrieving EMI measurement results described elsewhere:

- [CALCulate<n>:MARKer<m>:X](#) on page 640
[CALCulate<n>:DELTamarker<m>:X](#) on page 637
- [CALCulate<n>:MARKer<m>:Y?](#) on page 654
[CALCulate<n>:DELTamarker<m>:Y?](#) on page 654

Remote commands exclusive to retrieving EMI measurement results

CALCulate<n>:DELTamarker<m>:FUNction:FMEasurement:RESult?	544
CALCulate<n>:MARKer<m>:FUNction:FMEasurement:RESult?	544
CALCulate<n>:DELTamarker<m>:FUNction:FMEasurement:LIMit<k>:CONDition ?	544
CALCulate<n>:MARKer<m>:FUNction:FMEasurement:LIMit<k>:CONDition ?	545
CALCulate<n>:DELTamarker<m>:FUNction:FMEasurement:LIMit<k>:DELTA?	545
CALCulate<n>:MARKer<m>:FUNction:FMEasurement:LIMit<k>:DELTA?	546

CALCulate<n>:DELTaMarker<m>:FUNctioN:FMEaSurement:RESult? <Result>

This command 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>

This command 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<k>:CONDition ? <Condition>

This command queries the condition of a deltamarker position in relation to a certain limit line.

Suffix:

<n> irrelevant

<m> [Marker](#)

<k> [Limit line](#)

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:LIM2:COND?`
Queries the condition of deltamarker 2 in relation to limit line 2.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:LIMit<k>:CONDition ?
<Condition>

This command queries the condition of a marker position in relation to a certain limit line.

Suffix:

<n> [Window](#)

<m> [Marker](#)

<k> [Limit line](#)

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:LIM2:COND?`
Queries the condition of marker 1 in relation to limit line 2.

Usage: Query only

CALCulate<n>:DELTamarker<m>:FUNCTion:FMEasurement:LIMit<k>:DELTa?

This command queries the vertical distance from the deltamarker position to the limit line. The unit is dB.

If the deltamarker has been assigned to a different trace than the limit line, or if no limit line is defined for the marker position, the command returns -200.

Suffix:

<n> irrelevant

<m> [Marker](#)

<k> [Limit line](#)

Return values:

<Amplitude> Vertical distance to the limit line in dB.

Example: `CALC:DELT3:FUNC:FME:LIM2:DELT?`
Queries the distance of deltamarker 3 to the second limit line.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNction:FMEasurement:LIMit<k>:DELTA?
 <Amplitude>

This command queries the vertical distance from the marker position to the limit line. The unit is dB.

If the marker has been assigned to a different trace than the limit line, or if no limit line is defined for the marker position, the command returns -200.

Suffix:

<n> Window
 <m> Marker
 <k> Limit line

Return values:

<Amplitude> Vertical distance to the limit line in dB.

Example:

CALC:MARK3:FUNC:FME:LIM2:DELT?
 Queries the distance of marker 3 to the second limit line.

Usage:

Query only

5.3.15.7 Evaluating the Results

The commands required to control the demodulation of signals at the marker position are described in "[Marker Demodulation](#)" on page 675.

5.3.15.8 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 line
//for each marker
CALC:MARK1:FUNC:FME:LIM1:COND?
CALC:MARK1:FUNC:FME:LIM1:DELT?
CALC:MARK2:FUNC:FME:LIM1:COND?
CALC:MARK2:FUNC:FME:LIM1:DELT?
CALC:MARK3:FUNC:FME:LIM1:COND?
CALC:MARK3:FUNC:FME:LIM1:DELT?
CALC:MARK4:FUNC:FME:LIM1:COND?
CALC:MARK4:FUNC:FME:LIM1:DELT?
CALC:MARK5:FUNC:FME:LIM1:COND?
CALC:MARK5:FUNC:FME:LIM1:DELT?
CALC:MARK6:FUNC:FME:LIM1:COND?
CALC:MARK6:FUNC:FME:LIM1:DELT?

```

5.3.16 Programming Example: Performing a Basic Frequency Sweep

This example demonstrates how to configure and perform a basic frequency sweep measurement in a remote environment.

```

//-----Preparing the measurement -----
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//-----Configuring the Frequency and Span-----
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz

```



```

//Sets the span to 100 MHz on either side of the center frequency.

//Activate signal tracking to keep the center frequency on the signal peak:
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
//After each sweep the maximum on trace 1 is searched within a range of 20 MHz
//around the center frequency. It must have a minimum power of -90dBm.

//-----Configuring the Bandwidth-----
BAND:AUTO OFF
BAND 1MHz
BAND:TYPE RRC
//Defines the RBW as 1 MHz using an RRC filter

BAND:VID:AUTO OFF
BAND:VID 500kHz
//Decouples the VBW from the RBW and decreases it to smooth the trace.

//-----Configuring the Sweep-----
SENS:SWE:COUN 10
//Defines 10 sweeps to be performed in each measurement.
SENS:SWE:POIN 500
//During each sweep, 500 trace points will be measured.
SENS:SWE:TIME:AUTO OFF
SENS:SWE:TIME 50ms
//Decouples the sweep time from the RBW,VBW and span and increases it to
//make the measurement more precise.

//-----Configuring Attenuation-----
//Only if electronic attenuator is available:
//INP:EATT:STAT ON
//Switches on the electronic attenuator.
//INP:EATT 30dB
//Sets the electronic attenuation to 30 dB.
INP:ATT 10dB
//Sets the mechanical attenuation to 10 dB and couples the reference level
//to the attenuation instead of vice versa.

//-----Configuring the Amplitude and Scaling-----
DISP:TRAC1:Y:RLEV -10dBm
//Sets the reference level to -10 dBm.
DISP:TRAC1:Y:RLEV:OFFS 10dB
//Shifts the trace display in the diagram up by 10dB.
CALC:UNIT:POW V
//Sets the unit of the y-axis to Volt. The reference level is now 70.711 mV.
DISP:TRAC1:Y:SPAC LOG
//Uses logarithmic scaling with absolute values (V).
DISP:TRAC1:Y 110dB

```

```

//Increases the displayed range of the y-axis to 110 dB.
DISP:TRAC1:Y:RPOS 80PCT
//Shifts the display of the reference level down, it is no longer the top line
//in the diagram. The reference level is displayed as a red line.

//-----Triggering-----
TRIG:SOUR IFP
TRIG:LEV:IFP -10dBm
TRIG:SLOP POS
TRIG:DTIM 50ms
TRIG:IFP:HYST 5dB
TRIG:HOLD 10ms
//Defines triggering when the second intermediate frequency rises to a level
//of -10 dBm, with a dropout time of 50 ms, a hysteresis of 5 dB and a delay
//of 10 ms.

SWE:EGAT ON
SWE:EGAT:TYPE EDGE
SWE:EGAT:LENG 5ms
//Defines gating. Values are measured for 5 ms after triggering.

OUTP:TRIG2:DIR OUTP
OUTP:TRIG2:OTYP UDEF
OUTP:TRIG2:LEV HIGH
OUTP:TRIG2:PULS:LENG 100us
OUTP:TRIG2:PULS:IMM
//Configures a high trigger signal with a pulse length of 100 us to be output at
//the front TRIGGER INPUT/OUTPUT connector once.

//-----Configuring the Trace-----
DISP:TRAC2 ON
DISP:TRAC2:MODE AVER
DISP:TRAC3 ON
DISP:TRAC3:MODE MAXH
//Configures 3 traces: 1 (default): clear/write; 2: average; 3: max hold

SENS:DET1 POS
SENS:DET2 RMS
SENS:DET3 POS
//Configures traces 1 and 3 to use the positive peak detector; trace 2 uses
//the RMS detector.

TRAC:COPY TRACE4,TRACE1
//Copies trace 1 to a new trace 4 which will then be averaged.

SENS:AVER:STAT4 ON
SENS:AVER:COUN 10
SENS:AVER:TYPE LIN
//Configures trace 4 to be averaged linearly over 10 sweeps.

```

```

CALC:MATH:STAT ON
CALC:MATH:MODE LIN
CALC:MATH (TRACE1-TRACE2)
CALC:MATH:POS 100
//Calculates the linear difference between the measured and average values.
//The resulting trace is displayed at the top of the diagram.

//-----Performing the Measurement-----
INIT;*WAI
//Initiates a new measurement and waits until the last sweep has finished.

//-----Retrieving Results-----
TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
TRAC:DATA? TRACE4
//Returns one power and one frequency value per sweep point for each trace.

```

5.4 Remote Commands to Select the Spectrum Application

INSTrument:CREate:DUPLicate	551
INSTrument:CREate[:NEW]	552
INSTrument:CREate:REPLace	552
INSTrument:DELeTe	552
INSTrument:LIST?	553
INSTrument:REName	553
INSTrument[:SELeCt]	554

INSTrument:CREate:DUPLicate

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

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

Example:

```

INST:SEL 'Receiver'
INST:CRE:DUPL

```

Duplicates the channel named 'Receiver' and creates a new measurement channel named 'Receiver 2'.

Usage: Event

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

This command adds an additional measurement channel.

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

See also

- [INSTrument\[:SElect\]](#) on page 554
- [INSTrument:CREate:DUPLicate](#) on page 551

Parameters:

<ChannelType>	Channel type of the new channel. For a list of available channel types see INSTrument:LIST? on page 553.
<ChannelName>	String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel. Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see INSTrument:LIST? on page 553).

Example: `INST:CRE REC, 'Receiver 2'`
Adds an additional Receiver channel named "Receiver 2".

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

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1>	String containing the name of the measurement channel you want to replace.
<ChannelType>	Channel type of the new channel. For a list of available channel types see INSTrument:LIST? on page 553.
<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 553).

Example: `INST:CRE:REPL 'Receiver', REC, 'REC2'`
Replaces the channel named 'Receiver' by a new measurement channel of type 'Receiver' named 'REC2'.

Usage: Setting only

INSTrument:DELeTe <ChannelName>

This command deletes a measurement channel.

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

Parameters:

<ChannelName> String containing the name of the channel you want to delete. A measurement channel must exist in order to be able delete it.

Example:

```
INST:DEL 'Receiver'
```

Deletes the channel with the name 'Receiver'.

Usage:

Event

INSTrument:LIST?

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

Return values:

<ChannelType>, For each channel, the command returns the channel type and
<ChannelName> channel name (see tables below).

Tip: to change the channel name, use the [INSTrument:REName](#) command.

Example:

```
INST:LIST?
```

Result for 2 measurement channels:
'REC', 'Receiver', 'REC', 'Receiver2'

Usage:

Query only

Table 5-2: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Receiver	RECEIVER	Receiver
CISPR APD	n/a Use CALCulate:STATistics: CAPD[:STATe]	CISPR APD
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Real-Time Spectrum	RTIM	Real-Time Spectrum

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>

This command renames a measurement channel.

Parameters:

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

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

Example: `INST:REN 'Receiver', 'REC'`
Renames the channel with the name 'Receiver' to 'REC'.

Usage: Setting only

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

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

Also see

- [INSTrument:CREate\[:NEW\]](#) on page 552

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see [INSTrument:LIST?](#) on page 553.

<ChannelName> String containing the name of the channel.

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

Usage: SCPI confirmed

5.5 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 554).

DISPlay:FORMat	554
DISPlay[:WINDow<n>]:SElect	555
DISPlay[:WINDow<n>]:SIZE	555
DISPlay:WSElect?	555

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit

Displays the MultiView tab with an overview of all active channels

(See [Chapter 1.3, "R&S MultiView"](#), on page 13).

SINGLE

Displays the measurement channel that was previously focused.

*RST: SING

Example:

DISP:FORM SPL

DISPlay[:WINDow<n>]:SElect

This command sets the focus on the selected result display window.

This window is then the active window.

Suffix:

<n>

[Window](#)**Example:**

DISP:WIND1:SEL

Sets the window 1 active.

Usage:

Setting only

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*.

To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see [LAYout:SPLitter](#) on page 559).

Suffix:

<n>

[Window](#)**Parameters:**

<Size>

LARGE

Maximizes the selected window to full screen.

Other windows are still active in the background.

SMALI

Reduces the size of the selected window to its original size.

If more than one measurement window was displayed originally, these are visible again.

*RST: SMALI

Example:

DISP:WIND2:SIZE LARG

DISPlay:WSElect?

This command queries the currently active window (the one that is focused) *in the currently selected measurement channel*.

Return values:

<ActiveWindow> Index number of the currently active window.
Range: 1 to 16

Usage: Query only

5.6 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see [INSTrument\[:SElect\]](#) on page 554).

LAYout:ADD[:WINDow]?	556
LAYout:CATalog[:WINDow]?	557
LAYout:IDENtify[:WINDow]?	558
LAYout:REMOve[:WINDow]	558
LAYout:REPLace[:WINDow]	558
LAYout:SPLitter	559
LAYout:WINDow<n>:ADD?	560
LAYout:WINDow<n>:IDENtify?	560
LAYout:WINDow<n>:REMOve	561
LAYout:WINDow<n>:REPLace	561

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the [LAYout:REPLace\[:WINDow\]](#) command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the [LAYout:CATalog\[:WINDow\]?](#) query.

<Direction> LEFT | RIGHT | ABOVE | BELOW
Direction the new window is added relative to the existing window.

<WindowType> text value
Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAY:ADD? '1', LEFT, MTAB
```

Result:

```
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage:

Query only

Manual operation:

See "[Diagram](#)" on page 306

See "[Marker Table](#)" on page 306

See "[Marker Peak List](#)" on page 306

See "[Result Summary](#)" on page 307

See "[Spectrogram](#)" on page 307

Table 5-3: <WindowType> parameter values for the Spectrum application

Parameter value	Window type
DIAGram	Diagram
FACCes	Fast Access panel
MTABle	Marker table
PEAKlist	Marker peak list
PRESelection	Preselector configuration
RSUMmary	Result summary
SGRam	Spectrogram

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

```
<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>
```

Return values:

<WindowName>

string

Name of the window.

In the default state, the name of the window is its index.

<WindowIndex>

numeric value

Index of the window.

Example:

```
LAY:CAT?
```

Result:

```
'2',2,'1',1
```

Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENTify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENTify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example:

```
LAY:WIND:IDEN? '2'
```

Queries the index of the result display named '2'.

Response:

```
2
```

Usage: Query only

LAYout:REMOve[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Example:

```
LAY:REM '2'
```

Removes the result display in the window named '2'.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 556 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 555 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

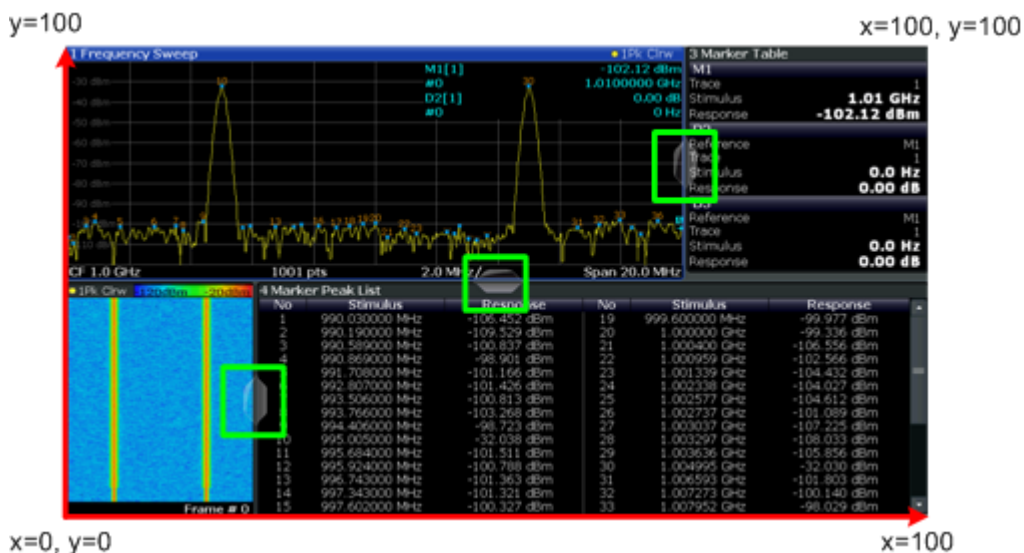


Figure 5-1: SmartGrid coordinates for remote control of the splitters

Parameters:

- <Index1> The index of one window the splitter controls.
 - <Index2> The index of a window on the other side of the splitter.
 - <Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 5-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.
- Range: 0 to 100

Example: `LAY:SPL 1,3,50`
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
 The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

`LAY:SPL 3,2,70`

`LAY:SPL 4,1,70`

`LAY:SPL 2,1,70`

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to [LAYout:ADD\[:WINDow\]?](#), for which the existing window is defined by a parameter.

To replace an existing window, use the [LAYout:WINDow<n>:REPLace](#) command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:

<n> [Window](#)

Parameters:

<Direction> LEFT | RIGHT | ABOVE | BELOW

<WindowType> Type of measurement window you want to add.
 See [LAYout:ADD\[:WINDow\]?](#) on page 556 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
 Result:
 '2'
 Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENTify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Suffix:

<n> [Window](#)

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example:

```
LAY:WIND2:IDEN?
Queries the name of the result display in window 2.
Response:
'2'
```

Usage: Query only

LAYout:WINDow<n>:REMOve

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMOve[:WINDow]` command.

Suffix:

<n> [Window](#)

Example:

```
LAY:WIND2:REM
Removes the result display in window 2.
```

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Suffix:

<n> [Window](#)

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 556 for a list of available window types.

Example:

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

5.7 Preset

SYSTem:PRESet	562
SYSTem:PRESet:CHANnel[:EXECute]	562

SYSTem:PRESet

This command presets the R&S ESW.

Example: `SYST:PRES`

Usage: Event
 SCPI confirmed

SYSTem:PRESet:CHANnel[:EXECute]

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

Use `INST:SEL` to select the channel.

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 218

5.8 Common Measurement Settings

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5.8.1 Introduction

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

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

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

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



Remote command examples

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

5.8.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
If not specified otherwise, commands can be used both for setting and for querying parameters.
If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
Parameters required only for setting are indicated as **Setting parameters**.
Parameters required only to refine a query are indicated as **Query parameters**.
Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S 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**
This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**

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

5.8.1.2 Long and Short Form

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

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

Example:

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

5.8.1.3 Numeric Suffixes

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

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

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

Example:

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

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

5.8.1.4 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

5.8.1.5 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.

5.8.1.6 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters may have different forms of values.

- [Numeric Values](#).....565
- [Boolean](#).....566
- [Character Data](#).....567
- [Character Strings](#).....567
- [Block Data](#).....567

Numeric Values

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

Example:

with unit: SENSe:FREQuency:CENTer 1GHZ

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

Boolean

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

Querying boolean parameters

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

Example:

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

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

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 5.1.2, "Long and Short Form"](#), on page 403.

Querying text parameters

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

Example:

Setting: `SENSe:BAWdwidth:RESolution:TYPE NORMal`

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

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'`

Block Data

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

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

5.8.2 Configuring Inputs and Ouputs

- [Selecting the Input Source](#)..... 567
- [Configuring the RF Input](#)..... 568
- [Configuring External Generators](#)..... 570
- [Configuring General Outputs](#)..... 578
- [Programming Example for External Generator Control](#)..... 581

5.8.2.1 Selecting the Input Source

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INPut:SElect <Source>

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

Parameters:

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

Manual operation: See "[Radio Frequency State](#)" on page 223

5.8.2.2 Configuring the RF Input

INPut:ATTenuation:PROTection:RESet.....	568
INPut:COUPling.....	568
INPut:IMPedance.....	569
INPut<n>:TYPE.....	569
INPut:UPORt[:VALue]?.....	569
INPut:UPORt:STATe.....	570

INPut:ATTenuation:PROTection:RESet

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

(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 3.3.1.1, "Increasing Measurement Sensitivity \(or Avoiding an Input Mixer Overload\)"](#), on page 218.

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

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

Example: INP:COUP DC

Usage: SCPI confirmed

Manual operation: See ["Input Coupling"](#) on page 223

INPut:IMPedance <Impedance>

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

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

Parameters:

<Impedance> 50 | 75
 *RST: 50 Ω

Example: INP:IMP 75

Usage: SCPI confirmed

Manual operation: See ["Impedance"](#) on page 223
 See ["Unit"](#) on page 265

INPut<n>:TYPE <Input>

The command selects the signal source.

Suffix:

<n> irrelevant

Parameters:

<Input> **INPUT1**
 Selects RF input 1.
INPUT2
 Selects RF input 2.
 *RST: INPUT1

Example: INP:TYPE INPUT1
 Selects RF input 1.

INPut:UPORt[:VALue]?

This command queries the control lines of the user ports.

For details see [OUTPut:UPORt\[:VALue\]](#) on page 580.

Return values:

<Value> 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.

Usage: Query only

INPut:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S 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

5.8.2.3 Configuring External Generators

[SENSe:]CORRection:COLLect[:ACQuire].....	570
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SOURce:EXTernal:FREQUency.....	573
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[SENSe:]CORRection:COLLect[:ACQuire] <MeasType>

This command 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 571).

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.

This command is only available if external generator control is active (see [SOURCE: EXTERNAL\[:STATe\]](#) on page 575).

Parameters:

<MeasType>

THRough

"TRANsmission" mode: calibration with direct connection between external 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

SCPI confirmed

Manual operation:

See ["Calibrate Reflection Short"](#) on page 241

See ["Calibrate Reflection Open"](#) on page 241

[SENSe:]CORRection:METHod

This command selects the type of measurement to be performed with the external generator.

This command is only available if external generator control is active (see [SOURCE: EXTERNAL\[:STATe\]](#) on page 575).

Parameters:

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 241

See ["Calibrate Reflection Short"](#) on page 241

See ["Calibrate Reflection Open"](#) on page 241

[SENSe:]CORRection:RECall

This command restores the measurement configuration used for calibration.

This command is only available if external generator control is active (see [SOURCE: EXTERNAL\[:STATE\]](#) on page 575).

Example: CORR:REC

Usage: Event

Manual operation: See ["Recall"](#) on page 242

[SENSe:]CORRection[:STATE] <State>

This command 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 570.

This command is only available if external generator control is active (see [SOURCE: EXTERNAL\[:STATE\]](#) on page 575).

Parameters:

<State> ON | OFF
*RST: OFF

Example: CORR ON
Activates normalization.

Usage: SCPI confirmed

Manual operation: See ["Source Calibration Normalize"](#) on page 242

[SENSe:]CORRection:TRANsducer:GENerator <Name>

This command 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:\r_s\instr\trd`. The frequency points are allocated in equidistant steps between start and stop frequency.

Parameters:

<Name> '<name>'

Example: CORR:TRAN:GEN 'SMW200A1'
Creates the transducer file
`C:\r_s\instr\trd\SMW200A.trd`.

Usage: SCPI confirmed

Manual operation: See ["Save As Trd Factor"](#) on page 242

SOURce:EXTernal:FREQuency <Frequency>

This command defines a fixed source frequency for the external generator.

Parameters:

<Frequency> Source frequency of the external generator.
*RST: 1100050000

Example: SOUR:EXT:FREQ 10MHz

Manual operation: See "[\(Manual\) Source Frequency](#)" on page 240

SOURce:EXTernal:FREQuency:COUPling[:STATe] <State>

This command couples the frequency of the external generator output to the R&S ESW.

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:EXTernal:FREQuency](#).

*RST: 1

Example: SOUR:EXT:FREQ:COUP ON

Manual operation: See "[Source Frequency Coupling](#)" on page 240

SOURce:EXTernal:FREQuency[:FACTor]:DENominator <Value>

This command defines the denominator of the factor with which the analyzer frequency is multiplied in order 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:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Parameters:

<Value> <numeric value>

*RST: 1

- Example:** SOUR:EXT:FREQ:NUM 4
 SOUR:EXT:FREQ:DEN 3
 Sets a multiplication factor of 4/3, i.e. the transmit frequency of the generator is 4/3 times the analyzer frequency.
- Manual operation:** See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 240

SOURce:EXTernal:FREQuency[:FACTor]:NUMerator <Value>

This command defines the numerator of the factor with which the analyzer frequency is multiplied in order 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:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Parameters:

<Value> <numeric value>
 *RST: 1

- Example:** SOUR:EXT:FREQ:NUM 4"
 "SOUR:EXT:FREQ:DEN 3"
 Sets a multiplication factor of 4/3, i.e. the transmit frequency of the generator is 4/3 times the analyzer frequency.

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 240

SOURce:EXTernal:FREQuency:OFFSet <Offset>

This command 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:

$$\text{Source Freq} = \text{RF} \cdot \frac{\text{Numerator}}{\text{Denominator}} + \text{Offset}$$

Parameters:

<Offset> <numeric value>, specified in Hz, kHz, MHz or GHz, rounded to the nearest Hz
 *RST: 0 Hz

- Example:** SOUR:EXT:FREQ:OFFS 10HZ
 Sets an offset of the generator output frequency compared to the analyzer frequency of 10 Hz.

Manual operation: See "(Automatic) Source Frequency (Numerator/Denominator/Offset)" on page 240

SOURce:EXTernal:FREQuency:SWEep[:STATe] <State>

Note that this command is maintained for compatibility reasons only. It is not required in new remote control programs.

This command activates or deactivates the frequency sweep for the selected generator.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

SOUR:EXT:FREQ:SWE ON
 Activates the frequency sweep for the external generator.

SOURce:EXTernal:POWer[:LEVel] <Level>

This command sets the output power of the selected generator.

Parameters:

<Level> <numeric value>
 *RST: -20 dBm

Example:

SOUR:EXT:POW -30dBm
 Sets the generator level to -30 dBm

Manual operation: See "Source Power" on page 239

SOURce:EXTernal[:STATe] <State>

This command activates or deactivates the connected external generator.

Parameters:

<State> ON | OFF
 *RST: OFF

Manual operation: See "Source State" on page 239

SOURce:POWer[:LEVel][:IMMEDIATE]:OFFSet <Offset>

This command defines a level offset for the external generator level. Thus, for example, attenuators or amplifiers at the output of the external generator can be taken into account for the setting.

Parameters:

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

- Example:** `SOUR:POW:OFFS -10dB`
Sets the level offset of the external generator to – 20 dBm.
- Usage:** SCPI confirmed
- Manual operation:** See "[Source Offset](#)" on page 239

SOURce:EXTernal:ROSCillator[:SOURce] <Source>

This command 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.

Parameters:

- <Source>
- INTernal**
the internal reference is used
- EXTernal**
the external reference is used; if none is available, an error flag is displayed in the status bar
- *RST: INT

- Example:** `SOUR:EXT:ROSC EXT`
Switches to external reference oscillator

- Manual operation:** See "[Reference](#)" on page 238

SYSTem:COMMunicate:GPIB:RDEvice:GENerator:ADDRess <Number>

Changes the IEC/IEEE-bus address of the external generator.

Parameters:

- <Number> Range: 0 to 30
- *RST: 28

- Example:** `SYST:COMM:GPIB:RDEV:GEN:ADDR 15`

- Manual operation:** See "[GPIB Address / TCP/IP Address](#)" on page 238

SYSTem:COMMunicate:RDEvice:GENerator:INTerface <Type>

Defines the interface used for the connection to the external generator.

This command is only available if external generator control is active (see [SOURce:EXTernal\[:STATe\]](#) on page 575).

Parameters:

- <Type> GPIB | TCPip
- *RST: GPIB

- Example:** `SYST:COMM:RDEV:GEN:INT TCP`

- Manual operation:** See "[Interface](#)" on page 238

SYSTem:COMMunicate:RDEvice:GENerator:LINK <Type>

This command 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. While, during GPIB operation, each frequency to be set is transmitted to the generator separately, a whole frequency list can be programmed in one go if the TTL interface is also used. Frequency switching can then be performed per TTL handshake which results in considerable speed advantages.

This command is only available if external generator control is active (see [SOURCE:EXTernal\[:STATe\]](#) on page 575).

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 238

SYSTem:COMMunicate:RDEvice:GENerator:TYPE <Type>

This command selects the type of external generator.

For a list of the available generator types see "[Overview of Supported Generators](#)" on page 228.

Parameters:

<Name>

<Generator name as string value>

*RST: SMU02

Example:

SYST:COMM:RDEV:GEN:TYPE 'SMW06'

Selects SMW06 as an external generator

Manual operation: See "[Generator Type](#)" on page 238

SYSTem:COMMunicate:TCPip:RDEvice:GENerator:ADDRESS <Address>

Configures the TCP/IP address for the external generator.

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 / TCP/IP Address](#)" on page 238

5.8.2.4 Configuring General Outputs

<code>OUTPut:IF:IFFRequency</code>	578
<code>OUTPut:IF[:SOURce]</code>	578
<code>OUTPut:TRIGger<port>:DIRection</code>	579
<code>OUTPut:TRIGger<port>:LEVel</code>	579
<code>OUTPut:TRIGger<port>:OTYPe</code>	579
<code>OUTPut:TRIGger<port>:PULSe:IMMediate</code>	580
<code>OUTPut:TRIGger<port>:PULSe:LENGth</code>	580
<code>OUTPut:UPORt[:VALue]</code>	580
<code>OUTPut:UPORt:STATe</code>	581

OUTPut:IF:IFFRequency <Frequency>

This command defines the frequency for the IF output of the R&S ESW. The IF frequency of the signal is converted accordingly.

This command is available in the time domain and if the IF/VIDEO/DEMODO output is configured for IF.

For more information see [Chapter 3.1.1, "IF and Video Signal Output"](#), on page 216.

Parameters:

<Frequency> *RST: 50.0 MHz

OUTPut:IF[:SOURce] <Source>

Defines the type of signal available at the IF/VIDEO/DEMODO or IF OUT 2 GHz connector 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:TRIGger<port>:DIRection <Direction>

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

Suffix:

<port> Selects the used trigger port.
 2 = trigger port 2 (front panel)
 3 = trigger port 3 (rear panel)

Parameters:

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

OUTPut
 Port works as an output.

*RST: INPut

Manual operation: See "[Trigger 2/3](#)" on page 251

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the (TTL compatible) signal generated at the trigger output.

This command works only if you have selected a user defined output with [OUTPut:TRIGger<port>:OTYPe](#).

Suffix:

<port> Selects the trigger port to which the output is sent.
 2 = trigger port 2 (front)
 3 = trigger port 3 (rear)

Parameters:

<Level> **HIGH**
 5 V

LOW
 0 V

*RST: LOW

Example: OUTP:TRIG2:LEV HIGH

Manual operation: See "[Level](#)" on page 252

OUTPut:TRIGger<port>:OTYPe <OutputType>

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

Suffix:

<port> Selects the trigger port to which the output is sent.
 2 = trigger port 2 (front)
 3 = trigger port 3 (rear)

Parameters:

<OutputType>

DEVICE

Sends a trigger signal when the R&S 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<port>:LEVel](#).

*RST: DEVICE

Manual operation: See "[Output Type](#)" on page 252

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

<port>

Selects the trigger port to which the output is sent.

2 = trigger port 2 (front)

3 = trigger port 3 (rear)

Usage:

Event

Manual operation: See "[Send Trigger](#)" on page 252

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

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

Suffix:

<port>

Selects the trigger port to which the output is sent.

2 = trigger port 2 (front)

3 = trigger port 3 (rear)

Parameters:

<Length>

Pulse length in seconds.

Example:

OUTPut:TRIG2:PULS:LENG 0.02

Manual operation: See "[Pulse Length](#)" on page 252

OUTPut:UPORt[:VALue] <Value>

This command sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern. If the user port is programmed to input instead of output (see `INPut:UPORt:STATe` on page 570), the output value is temporarily stored.

Parameters:

<Value> bit values in hexadecimal format
 TTL type voltage levels (max. 5V)
 Range: #B0000000 to #B0011111

Example:

`OUTP:UPOR #B00100100`
 Sets pins 5 and 7 to 5 V.

OUTPut:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S ESW.

Parameters:

<State> **ON**
 User port is switched to OUTPut
OFF
 User port is switched to INPut
 *RST: OFF

5.8.2.5 Programming Example for External Generator Control

The following example demonstrates how to work with an external generator in a remote environment.

5.8.3 Defining the Frequency

<code>[SENSe:]FREQuency:CENTer</code>	582
<code>[SENSe:]FREQuency:CENTer:STEP</code>	582
<code>[SENSe:]FREQuency:CENTer:STEP:AUTO</code>	583
<code>[SENSe:]FREQuency:CENTer:STEP:LINK</code>	583
<code>[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor</code>	583
<code>[SENSe:]FREQuency:OFFSet</code>	583
<code>[SENSe:]FREQuency:SPAN</code>	584
<code>[SENSe:]FREQuency:SPAN:FULL</code>	584
<code>[SENSe:]FREQuency:STARt</code>	584
<code>[SENSe:]FREQuency:STOP</code>	585
<code>CALCulate<n>:MARKer<m>:FUNCTion:CENTer</code>	585
<code>CALCulate<n>:MARKer<m>:FUNCTion:CSTep</code>	585
<code>CALCulate<n>:MARKer<m>:FUNCTion:STRack[:STATe]</code>	586
<code>CALCulate<n>:MARKer<m>:FUNCTion:STRack:BANDwidth</code>	586

CALCulate<n>:MARKer<m>:FUNction:STRack:THReshold.....	586
CALCulate<n>:MARKer<m>:FUNction:STRack:TRACe.....	586
DISPlay[:WINDow<n>]:TRACe:X:SPACing.....	587

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{\max} is specified in the data sheet.

UP

Increases the center frequency by the step defined using the
[SENSe:]FREQuency:CENTer:STEP command.

DOWN

Decreases the center frequency by the step defined using the
[SENSe:]FREQuency:CENTer:STEP command.

*RST: $f_{\max}/2$

Default unit: Hz

Example:

```
FREQ:CENT 100 MHz
```

```
FREQ:CENT:STEP 10 MHz
```

```
FREQ:CENT UP
```

Sets the center frequency to 110 MHz.

Usage:

SCPI confirmed

Manual operation:

See "Center frequency" on page 257

See "Frequency" on page 293

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

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the
SENS:FREQ UP AND SENS:FREQ DOWN commands, see [SENSe:]FREQuency:
CENTer on page 582.

Parameters:

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

Range: 1 to f_{\max}

*RST: 0.1 x span

Default unit: Hz

Example:

```
FREQ:CENT 100 MHz
```

```
FREQ:CENT:STEP 10 MHz
```

```
FREQ:CENT UP
```

Sets the center frequency to 110 MHz.

Manual operation:

See "Center Frequency Stepsize" on page 258

[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>

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

Parameters:

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

RBW
Couples the step size to the resolution bandwidth. Available for measurements in the time domain.

OFF
Decouples the step size.

*RST: SPAN

Example:

FREQ:CENT:STEP:LINK SPAN

Manual operation: See "[Center Frequency Stepsize](#)" on page 258

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

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

Parameters:

<Factor> 1 to 100 PCT
*RST: 10

Example:

FREQ:CENT:STEP:LINK:FACT 20PCT

Manual operation: See "[Center Frequency Stepsize](#)" on page 258

[SENSe:]FREQUENCY:OFFSet <Offset>

This command defines a frequency offset.

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

See also "[Frequency Offset](#)" on page 259.

Parameters:

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

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual operation: See "[Frequency Offset](#)" on page 259

**[SENSe:]FREQuency:SPAN **

This command 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:

 The minimum span for measurements in the frequency domain is 10 Hz. For SEM and spurious emission measurements, the minimum span is 20 Hz.

Range: 0 Hz to fmax
 *RST: Full span

Usage: SCPI confirmed

Manual operation: See "[Zero Span](#)" on page 16
 See "[Span](#)" on page 257
 See "[Zero Span](#)" on page 258
 See "[Last Span](#)" on page 258

[SENSe:]FREQuency:SPAN:FULL

This command restores the full span.

Usage: Event
 SCPI confirmed

Manual operation: See "[Full Span](#)" on page 258

[SENSe:]FREQuency:STARt <Frequency>

This command defines a start frequency for measurements in the frequency domain.

Parameters:

<Frequency> 0 to (fmax - min span)
 *RST: 0

Example: `FREQ:STAR 20MHz`

Usage: SCPI confirmed

Manual operation: See ["Frequency Sweep"](#) on page 16
See ["Start / Stop"](#) on page 257

[SENSe:]FREQuency:STOP <Frequency>

This command defines a stop frequency for measurements in the frequency domain.

Parameters:

<Frequency> min span to fmax
*RST: fmax

Example: `FREQ:STOP 2000 MHz`

Usage: SCPI confirmed

Manual operation: See ["Frequency Sweep"](#) on page 16
See ["Start / Stop"](#) on page 257

CALCulate<n>:MARKer<m>:FUNCTion:CENTer

This command matches the center frequency to the frequency of a marker.

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

Suffix:

<n> [Window](#)

<m> [Marker](#)

Example: `CALC:MARK2:FUNC:CENT`
Sets the center frequency to the frequency of marker 2.

Usage: Event

Manual operation: See ["Harmonic Distortion"](#) on page 19
See ["Center Frequency = Marker Frequency"](#) on page 371

CALCulate<n>:MARKer<m>:FUNCTion:CSTep

This command matches the center frequency step size to the current marker frequency.

The command turns delta markers into normal markers.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:FUNCTION:STRack[:STATe] <State>

This command turns signal tracking on and off.

Suffix:

<n>, <m> irrelevant

Parameters:

<State> ON | OFF
*RST: OFF

Manual operation: See "[Signal Tracking State](#)" on page 259

CALCulate<n>:MARKer<m>:FUNCTION:STRack:BANDwidth <Bandwidth>

This command defines the bandwidth around the center frequency that is included in the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Suffix:

<n>, <m> irrelevant

Parameters:

<Bandwidth> Range: 10 Hz to Max span
*RST: (= span/10 on activating the function)
Default unit: Hz

Manual operation: See "[Tracking Bandwidth](#)" on page 260

CALCulate<n>:MARKer<m>:FUNCTION:STRack:THReshold <Level>

This command defines the threshold level for the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Suffix:

<n>, <m> irrelevant

Parameters:

<Level> The unit depends on [CALCulate<n>:UNIT:POWer](#).
Range: -130 dBm to 30 dBm
*RST: -120 dBm

Manual operation: See "[Tracking Threshold](#)" on page 260

CALCulate<n>:MARKer<m>:FUNCTION:STRack:TRACe <TraceNumber>

This command selects the trace on which the largest signal is searched for.

Suffix:

<n>, <m> irrelevant

Parameters:

<TraceNumber> 1 to 6
 Range: 1 to 6
 *RST: 1

Manual operation: See "[Signal Track Trace](#)" on page 260

DISPlay[:WINDow<n>]:TRACe:X:SPACing <ScalingType>

This command selects the scaling of the x-axis.

Suffix:

<n> [Window](#)

Parameters:

<ScalingType> **LOGarithmic**
 Logarithmic scaling.
LINear
 Linear scaling.
 *RST: LINear

Example: DISP:TRAC:X:SPAC LOG

Manual operation: See "[Frequency Axis Scaling](#)" on page 208

5.8.4 Amplitude Settings

Remote commands to configure level characteristics described elsewhere:

- [INPut:COUPling](#) on page 568

[SENSe:]POWer:NCORrection	587
CALCulate<n>:MARKer<m>:FUNCTion:REFerence	588
CALCulate<n>:UNIT:POWer	588
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel	588
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet	589
INPut<n>:ATTenuation	589
INPut<n>:ATTenuation:AUTO	589
INPut<n>:ATTenuation:PROTection[:STATe]	590
INPut<n>:GAIN:LNA:STATe	590
INPut<n>:GAIN:STATe	591

[SENSe:]POWer:NCORrection <State>

This command turns noise cancellation on and off.

If noise cancellation is on, the R&S ESW performs a reference measurement to determine its inherent noise and subtracts the result from the channel power measurement result (first active trace only).

For more information see "[Noise Cancelation](#)" on page 58.

Parameters:

<State> ON | OFF
 *RST: OFF

Example: POW:NCOR ON

Manual operation: See ["Noise Cancelation"](#) on page 58

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

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

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

Suffix:

<n> [Window](#)

<m> [Marker](#)

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

Usage: Event

Manual operation: See ["Reference Level = Marker Level"](#) on page 371

CALCulate<n>:UNIT:POWER <Unit>

This command selects the unit of the y-axis.

The unit applies to all power-based measurement windows with absolute values.

Suffix:

<n> irrelevant

Parameters:

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT |
 DBUA | AMPere
 *RST: dBm

Example: CALC:UNIT:POW DBM
 Sets the power unit to dBm.

Manual operation: See ["Unit"](#) on page 265

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

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

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:

<n>, <t> irrelevant

Parameters:

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

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

Usage: SCPI confirmed

Manual operation: See "[Reference Level](#)" on page 264

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

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

Suffix:

<n>, <t> irrelevant

Parameters:

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

Example: DISP:TRAC:Y:RLEV:OFFS -10dB

Manual operation: See "[Shifting the Display \(Offset\)](#)" on page 166
 See "[Shifting the Display \(Offset\)](#)" on page 265

INPut<n>:ATTenuation <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 the input protection off with [INPut<n>:ATTenuation:PROTection\[:STATe\]](#) on page 590.

Suffix:

<n> irrelevant

Parameters:

<Attenuation> numeric value
 Range: 0 dB to 79 dB
 *RST: 10 dB
 Default unit: dB

Example: INP:ATT 40dB
 Defines an attenuation level of 40 dB.

Manual operation: See "[Attenuation](#)" on page 266

INPut<n>: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.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

ON

Selects automatic attenuation mode.

ON

Selects manual attenuation mode.

*RST: ON

Example:

INP:ATT:AUTO ON

Turns the auto ranging function on.

Manual operation: See "[Attenuation](#)" on page 266

INPut<n>:ATTenuation:PROTection[:STATe] <State>

This command turns the availability of attenuation levels of 10 dB or less on and off.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: OFF

Example:

INP:ATT:PROT ON

Manual operation: See "[10 dB Minimum Attenuation](#)" on page 265

INPut<n>: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.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: OFF

Example:

INP:GAIN:LNA:STAT ON

Turns on the low noise amplifier.

Usage:

SCPI confirmed

Manual operation: See "[Preamplifier](#)" on page 266

INPut<n>:GAIN:STATe <State>

This command turns the preamplifier on and off.

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF

*RST: OFF

Example:

INP:GAIN:STAT ON

Turns on the preamplifier.

Manual operation: See "Preamplifier" on page 266

5.8.5 Scaling the Y-Axis

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe].....	591
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE.....	591
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE.....	592
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSITION.....	592
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue.....	593
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing.....	593

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

This command 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>]:TRACe<t>:Y:SPACing`.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Range> Range: 1 dB to 200 dB

*RST: 100 dB

Example:

DISP:TRAC:Y 110dB

Usage:

SCPI confirmed

Manual operation: See "Range" on page 267

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

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

Suffix:

<n> Window

<t> irrelevant

Usage: SCPI confirmed

Manual operation: See ["Auto Scale Once"](#) on page 268

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

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

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

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

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

Example: DISP:TRAC:Y:MODE REL

Manual operation: See ["Scaling"](#) on page 268

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

This command defines the vertical position of the reference level on the display grid (for all traces).

The R&S 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](#)

<t> irrelevant

Parameters:

<Position> 0 PCT corresponds to the lower display border, 100% corresponds to the upper display border.
*RST: 100 PCT = frequency display; 50 PCT = time display

Example: DISP:TRAC:Y:RPOS 50PCT

Usage: SCPI confirmed

Manual operation: See ["Reference Position"](#) on page 242
See ["Ref Level Position"](#) on page 268

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

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

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

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

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

Example:

DISP:TRAC:Y:RVAL -20dBm

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

Manual operation: See "[Reference Value](#)" on page 243

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

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

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<ScalingType> **LOGarithmic**
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example:

DISP:TRAC:Y:SPAC LIN

Selects linear scaling in %.

Usage: SCPI confirmed

Manual operation: See "[Scaling](#)" on page 268

5.8.6 Remote Commands to Define Filter Characteristics

[SENSe:]BANDwidth[:RESolution]:AUTO.....	594
[SENSe:]BANDwidth[:RESolution].....	594
[SENSe:]BANDwidth[:RESolution]:RATio.....	595
[SENSe:]BANDwidth[:RESolution]:TYPE.....	595
[SENSe:]BANDwidth:VIDeo.....	595
[SENSe:]BANDwidth:VIDeo:AUTO.....	596
[SENSe:]BANDwidth:VIDeo:RATio.....	596
[SENSe:]BANDwidth:VIDeo:TYPE.....	596

[SENSe:]BANDwidth[:RESolution]:AUTO <State>

This command 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.

Usage: SCPI confirmed

Manual operation: See "RBW" on page 207
 See "Default Coupling" on page 279

[SENSe:]BANDwidth[:RESolution] <Bandwidth>

This command defines the resolution bandwidth and decouples the resolution bandwidth from the span.

For statistics measurements, this command defines the **demodulation** bandwidth.

Parameters:

<Bandwidth> refer to data sheet
 *RST: RBW: AUTO is set to ON; DBW: 3MHz

Example:

BAND 1 MHz

Sets the resolution bandwidth to 1 MHz

Usage: SCPI confirmed

Manual operation: See "Analysis Bandwidth" on page 162
 See "RBW" on page 207
 See "Res BW CISPR" on page 208
 See "Res BW MIL" on page 209
 See "RBW" on page 293

[SENSe:]BANDwidth[:RESolution]:RATio <Ratio>

This command 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

Usage: SCPI confirmed

Manual operation: See "[Span/RBW](#)" on page 278

[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
3 dB Gauss filters

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: BAND:TYPE NORM

Manual operation: See "[Filter Type](#)" on page 207
 See "[Res BW CISPR](#)" on page 208
 See "[Res BW MIL](#)" on page 209

[SENSe:]BANDwidth:VIDeo <Bandwidth>

This command defines the video bandwidth.

The command decouples the video bandwidth from the resolution bandwidths.

Parameters:

<Bandwidth> refer to data sheet
*RST: AUTO is set to ON

Example: BAND:VID 10 kHz

Usage: SCPI confirmed

Manual operation: See "[VBW](#)" on page 277

[SENSe:]BANDwidth:VIDeo:AUTO <State>

This command couples and decouples the video bandwidth to the resolution bandwidth.

Parameters:

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

Example: BAND:VID:AUTO OFF

Usage: SCPI confirmed

Manual operation: See "[VBW](#)" on page 277
See "[RBW/VBW](#)" on page 278
See "[Default Coupling](#)" on page 279

[SENSe:]BANDwidth:VIDeo:RATio <Ratio>

This command defines the coupling ratio of the video bandwidth to the resolution bandwidth (RBW/VBW).

Parameters:

<Ratio> Range: 0,001 to 1000
*RST: 1

Example: BAND:VID:RAT 3
Sets the coupling of video bandwidth to video bandwidth = 3*resolution bandwidth

Usage: SCPI confirmed

Manual operation: See "[RBW/VBW](#)" on page 278

[SENSe:]BANDwidth:VIDeo:TYPE <Mode>

This command selects the position of the video filter in the signal path.

Parameters:

<Mode>

LINear

The video filter is applied in front of the logarithmic amplifier. In linear mode, measurements with a logarithmic level scale result in flatter falling edges compared to logarithmic mode. The reason is the conversion of linear power values into logarithmic level values: if you halve the linear power, the logarithmic level decreases by 3 dB.

LOGarithmic

The video filter is applied after the logarithmic amplifier

*RST: LOGarithmic

Example:

BAND:VID:TYPE LIN

Video filter ahead of the logarithmic amplifier

5.8.7 Remote Commands to Control a Measurement

[SENSe:]AVERAge<n>:COUNT.....	597
[SENSe:]AVERAge<n>[:STATe<t>].....	598
[SENSe:]AVERAge<n>:TYPE.....	598
[SENSe:]BANDwidth[:RESolution]:FFT.....	598
[SENSe:]SWEep:COUNT.....	599
[SENSe:]SWEep:DURation?.....	600
[SENSe:]SWEep:OPTimize.....	600
[SENSe:]SWEep:POINts.....	601
[SENSe:]SWEep:TIME.....	601
[SENSe:]SWEep:TIME:AUTO.....	602
[SENSe:]SWEep:TYPE.....	602
[SENSe:]SWEep:TYPE:USED.....	602

[SENSe:]AVERAge<n>:COUNT <AverageCount>

This command 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

Usage: SCPI confirmed
Manual operation: See "[Average Count](#)" on page 334

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

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

Suffix:
 <n> [Window](#)
 <t> [Trace](#)

Parameters:
 <State> ON | OFF

Usage: SCPI confirmed

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

This command selects the trace averaging mode.

Suffix:
 <n> [Window](#)

Parameters:
 <Mode>

VIDeo
 The logarithmic power values are averaged.

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

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

*RST: VIDeo

Example: AVER:TYPE LIN
 Switches to linear average calculation.

Usage: SCPI confirmed

Manual operation: See "[Average Mode](#)" on page 333

[SENSe:]BANDwidth[:RESolution]:FFT <FilterMode>

Defines the filter mode to be used for FFT filters by defining the partial span size. The partial span is the span which is covered by one FFT analysis.

This command is only available when using the sweep type "FFT".

Note: this command is maintained for compatibility reasons only. For new remote control programs, use the [\[SENSe:\]SWEep:OPTimize](#) command.

Parameters:

<FilterMode>

WIDE | AUTO | NARRow

AUTO

Automatically applies the sweep optimization mode that is best for the current measurement.

NARRow

Optimizes the sweep mode for a large dynamic range.

WIDE

Optimizes the sweep mode for high performance.

*RST: AUTO

Example:

```
BAND:TYPE FFT
```

Select FFT filter.

Example:

```
BAND:FFT NARR
```

Select narrow partial span for FFT filter.

[SENSe:]SWEep:COUNT <SweepCount>

This command 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>

[Window](#)**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.

Usage:

SCPI confirmed

Manual operation: See "[Sweep / Average Count](#)" on page 279

[SENSe:]SWEep:DURation? <Time>

This command 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 601).

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 *partial span*. The partial span cannot be defined directly, but it can be optimized according to measurement requirements.

Table 5-4: Optimization parameters in FFT mode

Optimization mode	Description
DYNamic	Optimizes the dynamic range by using the narrowest possible partial span (depending on the RBW). 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 partial span (depending on the RBW). 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). It is recommended that you set the Sweep Time to "Auto" to optimize the sweep rate.
AUTO	Uses a medium-sized partial span to obtain a compromise between a large dynamic range and a fast sweep rate. The autorange function for the internal IF gain calculation is activated to obtain the best control range for the A/D converter.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 5-5: 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 280

[SENSe:]SWEep:POINTs <SweepPoints>

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

Note that the number of sweep points is limited to 10001 when measuring spurious emissions.

For EMI measurements, 200001 sweep points are available.

Parameters:

<SweepPoints> Range: 101 to 100001
*RST: 1001

Example:

SWE:POIN 251

Usage:

SCPI confirmed

Manual operation: See "[Sweep Points](#)" on page 280

[SENSe:]SWEep:TIME <Time>

This command defines the sweep time.

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 data sheet
*RST: depends on current settings (determined automatically)

Example:

SWE:TIME 10s

Usage:

SCPI confirmed

Manual operation: See "[Sweep Time](#)" on page 61
See "[Sweep Time](#)" on page 293

[SENSe:]SWEep:TIME:AUTO <State>

This command couples and decouples the sweep time to the span and the resolution and video bandwidths.

Parameters:

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

Example: SWE:TIME:AUTO ON
Activates automatic sweep time.

Usage: SCPI confirmed

Manual operation: See "[Harmonic Sweep Time](#)" on page 179
See "[Sweep Time](#)" on page 278
See "[Default Coupling](#)" on page 279

[SENSe:]SWEep:TYPE <Type>

This command selects the sweep type.

Parameters:

<Type> **AUTO**
Automatic selection of the sweep type between sweep mode and FFT.
FFT
FFT mode
SWE
Sweep list
*RST: AUTO

Example: SWE:TYPE FFT

Manual operation: See "[Sweep Type](#)" on page 281

[SENSe:]SWEep:TYPE:USED

This command queries the sweep type if you have turned on automatic selection of the sweep type.

Return values:

<Type> **SWE**
Normal sweep
FFT
FFT mode

5.8.8 Trigger Configuration

- [Configuring Trigger Conditions](#)..... 603
- [Configuring Gated Measurements](#)..... 608
- [Configuring Trigger Output](#)..... 610

5.8.8.1 Configuring Trigger Conditions

TRIGger[:SEQuence]:DTIME	603
TRIGger<n>[:SEQuence]:HOLDoff[:TIME]	603
TRIGger[:SEQuence]:IFPower:HOLDoff	604
TRIGger[:SEQuence]:IFPower:HYSteresis	604
TRIGger<n>[:SEQuence]:LEVel[:EXternal<port>]	605
TRIGger[:SEQuence]:LEVel:IFPower	605
TRIGger[:SEQuence]:LEVel:IQPower	605
TRIGger[:SEQuence]:LEVel:RFPower	606
TRIGger[:SEQuence]:LEVel:VIDeo	606
TRIGger<n>[:SEQuence]:SLOPe	606
TRIGger<n>[:SEQuence]:SOURce	606
TRIGger[:SEQuence]:TIME:RINTerval	607

TRIGger[:SEQuence]:DTIME <DropoutTime>

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

Parameters:

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

Manual operation: See "[Drop-Out Time](#)" on page 296

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

Defines the time offset between the trigger event and the start of the sweep (data capturing).

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger offset as well.

Suffix:

<n>	irrelevant
-----	------------

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
 For measurements in the time domain, the range is the negative sweep time to 30 s.
 *RST: 0 s

Example:

TRIG:HOLD 500us
 Defines a trigger offset of 500 µs.

Manual operation: See ["Trigger Offset"](#) on page 296

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

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

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

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

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 296

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

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

Parameters:

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

Example:

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

Manual operation: See ["Hysteresis"](#) on page 296

TRIGger<n>[:SEQuence]:LEVel[:EXtErnal<port>] <Level>

This command 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<port>:DIRection` command.

Suffix:

<n>	irrelevant
<port>	Selects the trigger port. 1 = trigger port 1 (TRIGGER INPUT connector on front panel) 2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)

Parameters:

<Level> Numeric value in V.

Example:

```
TRIG:SOUR EXT
TRIG:LEV 2V
```

Defines a trigger level of 2 V for an external trigger source.

Manual operation: See "[Trigger Level](#)" on page 295

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

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

Parameters:

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

*RST: -10 dBm

Example:

```
TRIG:LEV:IFP -30DBM
```

Manual operation: See "[Trigger Level](#)" on page 295

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

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

Parameters:

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

Example:

```
TRIG:LEV:IQP -30DBM
```

Manual operation: See "[Trigger Level](#)" on page 295

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

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

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

Parameters:

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

*RST: -20 dBm

Example:

TRIG:LEV:RFP -30dBm

Manual operation: See "[Trigger Level](#)" on page 295

TRIGger[:SEQuence]:LEVel:VIDeo <Level>

This command defines the level the video signal must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<Level> Range: 0 PCT to 100 PCT

*RST: 50 PCT

Example:

TRIG:LEV:VID 50PCT

TRIGger<n>[:SEQuence]:SLOPe <Type>

This command selects the trigger slope.

Suffix:

<n> 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:

TRIG:SLOP NEG

Manual operation: See "[Slope](#)" on page 296

TRIGger<n>[:SEQuence]:SOURce <Source>

This command 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 677).

Note on external triggers:

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

For troubleshooting tips see ["Incompleted sequential commands - blocked remote channels"](#) on page 700.

Suffix:

<n> irrelevant

Parameters:

<Source> See table below.

*RST: IMMEDIATE

Example:

TRIG:SOUR EXT

Selects the external trigger input as source of the trigger signal

Manual operation:

See ["Trigger Source"](#) on page 293

See ["Free Run"](#) on page 294

See ["Ext. Trigger 1/2"](#) on page 294

See ["Video"](#) on page 294

See ["IF Power"](#) on page 294

See ["RF Power"](#) on page 295

See ["Time"](#) on page 295

Table 5-6: 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. Note: Connector must be configured for "Input".
IFPower	Second intermediate frequency.
IMMEDIATE	Free Run trigger.
IQPower	Magnitude of sampled I/Q data. 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>

This command defines the repetition interval for the time trigger.

Parameters:

<Interval> 2.0 ms to 5000

Range: 2 ms to 5000 s

*RST: 1.0 s

Example: TRIG:SOUR TIME
 Selects the time trigger input for triggering.
 TRIG:TIME:RINT 50
 The sweep starts every 50 s.

Manual operation: See "[Repetition Interval](#)" on page 295

5.8.8.2 Configuring Gated Measurements

[SENSe:]SWEep:EGATe.....	608
[SENSe:]SWEep:EGATe:HOLDoff.....	608
[SENSe:]SWEep:EGATe:LENGth.....	609
[SENSe:]SWEep:EGATe:POLarity.....	609
[SENSe:]SWEep:EGATe:SOURce.....	609
[SENSe:]SWEep:EGATe:TYPE.....	610

[SENSe:]SWEep:EGATe <State>

This command turns gated measurements on and off.

In case of measurements with an external gate, the measured values are recorded as long as the gate is opened. During a sweep the gate can be opened and closed several times. The synchronization mechanisms with *OPC, *OPC? and *WAI remain completely unaffected.

The measurement ends when a particular number of measurement points has been recorded (see [SENSe:]SWEep:POINTs on page 601).

Performing gated measurements turns the squelch off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example: SWE:EGAT ON
 Switches on the external gate mode.
 SWE:EGAT:TYPE EDGE
 Switches on the edge-triggered mode.
 SWE:EGAT:HOLD 100US
 Sets the gate delay to 100 µs.
 SWE:EGAT:LEN 500US
 Sets the gate opening time to 500 µs.
 INIT;*WAI
 Starts a sweep and waits for its end.

[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>

This command defines the 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

Example: SWE:EGAT:HOLD 100us

Manual operation: See "[Gate Delay](#)" on page 299

[SENSe:]SWEep:EGATe:LENGth <GateLength>

This command defines the gate length.

Parameters:

<GateLength> Range: 125 ns to 30 s
 *RST: 400µs

Example: SWE:EGAT:LENG 10ms

Manual operation: See "[Gate Length](#)" on page 299

[SENSe:]SWEep:EGATe:POLarity <Polarity>

This command selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

Parameters:

<Polarity> POSitive | NEGative
 *RST: POSitive

Example: SWE:EGAT:POL POS

Manual operation: See "[Slope](#)" on page 296

[SENSe:]SWEep:EGATe:SOURce <Source>

This command selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information see "[Trigger Source](#)" on page 293.

Parameters:

<Source> *RST: IFPower

Example: SWE:EGAT:SOUR IFP
Switches the gate source to IF power.

Manual operation: See "[Trigger Source](#)" on page 293
See "[RF Power](#)" on page 295

[SENSe:]SWEep:EGATe:TYPE <Type>

This command selects the way gated measurements are triggered.

Parameters:

<Type>

LEVel

The trigger event for the gate to open is a particular power level. After the gate signal has been detected, the gate remains open until the signal disappears.

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S 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 298

5.8.8.3 Configuring Trigger Output

Commands to configure the trigger output described elsewhere:

- `OUTPut:TRIGger<port>:DIRection` on page 579
- `OUTPut:TRIGger<port>:LEVel` on page 579
- `OUTPut:TRIGger<port>:OTYPe` on page 579
- `OUTPut:TRIGger<port>:PULSe:IMMediate` on page 580
- `OUTPut:TRIGger<port>:PULSe:LENGth` on page 580

5.8.9 Automatic Configuration

<code>[SENSe:]ADJust:ALL</code>	610
<code>[SENSe:]ADJust:CONFigure:DURation</code>	611
<code>[SENSe:]ADJust:CONFigure:DURation:MODE</code>	611
<code>[SENSe:]ADJust:CONFigure:HYSteresis:LOWer</code>	612
<code>[SENSe:]ADJust:CONFigure:HYSteresis:UPPer</code>	612
<code>[SENSe:]ADJust:CONFigure:TRIG</code>	612
<code>[SENSe:]ADJust:FREQuency</code>	613
<code>[SENSe:]ADJust:LEVel</code>	613

[SENSe:]ADJust:ALL

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

This includes:

- Center frequency
- Reference level

Example: ADJ:ALL

Usage: Event

Manual operation: See ["Adjusting all Determinable Settings Automatically \(Auto All\)"](#) on page 303

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

In order 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:]ADJJust:CONFigure:DURation:MODE is set to MANual.

Parameters:

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

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

Manual operation: See ["Changing the Automatic Measurement Time \(Meastime Manual\)"](#) on page 304

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

In order 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:]ADJJust:CONFigure:DURation on page 611.

*RST: AUTO

Manual operation: See ["Resetting the Automatic Measurement Time \(Meastime Auto\)"](#) on page 303
 See ["Changing the Automatic Measurement Time \(Meastime Manual\)"](#) on page 304

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

When the reference level is adjusted automatically using the [\[SENSe:\]ADJust:LEVel](#) on page 613 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

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

Example:

SENS:ADJ:CONF:HYST:LOW 2

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

Manual operation: See "[Lower Level Hysteresis](#)" on page 304

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

When the reference level is adjusted automatically using the [\[SENSe:\]ADJust:LEVel](#) on page 613 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

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

Example:

SENS:ADJ:CONF:HYST:UPP 2

Example:

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

Manual operation: See "[Upper Level Hysteresis](#)" on page 304

[SENSe:]ADJust:CONFigure:TRIG <State>

Defines the behavior of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

Parameters:

<State>

ON | 1

The measurement for automatic adjustment waits for the trigger.

OFF | 0

The measurement for automatic adjustment is performed immediately, without waiting for a trigger.

*RST: 1

[SENSe:]ADJust:FREQuency

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

Example: ADJ:FREQ**Usage:** Event**Manual operation:** See ["Adjusting the Center Frequency Automatically \(Auto Freq\)"](#) on page 303**[SENSe:]ADJust:LEVel**

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

Example: ADJ:LEV**Usage:** Event**Manual operation:** See ["Setting the Reference Level Automatically \(Auto Level\)"](#) on page 303

5.9 Common Analysis and Display Functions

- [Zoom](#).....613
- [Remote Commands to Configure Traces](#).....616
- [Marker Usage](#).....634
- [Lines](#).....681

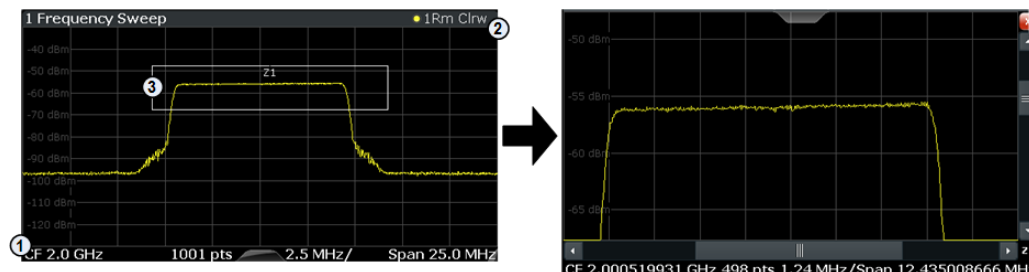
5.9.1 Zoom

- [DISPlay\[:WINDow<n>\]:ZOOM:AREA](#).....614
- [DISPlay\[:WINDow<n>\]:ZOOM:MULTiple<zoom>:AREA](#).....614
- [DISPlay\[:WINDow<n>\]:ZOOM:MULTiple<zoom>:STATe](#).....615
- [DISPlay\[:WINDow<n>\]:ZOOM:STATe](#).....615

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)

2 = end point of system (x2 = 100, y2 = 100)

3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<n>

Window

Parameters:

<x1>,<y1>,<x2>,<y2>

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

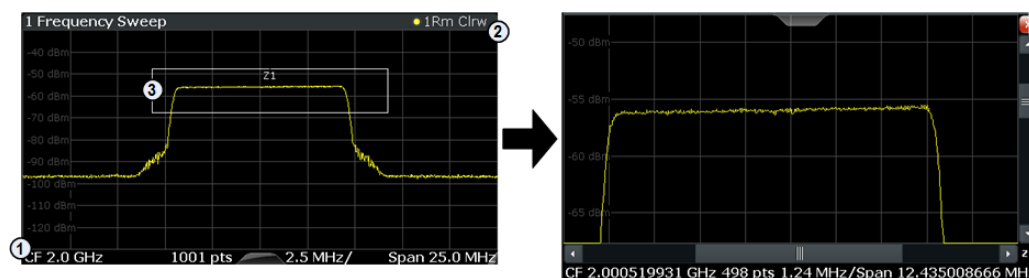
Default unit: PCT

Manual operation: See "Single Zoom" on page 314

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)

2 = end point of system (x2 = 100, y2 = 100)

3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<n>

Window

<zoom>

1...4

Selects the zoom window.

Parameters:

<x1>,<y1>
<x2>,<y2>

Diagram coordinates in % of the complete diagram that define the zoom area.

The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100

Default unit: PCT

Manual operation: See "[Multiple Zoom](#)" on page 314

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe <State>

This command turns the multiple zoom on and off.

Suffix:

<n> [Window](#)

<zoom> 1...4

Selects the zoom window.

If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "[Multiple Zoom](#)" on page 314
See "[Restore Original Display](#)" on page 314
See "[Deactivating Zoom \(Selection mode\)](#)" on page 314

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

DISP:ZOOM ON

Activates the zoom mode.

Manual operation: See "[Single Zoom](#)" on page 314
See "[Restore Original Display](#)" on page 314
See "[Deactivating Zoom \(Selection mode\)](#)" on page 314

5.9.2 Remote Commands to Configure Traces

- [Getting Trace Data](#).....616
- [Configuring Traces](#).....618
- [Performing Trace Mathematics](#).....623
- [Exporting Traces](#).....625
- [Configuring Spectrograms](#).....627

5.9.2.1 Getting Trace Data

MMEMory:STORe<n>:TRACe	616
TRACe<n>[:DATA]	617
TRACe<n>[:DATA]:MEMory?	617
TRACe<n>[:DATA]:X?	618

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

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

For details on the file format see [Chapter 4.3.6, "Reference: ASCII File Export Format"](#), on page 347.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S 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 627).

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3, 'C:\TEST.ASC'`
Stores trace 3 from window 1 in the file TEST.ASC.

Usage: SCPI confirmed

Manual operation: See "[Export Trace to ASCII File](#)" on page 336

TRACe<n>[:DATA]

This command queries current trace data and measurement results.

The data format depends on [FORMat \[:DATA\]](#).

Suffix:

<n> [Window](#)

Query parameters:

<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6

Returns the trace data for the corresponding trace.

SPECTrogram | SGRam

Returns the results of the spectrogram result display.

For details see [Table 5-7](#).

Example:

TRAC? TRACE3

Queries the data of trace 3.

Usage:

SCPI confirmed

Manual operation:

See "[Spectrum Emission Mask](#)" on page 17

See "[Spurious Emissions](#)" on page 18

See "[List Evaluation \(Result Summary\) State](#)" on page 130

See "[List Evaluation State](#)" on page 152

Table 5-7: Return values for SPECTrogram parameter

For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the unit you have currently set.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

This command queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA? TRACE1` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command is identical to `TRAC:DATA? TRACE1`

For details on the returned values see the [TRAC:DATA? <TRACE...>](#) command.

Suffix:

<n> [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.

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

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

This command queries the horizontal trace data 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.

TRACE1 | ... | TRACE6

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

Manual operation: See "[Spectrum Emission Mask](#)" on page 17

5.9.2.2 Configuring Traces

<code>[SENSe:][WINDow<n>:]DETEctor<t>[:FUNCTion]:AUTO</code>	618
<code>[SENSe:][WINDow<n>:]DETEctor<t>[:FUNCTion]</code>	619
<code>DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture</code>	620
<code>DISPlay[:WINDow<n>]:TRACe<t>:MODE</code>	620
<code>DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous</code>	621
<code>DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]</code>	621
<code>DISPlay[:WINDow<n>]:TRACe<t>[:STATe]</code>	622
<code>DISPlay[:WINDow<n>]:TRACe:X:SPACing</code>	622
<code>DISPlay[:WINDow<n>]:TRACe<t>[:STATe]</code>	622
<code>TRACe<n>:COPY</code>	623

[SENSe:][WINDow<n>:]DETEctor<t>[:FUNCTion]:AUTO <State>

This command couples and decouples the detector to the trace mode.

Suffix:
<n> [Window](#)
<t> [Trace](#)

Parameters:

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

Example:

DET:AUTO OFF

The selection of the detector is not coupled to the trace mode.

Manual operation: See "[Detector](#)" on page 332

[SENSe:][WINDow<n>:]DETEctor<t>[:FUNction] <Detector>

Defines the trace detector to be used for trace analysis.

For details see [Chapter 4.3.1.1, "Mapping Samples to sweep Points with the Trace Detector"](#), on page 317.

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<Detector> **APEak**
 Autopeak
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 332

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

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

Suffix:

<n> Window

<t> Trace

Parameters:

<Percentage> Range: 1 to 50
*RST: 2
Default unit: PCT

Example: `DISP3:TRAC2:SMO:APER 5`
Defines an aperture of 5% for trace 2 in window 3

Manual operation: See "Smoothing" on page 333

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

This command selects the trace mode.

Suffix:

<n> Window

<t> Trace

Parameters:

<Mode>

WRITe

Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage

The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold

The maximum value is determined over several sweeps and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold

The minimum value is determined from several measurements and displayed. The R&S 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 332

DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous <State>

This command turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<State> **ON**
The automatic reset is off.

OFF
The automatic reset is on.

*RST: OFF

Example:

```
DISP:WIND:TRAC3:MODE:HCON ON
Switches off the reset function.
```

Manual operation: See "[Hold](#)" on page 332

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

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

If enabled, the trace is smoothed by the value specified using [DISPlay\[:WINDow<n>\]:TRACe<t>:SMOothing:APERture](#) on page 620.

For more information see [Chapter 4.3.1.6, "Trace Smoothing"](#), on page 323.

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

DISP3:TRAC2:SMO ON
 Turns on trace smoothing for trace 2 in window 3

Usage:

SCPI confirmed

Manual operation: See "[Smoothing](#)" on page 333

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

This command turns a trace on and off.

Parameters:

<State> ON | OFF
 *RST: Trace 1: ON, Trace 2-6: OFF

Example:

DISP:TRAC3 ON

Usage:

SCPI confirmed

DISPlay[:WINDow<n>]:TRACe:X:SPACing <ScalingType>

This command selects the scaling of the x-axis.

Suffix:

<n> [Window](#)

Parameters:

<ScalingType> **LOGarithmic**
 Logarithmic scaling.
LINear
 Linear scaling.
 *RST: LINear

Example:

DISP:TRAC:X:SPAC LOG

Manual operation: See "[Frequency Axis Scaling](#)" on page 208

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

This command turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> [Window](#)
 Irrelevant in the Receiver application.

<t> [Trace](#)

Parameters:

<State> ON | OFF | 0 | 1
 *RST: 1 for TRACe1, 0 for TRACe 2 to 6

Example: DISP:TRAC3 ON

Usage: SCPI confirmed

Manual operation: See "[Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6](#)" on page 331
 See "[Trace 1/Trace 2/Trace 3/Trace 4 \(Softkeys\)](#)" on page 334

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Suffix:

<n> [Window](#)

Parameters:

<TraceNumber>, **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
 <TraceNumber> 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.

Usage: SCPI confirmed

Manual operation: See "[Copy Trace](#)" on page 335

5.9.2.3 Performing Trace Mathematics

CALCulate<n>:MATH[:EXpression][:DEFine]	623
CALCulate<n>:MATH:MODE	624
CALCulate<n>:MATH:POSition	624
CALCulate<n>:MATH:STATe	625

CALCulate<n>:MATH[:EXpression][:DEFine] <Expression>

This command selects the mathematical expression for trace mathematics.

Before you can use the command, you have to turn trace mathematics on.

Suffix:

<n> [Window](#)

Parameters:

<Expression> **(TRACE1-TRACE2)**
Subtracts trace 2 from trace 1.

(TRACE1-TRACE3)
Subtracts trace 3 from trace 1.

(TRACE1-TRACE4)
Subtracts trace 4 from trace 1.

(TRACE1-TRACE5)
Subtracts trace 5 from trace 1.

(TRACE1-TRACE6)
Subtracts trace 6 from trace 1.

Example:

```
CALC:MATH:STAT ON
Turns trace mathematics on.
CALC:MATH:EXPR:DEF (TRACE1-TRACE3)
Subtracts trace 3 from trace 1.
```

Usage: SCPI confirmed

Manual operation: See "[Trace Math Function](#)" on page 336

CALCulate<n>:MATH:MODE <Mode>

This command selects the way the R&S ESW calculates trace mathematics.

Suffix:

<n> [Window](#)

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 337

CALCulate<n>:MATH:POSition <Position>

This command defines the position of the trace resulting from the mathematical operation.

Suffix:

<n> [Window](#)

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 337

CALCulate<n>:MATH:STATe <State>

This command turns the trace mathematics on and off.

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:MATH:STAT ON
 Turns on trace mathematics.

Usage:

SCPI confirmed

Manual operation: See ["Trace Math Function"](#) on page 336
 See ["Trace Math Off"](#) on page 337

5.9.2.4 Exporting Traces

FORMat[:DATA]	625
FORMat:DEXPort:DSEParator	626
FORMat:DEXPort:HEADer	626
FORMat:DEXPort:TRACes	627

FORMat[:DATA] <Format>

This command 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 4.3.7, "Formats for Returned Values: ASCII Format and Binary Format"](#), on page 349.

Parameters:

<Format>

ASCIi

ASCIi format, separated by commas.

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

REAL,32

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

The format setting `REAL` is used for the binary transmission of trace data.

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

*RST: ASCII

Example:

```
FORM REAL, 32
```

Usage:

SCPI confirmed

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

COMMa

Uses a comma as decimal separator, e.g. `4,05`.

POINt

Uses a point as decimal separator, e.g. `4.05`.

*RST: *RST has no effect on the decimal separator.
Default is `POINt`.

Example:

```
FORM:DEXP:DSEP POIN
```

Sets the decimal point as separator.

Manual operation: See ["Saving the Result Summary \(Evaluation List\) to a File"](#) on page 130
 See ["Saving the Evaluation List"](#) on page 153
 See ["Decimal Separator"](#) on page 336
 See ["Exporting the Peak List"](#) on page 382

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 4.3.6, "Reference: ASCII File Export Format"](#), on page 347 for details.

Parameters:

<State>

ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

Manual operation: See "Include Instrument Measurement Settings" on page 335

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see [MMEMory:STORe<n>:TRACe](#) on page 616).

For details on exporting data see [Chapter 4.3.2.2, "Trace / Data Export Configuration"](#), on page 335.

Parameters:

<Selection>

SINGLE

Only a single trace is selected for export, namely the one specified by the [MMEMory:STORe<n>:TRACe](#) command.

ALL

Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.

The <trace> parameter for the [MMEMory:STORe<n>:TRACe](#) command is ignored.

*RST: SINGLE

Usage: SCPI confirmed

Manual operation: See "Export all Traces and all Table Results" on page 335

5.9.2.5 Configuring Spectrograms

CALCulate<n>:SPECtrogram:CLEar[:IMMEDIATE]	627
CALCulate<n>:SPECtrogram:CONT	628
CALCulate<n>:SPECtrogram:FRAME:COUNT	628
CALCulate<n>:SPECtrogram:FRAME:SElect	629
CALCulate<n>:SPECtrogram:HDEPth	629
CALCulate<n>:SPECtrogram:TSTamp:DATA?	630
CALCulate<n>:SPECtrogram:TSTamp[:STATe]	631
CALCulate<n>:SPECtrogram[:STATe]	631
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault	631
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer	632
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE	632
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer	632
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]	633
MMEMory:STORe<n>:SPECtrogram	633

CALCulate<n>:SPECtrogram:CLEar[:IMMEDIATE]

This command resets the spectrogram and clears the history buffer.

Suffix:

<n> Receiver application: [Window](#)
 I/Q Analyzer: [Window](#)
 Spectrum application: irrelevant
 Real-Time application: irrelevant

Example:

CALC:SGR:CLE
 Resets the result display and clears the memory.

Usage:

Event

Manual operation: See "[Clear Spectrogram](#)" on page 283

CALCulate<n>:SPECtrogram:CONT <State>

This command 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 measurement channel.

Suffix:

<n> irrelevant

Parameters:

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

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 281
 See "[Continue Frame](#)" on page 283

CALCulate<n>:SPECtrogram:FRAME:COUNT <Frames>

This command defines the number of frames to be recorded in a single sweep.

This value applies to all spectrograms in the measurement channel.

Suffix:

<n> irrelevant

Parameters:

<Frames> The maximum number of frames depends on the history depth.
 Range: 1 to history depth
 Increment: 1
 *RST: 1

Example:

```
INIT:CONT OFF
Selects single sweep mode.
CALC:SGR:FRAM:COUN 200
Sets the number of frames to 200.
```

Manual operation: See ["Frame Count"](#) on page 283

CALCulate<n>:SPECtrogram:FRAME:SELEct <Frame> | <Time>

This command selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:

<n> Receiver application: [Window](#)
 I/Q Analyzer: [Window](#)
 Spectrum application: irrelevant
 Real-Time application: irrelevant

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
 The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
 The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:

```
INIT:CONT OFF
Stop the continuous sweep.
CALC:SGR:FRAM:SEL -25
Selects frame number -25.
```

Manual operation: See ["Selecting a frame to display"](#) on page 282

CALCulate<n>:SPECtrogram:HDEPth <History>

This command defines the number of frames to be stored in the R&S ESW memory.

Suffix:

<n> Receiver application: [Window](#)
 I/Q Analyzer: [Window](#)
 Spectrum application: irrelevant
 Real-Time application: irrelevant

Parameters:

<History> The maximum number of frames depends on the number of sweep points.
 Range: 781 to 20000
 Increment: 1
 *RST: 3000

Example:

CALC:SGR:SPEC 1500
 Sets the history depth to 1500.

Manual operation: See ["History Depth"](#) on page 338

CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

This command 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 617.

Suffix:

<n> Receiver application: [Window](#)
 I/Q Analyzer: [Window](#)
 Spectrum application: irrelevant
 Real-Time application: irrelevant

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 till the frame start
 <Nanoseconds> Number of nanoseconds that have passed *in addition to the* <Seconds> since 01.01.1970 till the frame start.
 <Reserved> The third and fourth value are reserved for future uses.

Example:

CALC:SGR:TST ON
 Activates the time stamp.
 CALC:SGR:TST:DATA? ALL
 Returns the starting times of all frames sorted in a descending order.

Usage: Query only

Manual operation: See ["Timestamp"](#) on page 339

CALCulate<n>:SPECtrogram:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- [CALCulate<n>:DELTaMarker<m>:SPECtrogram:FRAMe](#) on page 636
- [CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe](#) on page 639
- [CALCulate<n>:SPECtrogram:FRAMe:SELect](#) on page 629

Suffix:

<n> Receiver application: [Window](#)
 I/Q Analyzer: [Window](#)
 Spectrum application: irrelevant
 Real-Time application: irrelevant

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:SGR:TST ON
 Activates the time stamp.

Manual operation: See ["Timestamp"](#) on page 339

CALCulate<n>:SPECtrogram[:STATe] <State>

This command turns the spectrogram on and off.

Suffix:

<n> Receiver application: [Window](#)
 I/Q Analyzer: [Window](#)
 Spectrum application: irrelevant
 Real-Time application: irrelevant

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:SGR ON
 Activates the Spectrogram result display.

Manual operation: See ["State"](#) on page 338

DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

This command restores the original color map.

Suffix:

<n> [Window](#)

Usage: Event

Manual operation: See "Set to Default" on page 341

DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Suffix:

<n> [Window](#)

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66

*RST: 0

Default unit: %

Example:

DISP:WIND:SGR:COL:LOW 10

Sets the start of the color map to 10%.

Manual operation: See "Start / Stop" on page 341

DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Suffix:

<n> [Window](#)

Parameters:

<Shape> Shape of the color curve.

Range: -1 to 1

*RST: 0

Manual operation: See "Shape" on page 341

DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Suffix:

<n> [Window](#)

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 66

*RST: 0

Default unit: %

Example:

DISP:WIND:SGR:COL:UPP 95

Sets the start of the color map to 95%.

Manual operation: See "Start / Stop" on page 341

DISPlay[:WINDow<n>]:SPECTrogram:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Parameters:

<ColorScheme>

HOT

Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD

Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar

Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale

Shows the results in shades of gray.

*RST: HOT

Example:

```
DISP:WIND:SPEC:COL GRAY
```

Changes the color scheme of the spectrogram to black and white.

Manual operation: See "[Hot/Cold/Radar/Grayscale](#)" on page 341

MMEMory:STORe<n>:SPECTrogram <FileName>

This command exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S 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.

5.9.3 Marker Usage

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5.9.3.1 Individual Marker Setup

<code>CALCulate<n>:DELTamarker<m>:AOFF</code>	634
<code>CALCulate<n>:DELTamarker<m>:LINK</code>	634
<code>CALCulate<n>:DELTamarker<m>:LINK:TO:MARKer<m></code>	635
<code>CALCulate<n>:DELTamarker<m>:MODE</code>	635
<code>CALCulate<n>:DELTamarker<m>:MREF</code>	636
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAME</code>	636
<code>CALCulate<n>:DELTamarker<m>[:STATE]</code>	637
<code>CALCulate<n>:DELTamarker<m>:TRACe</code>	637
<code>CALCulate<n>:DELTamarker<m>:X</code>	637
<code>CALCulate<n>:MARKer<m>:AOFF</code>	638
<code>CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m></code>	638
<code>CALCulate<n>:MARKer<m>:SPECTrogram:FRAME</code>	639
<code>CALCulate<n>:MARKer<m>[:STATE]</code>	639
<code>CALCulate<n>:MARKer<m>:TRACe</code>	639
<code>CALCulate<n>:MARKer<m>:X</code>	640

`CALCulate<n>:DELTamarker<m>:AOFF`

This command turns *all* delta markers off.

Suffix:

`<n>` Window
`<m>` irrelevant

Example: `CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

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

This command links delta marker `<m>` to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the `CALCulate<n>:DELTaMarker<m>:LINK:TO:MARKer<m>` or `CALCulate<n>:MARKer<m>:LINK:TO:MARKer<m>` commands.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2:LINK ON`

Manual operation: See "[Linking to Another Marker](#)" on page 205

CALCulate<n>:DELTaMarker<m>:LINK:TO:MARKer<m> <State>

This command links delta marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, delta marker <m1> changes its horizontal position to the same value.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See "[Linking to Another Marker](#)" on page 205

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

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

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see `CALCulate<n>:DELTaMarker<m>:X` on page 637)!

Suffix:

<n> [Window](#)

<m> irrelevant

Parameters:

<Mode>

ABSolute

Delta marker position in absolute terms.

RELative

Delta marker position in relation to a reference marker.

*RST: RELative

Example:

CALC:DELT:MODE ABS

Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

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 205**CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAME <Frame> | <Time>**

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n>

Window

<m>

Marker

Parameters:

<Frame>

Selects a frame directly by the frame number. Valid if the time stamp is off.

The range depends on the history depth.

<Time>

Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example: `CALC:DELT4:SGR:FRAM -20`
Sets fourth deltamarker 20 frames below marker 1.
`CALC:DELT4:SGR:FRAM 2 s`
Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "[Frame \(Spectrogram only\)](#)" on page 362

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTmarker turns on delta marker 1.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "[Marker State](#)" on page 204
See "[Marker Type](#)" on page 205
See "[Select Marker](#)" on page 206

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:

<m> [Marker](#)

<n> [Window](#)

Parameters:

<Position> Numeric value that defines the marker position on the x-axis. The 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.

Example:

CALC:DELT:X?

Outputs the absolute x-value of delta marker 1.

Manual operation:

See "[Marker 1/2/3/4](#)" on page 187

See "[Marker 1/2/3](#)" on page 192

See "[Marker Position \(X-value\)](#)" on page 204

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Example:

CALC:MARK:AOFF

Switches off all markers.

Usage:

Event

Manual operation:

See "[All Markers Off](#)" on page 364

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

This command links normal marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, marker <m1> changes its horizontal position to the same value.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

CALC:MARK4:LINK:TO:MARK2 ON

Links marker 4 to marker 2.

Manual operation: See ["Linking to Another Marker"](#) on page 205

CALCulate<n>:MARKer<m>:SPECTrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.

The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the (negative) distance to frame 0 in seconds. The range depends on the history depth.

Example:

```
CALC:MARK:SGR:FRAM -20
```

Sets the marker on the 20th frame before the present.

```
CALC:MARK2:SGR:FRAM -2s
```

Sets second marker on the frame 2 seconds ago.

Manual operation: See ["Frame \(Spectrogram only\)"](#) on page 362

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
CALC:MARK3 ON
```

Switches on marker 3.

Manual operation: See ["Marker State"](#) on page 204
See ["Marker Type"](#) on page 205
See ["Select Marker"](#) on page 206

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**<Trace> **1 to 6**

Trace number the marker is assigned to.

Example:

CALC:MARK3:TRAC 2

Assigns marker 3 to trace 2.

Manual operation: See ["Assigning the Marker to a Trace"](#) on page 205**CALCulate<n>:MARKer<m>:X <Position>**

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:<m> [Marker](#) (query: 1 to 16)<n> [Window](#)**Parameters:**

<Position>

Numeric value that defines the marker position on the x-axis. The unit is either Hz (frequency domain) or s (time domain) or dB (statistics).

Range: The range depends on the current x-axis range.

Example:

CALC:MARK2:X 1.7MHz

Positions marker 2 to frequency 1.7 MHz.

Manual operation: See ["Marker 1/2/3/4"](#) on page 187
See ["Marker 1/2/3"](#) on page 192
See ["Marker Position \(X-value\)"](#) on page 204
See ["Marker Table"](#) on page 306
See ["Marker Peak List"](#) on page 306**5.9.3.2 General Marker Settings**

CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:MAXimum[:PEAK].....	641
CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:X.....	641
CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y.....	641
CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed:RPOint:Y:OFFSet.....	642
CALCulate<n>:DELTamarker<m>:FUNCTION:FIXed[:STATe].....	642
CALCulate<n>:MARKer<m>:X:SSize.....	642
DISPlay:MINFo[:STAT].....	643
DISPlay:MTABLE.....	643

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:MAXimum[:PEAK]

This command 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.

Usage:

Event

Manual operation:

See ["Defining a Fixed Reference"](#) on page 365

See ["Defining a Reference Point"](#) on page 376

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:X <RefPoint>

This command defines the horizontal position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<RefPoint> Numeric value that defines the horizontal position of the reference.

For frequency domain measurements, it is a frequency in Hz.

For time domain measurements, it is a point in time in s.

*RST: Fixed Reference: OFF

Example:

CALC:DELT:FUNC:FIX:RPO:X 128 MHz

Sets the frequency reference to 128 MHz.

Manual operation:

See ["Defining a Fixed Reference"](#) on page 365

See ["Defining a Reference Point"](#) on page 376

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:Y <RefPointLevel>

This command defines the vertical position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<RefPoint> Numeric value that defines the vertical position of the reference. The unit and value range is variable.

*RST: Fixed Reference: OFF

Example: `CALC:DELTA: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 365
See ["Defining a Reference Point"](#) on page 376

CALCulate<n>:DELTaMarker<m>:FUNCTion:FIXed:RPOint:Y:OFFSet <Offset>

This command 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>

This command 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

*RST: OFF

Example: `CALC:DELTA:FUNC:FIX ON`
Switches on the measurement with fixed reference value for all delta markers.

`CALC:DELTA:FUNC:FIX:RPO:X 128 MHZ`

Sets the frequency reference to 128 MHz.

`CALC:DELTA:FUNC:FIX:RPO:Y 30 DBM`

Sets the reference level to +30 dBm.

Manual operation: See ["Defining a Fixed Reference"](#) on page 365

CALCulate<n>:MARKer<m>:X:SSIZE <StepSize>

This command selects the marker step size mode for *all* markers in *all* windows.

It therefore takes effect in manual operation only.

Suffix:

<n>, <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 365

DISPlay:MINFo[:STAT] <DisplayMode>

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

Parameters:

<DisplayMode>

ON

Displays the marker information in the diagrams.

OFF

Hides the marker information in the diagrams.

*RST: ON

Example:

DISP:MINF OFF

Hides the marker information.

Manual operation: See "[Marker Info](#)" on page 365

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode>

ON

Turns the marker table on.

OFF

Turns the marker table off.

AUTO

Turns the marker table on if 3 or more markers are active.

*RST: AUTO

Example:

DISP:MTAB ON

Activates the marker table.

Manual operation: See "[Marker Table Display](#)" on page 365

5.9.3.3 Marker Search

CALCulate<n>:MARKer<m>:LOEXclude.....	644
CALCulate<n>:MARKer<m>:PEXCursion.....	644
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT.....	645
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT.....	645
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe].....	646
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe].....	646
CALCulate<n>:THReshold.....	646
CALCulate<n>:THReshold:STATe.....	647

CALCulate<n>:MARKer<m>:LOEXclude <State>

This command turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows).

Suffix:

<n>, <m> irrelevant

Parameters:

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

Example: CALC:MARK:LOEX ON

Manual operation: See "Exclude LO" on page 367

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB
Receiver	dB

Suffix:

<n>, <m> irrelevant

Parameters:

<Excursion> The excursion is the distance to a trace maximum that must be attained before a new maximum is recognized, or the distance to a trace minimum that must be attained before a new minimum is recognized
 *RST: 6 dB

Example: CALC:MARK:PEXC 10dB
 Defines peak excursion as 10 dB.

Manual operation: See ["Peak Excursion"](#) on page 368

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

This command 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>, <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

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 97

See ["Left Limit / Right Limit"](#) on page 173

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <SearchLimit>

This command 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>, <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

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 97

See ["Left Limit / Right Limit"](#) on page 173

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

This command adjusts the marker search range to the zoom area for *all* markers in *all* windows.

Suffix:

<n>, <m> irrelevant

Parameters:

<State> ON | OFF
*RST: OFF

Example:

```
CALC:MARK:X:SLIM:ZOOM ON
Switches the search limit function on.
CALC:MARK:X:SLIM:RIGH 20MHZ
Sets the right limit of the search range to 20 MHz.
```

Manual operation: See ["Using Zoom Limits"](#) on page 368

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

This command 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>, <m> irrelevant

Parameters:

<State> ON | OFF
*RST: OFF

Example:

```
CALC:MARK:X:SLIM ON
Switches on search limitation.
```

Manual operation: See ["Search Limits \(Left / Right\)"](#) on page 97
See ["Deactivating All Search Limits"](#) on page 97
See ["Limit State"](#) on page 173

CALCulate<n>:THReshold <Level>

This command defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

Parameters:

<Level> Numeric value. The value range and unit are variable.
*RST: -120 dBm

Example:

```
CALC:THR -82DBM
Sets the threshold value to -82 dBm.
```

Manual operation: See ["Search Threshold"](#) on page 368

CALCulate<n>:THReshold:STATe <State>

This command turns a threshold for the marker peak search on and off (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF
*RST: OFF

Example:

CALC:THR:STAT ON
Switches on the threshold line.

Manual operation: See ["Deactivating All Search Limits"](#) on page 97

5.9.3.4 Positioning Markers

CALCulate<n>:DELTAmarker<m>:MAXimum:LEFT.....	647
CALCulate<n>:DELTAmarker<m>:MAXimum:NEXT.....	648
CALCulate<n>:DELTAmarker<m>:MAXimum:RIGHT.....	648
CALCulate<n>:DELTAmarker<m>:MAXimum[:PEAK].....	648
CALCulate<n>:DELTAmarker<m>:MINimum:LEFT.....	649
CALCulate<n>:DELTAmarker<m>:MINimum:NEXT.....	649
CALCulate<n>:DELTAmarker<m>:MINimum:RIGHT.....	649
CALCulate<n>:DELTAmarker<m>:MINimum[:PEAK].....	649
CALCulate<n>:MARKer<m>:MAXimum:AUTO.....	650
CALCulate<n>:MARKer<m>:MAXimum:LEFT.....	650
CALCulate<n>:MARKer<m>:MAXimum:NEXT.....	650
CALCulate<n>:MARKer<m>:MAXimum:RIGHT.....	651
CALCulate<n>:MARKer<m>:MAXimum[:PEAK].....	651
CALCulate<n>:MARKer<m>:MINimum:AUTO.....	651
CALCulate<n>:MARKer<m>:MINimum:LEFT.....	652
CALCulate<n>:MARKer<m>:MINimum:NEXT.....	652
CALCulate<n>:MARKer<m>:MINimum:RIGHT.....	652
CALCulate<n>:MARKer<m>:MINimum[:PEAK].....	653

CALCulate<n>:DELTAmarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the 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

Usage: Event

Manual operation: See "[Search Next Peak](#)" on page 371

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher 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> Window

<m> Marker

Usage: Event

Manual operation: See "[Search Next Peak](#)" on page 371

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the 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

Usage: Event

Manual operation: See "[Search Next Peak](#)" on page 371

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the 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

Usage: Event

Manual operation: See "[Peak Search](#)" on page 370

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the 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](#)

Usage: Event

Manual operation: See "[Search Next Minimum](#)" on page 371

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum 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](#)

Usage: Event

Manual operation: See "[Search Next Minimum](#)" on page 371

CALCulate<n>:DELTamarker<m>:MINimum:RIGHT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the 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](#)

Usage: Event

Manual operation: See "[Search Next Minimum](#)" on page 371

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command 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](#)

Usage: Event

Manual operation: See "[Search Minimum](#)" on page 371

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

This command turns an automatic marker peak search for a trace maximum on and off. The R&S ESW performs the peak search after each sweep.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

`CALC:MARK:MAX:AUTO ON`

Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See "[Auto Max / Min Peak Search](#)" on page 368

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the 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](#)

Usage: Event

Manual operation: See "[Search Next Peak](#)" on page 371

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower 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](#)

Usage: Event

Manual operation: See "[Search Next Peak](#)" on page 371

CALCulate<n>:MARKer<m>:MAXimum:RIGHT

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the 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](#)

Usage: Event

Manual operation: See "[Search Next Peak](#)" on page 371

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the 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](#)

Usage: Event

Manual operation: See "[Peak Search](#)" on page 370

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

This command turns an automatic marker peak search for a trace minimum on and off. The R&S ESW performs the peak search after each sweep.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

CALC:MARK:MIN:AUTO ON

Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See "[Auto Max / Min Peak Search](#)" on page 368

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the 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](#)

Usage: Event

Manual operation: See "[Search Next Minimum](#)" on page 371

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum 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](#)

Usage: Event

Manual operation: See "[Search Next Minimum](#)" on page 371

CALCulate<n>:MARKer<m>:MINimum:RIGHT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the 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](#)

Usage: Event

Manual operation: See "[Search Next Minimum](#)" on page 371

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)

Usage: Event

Manual operation: See "[Search Minimum](#)" on page 371

5.9.3.5 Retrieving Marker Positions

Commands useful to retrieve marker positions described elsewhere:

- [CALCulate<n>:DELTamarker<m>:X](#) on page 637
- [CALCulate<n>:MARKer<m>:X](#) on page 640

CALCulate<n>:DELTamarker<m>:X:RELative?	653
CALCulate<n>:DELTamarker<m>:Y?	654
CALCulate<n>:MARKer<m>:Y?	654

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)

Return values:
 <Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
 Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

Manual operation: See "Marker 1/2/3/4" on page 187
See "Marker 1/2/3" on page 192

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

The unit depends on the application of the command.

Table 5-8: Base unit

Parameter, measuring function or result display	Output unit
DBM DBPW DBUV DBMV DBUA	dB (lin/log)
WATT VOLT AMPere	dB (lin), % (log)
statistics function (APD or CCDF) on	dimensionless output

Suffix:

<m> [Marker](#)

<n> [Window](#)

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
INIT;*WAI
Starts a sweep and waits for its end.
CALC:DELT2 ON
Switches on delta marker 2.
CALC:DELT2:Y?
Outputs measurement value of delta marker 2.
```

Usage: Query only

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n> [Window](#)

<m>	Marker
Return values:	
<Result>	Result at the marker position. The unit is variable and depends on the one you have currently set.
Example:	<pre>INIT:CONT OFF Switches to single measurement mode. CALC:MARK2 ON Switches marker 2. INIT;*WAI Starts a measurement and waits for the end. CALC:MARK2:Y? Outputs the measured value of marker 2.</pre>
Usage:	Query only
Manual operation:	See "Marker Table" on page 306 See "Marker Peak List" on page 306

5.9.3.6 Using Markers in Spectrograms

- [Using Markers](#)..... 655
- [Using Delta Markers](#)..... 659

Using Markers

Commands useful to position markers in a spectrogram described elsewhere:

- [CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 650
- [CALCulate<n>:MARKer<m>:MAXimum:NEXT](#) on page 650
- [CALCulate<n>:MARKer<m>:MAXimum\[:PEAK\]](#) on page 651
- [CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 651
- [CALCulate<n>:MARKer<m>:MINimum:LEFT](#) on page 652
- [CALCulate<n>:MARKer<m>:MINimum:NEXT](#) on page 652
- [CALCulate<n>:MARKer<m>:MINimum\[:PEAK\]](#) on page 653
- [CALCulate<n>:MARKer<m>:MINimum:RIGHT](#) on page 652

CALCulate<n>:MARKer<m>:SPEctrogram:FRAME	656
CALCulate<n>:MARKer<m>:SPEctrogram:SARea	656
CALCulate<n>:MARKer<m>:SPEctrogram:XY:MAXimum[:PEAK]	656
CALCulate<n>:MARKer<m>:SPEctrogram:XY:MINimum[:PEAK]	657
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:ABOVE	657
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:BELOW	657
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CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum[:PEAK]	658
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:ABOVE	658
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:BELOW	658
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:NEXT	658
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum[:PEAK]	659

CALCulate<n>:MARKer<m>:SPECTrogram:FRAME <Frame> | <Time>

This command positions a marker on a particular frame.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.

The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the (negative) distance to frame 0 in seconds. The range depends on the history depth.

Example:

```
CALC:MARK:SGR:FRAM -20
```

Sets the marker on the 20th frame before the present.

```
CALC:MARK2:SGR:FRAM -2s
```

Sets second marker on the frame 2 seconds ago.

Manual operation: See "[Frame \(Spectrogram only\)](#)" on page 362

CALCulate<n>:MARKer<m>:SPECTrogram:SARea <SearchArea>

This command defines the marker search area for all spectrogram markers in the measurement 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 370

CALCulate<n>:MARKer<m>:SPECTrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:ABOVE

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:BELOW

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:ABOVE

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:BELOW

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)
Usage: Event

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:
 <n> [Window](#)
 <m> [Marker](#)
Usage: Event

Using Delta Markers

Commands to define the horizontal position of delta markers:

- [CALCulate<n>:DELTamarker<m>:MAXimum:LEFT](#) on page 647
- [CALCulate<n>:DELTamarker<m>:MAXimum:NEXT](#) on page 648
- [CALCulate<n>:DELTamarker<m>:MAXimum\[:PEAK\]](#) on page 648
- [CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT](#) on page 648
- [CALCulate<n>:DELTamarker<m>:MINimum:LEFT](#) on page 649
- [CALCulate<n>:DELTamarker<m>:MINimum:NEXT](#) on page 649
- [CALCulate<n>:DELTamarker<m>:MINimum\[:PEAK\]](#) on page 649
- [CALCulate<n>:DELTamarker<m>:MINimum:RIGHT](#) on page 649

CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAMe	660
CALCulate<n>:DELTamarker<m>:SPECTrogram:SARea	660
CALCulate<n>:DELTamarker<m>:SPECTrogram:XY:MAXimum[:PEAK]	660
CALCulate<n>:DELTamarker<m>:SPECTrogram:XY:MINimum[:PEAK]	661
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:ABOVe	661
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:BELow	661
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:NEXT	661
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum[:PEAK]	662
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:ABOVe	662
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:BELow	662
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:NEXT	663
CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum[:PEAK]	663

CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.

The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:

```
CALC:DELT4:SGR:FRAM -20
```

Sets fourth deltamarker 20 frames below marker 1.

```
CALC:DELT4:SGR:FRAM 2 s
```

Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "[Frame \(Spectrogram only\)](#)" on page 362

CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for *all* spectrogram markers in the measurement 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 370

CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MAXimum:ABOVE

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MAXimum:BELOW

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MINimum:ABOVE

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MINimum:BELOW

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

CALCulate<n>:DELTaMarker<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Usage: Event

5.9.3.7 Marker Functions

- [Signal Count](#).....663
- [Noise Marker](#).....665
- [Phase Noise Marker](#).....666
- [n dB Down Marker](#).....669
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Signal Count

[CALCulate<n>:MARKer<m>:COUNT](#).....663

[CALCulate<n>:MARKer<m>:COUNT:FREQuency?](#).....664

[CALCulate<n>:MARKer<m>:COUNT:RESolution](#).....665

CALCulate<n>:MARKer<m>:COUNT <State>

This command turns the frequency counter at the marker position on and off.

The frequency counter works for one marker only. If you perform a frequency count with another marker, the R&S 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:

<State> ON | OFF

*RST: OFF

Example:

```
INIT:CONT OFF
```

Switches to single sweep mode.

```
CALC:MARK ON
```

Switches on marker 1.

```
CALC:MARK:COUN ON
```

Switches on the frequency counter for marker 1.

```
INIT;*WAI
```

Starts a sweep and waits for the end.

```
CALC:MARK:COUN:FREQ?
```

Outputs the measured value.

Manual operation: See "[Signal Count Marker State](#)" on page 373

CALCulate<n>:MARKer<m>:COUNt:FREQUency?

This command queries the frequency at the marker position.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Before you can use the command, you have to turn on the frequency counter.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<Frequency> Frequency at the marker position.

Example:	<pre>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.</pre>
Usage:	Query only
Manual operation:	See " Signal Count Marker State " on page 373

CALCulate<n>:MARKer<m>:COUNt:RESolution <Resolution>

This command 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

Example:

```
CALC:MARK:COUN:RES 1kHz
```


Sets the resolution of the frequency counter to 1 kHz.

Manual operation: See "[Resolution](#)" on page 373

Noise Marker

CALCulate<n>:MARKer<m>:FUNctioN:NOISe:RESult?	665
CALCulate<n>:MARKer<m>:FUNctioN:NOISe[:STATe]	666

CALCulate<n>:MARKer<m>:FUNctioN:NOISe:RESult?

This command queries the result of the noise measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single 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 374

CALCulate<n>:MARKer<m>:FUNCTION:NOISe[:STATe] <State>

This command turns the noise measurement at the marker position on and off.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: CALC:MARK:FUNC:NOIS ON
Switches on the noise measurement.

Manual operation: See ["Noise Measurement State"](#) on page 374
See ["Switching All Noise Measurements Off"](#) on page 375

Phase Noise Marker

CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:AUTO.....	666
CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:RESult?.....	667
CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise[:STATe].....	667
CALCulate<n>:MARKer<m>:FUNCTION:PNOise:RESult?.....	668
CALCulate<n>:MARKer<m>:FUNCTION:PNOise[:STATe].....	668

CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:AUTO <State>

This command turns an automatic peak search for the fixed reference marker at the end of a sweep on and off.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:DELT:FUNC:PNO:AUTO ON

Activates an automatic peak search for the reference marker in a phase-noise measurement.

Manual operation: See ["Defining a Reference Point"](#) on page 376

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?

This command queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

This command 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 375

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] <State>

This command turns the phase noise measurement at the delta marker position on and off.

The reference marker for phase noise measurements is either a normal marker or a fixed reference. If necessary, the command turns on the reference marker.

The correction values for the bandwidth and the log amplifier are taken into account in the measurement.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF
 *RST: OFF

- Example:** `CALC:DELT:FUNC:PNO ON`
Switches on the phase-noise measurement with all delta markers.
- `CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`
Sets the frequency reference to 128 MHz.
- `CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`
Sets the reference level to +30 dBm
- Manual operation:** See ["Phase Noise Measurement State"](#) on page 375
See ["Switching All Phase Noise Measurements Off"](#) on page 376

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?

This command queries the result of a phase noise measurement in the Analog Demodulation application.

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>

This command turns the phase noise measurement at the marker position on and off in the Analog Demodulation application.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

- Example:** `CALC:MARK2:FUNC:PNO ON`
Switches on the phase-noise measurement for the marker 2.

n dB Down Marker

CALCulate<n>:MARKer<m>:FUNction:NDBDown.....	669
CALCulate<n>:MARKer<m>:FUNction:NDBDown:FREquency?.....	669
CALCulate<n>:MARKer<m>:FUNction:NDBDown:QFACTOR?.....	670
CALCulate<n>:MARKer<m>:FUNction:NDBDown:RESult?.....	670
CALCulate<n>:MARKer<m>:FUNction:NDBDown:STATe.....	671
CALCulate<n>:MARKer<m>:FUNction:NDBDown:TIME?.....	671

CALCulate<n>:MARKer<m>:FUNction:NDBDown <Distance>

This command 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

Example:

CALC:MARK:FUNC:NDBD 3dB

Sets the distance to the reference marker to 3 dB.

CALCulate<n>:MARKer<m>:FUNction:NDBDown:FREquency?

This command queries the position of the n dB down markers on the x-axis when measuring in the frequency domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n>, <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 Delta Value](#)" on page 377

CALCulate<n>:MARKer<m>:FUNction:NDBDown:QFActor?

This command queries the Q factor of n dB down measurements.

Suffix:

<n>, <m> irrelevant

Return values:

<QFactor>

Usage: Query only

CALCulate<n>:MARKer<m>:FUNction:NDBDown:RESult?

This command queries the distance of the n dB down markers from each other.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:

<n>, <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 376

CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:STATe <State>

This command turns the n dB Down marker function on and off.

Suffix:
<n>, <m> irrelevant

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

Example:

```
CALC:MARK:FUNC:NDBD:STAT ON
Turns the n dB Down marker on.
```

Manual operation: See "[n dB down Marker State](#)" on page 376

CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:TIME?

This command queries the position of the n dB down markers on the x-axis when measuring in the time domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:
<n>, <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 Delta Value" on page 377

Band Power Marker

CALCulate<n>:DELTamarker<m>:FUNction:BPOWer:MODE.....	672
CALCulate<n>:DELTamarker<m>:FUNction:BPOWer:RESult?.....	672
CALCulate<n>:DELTamarker<m>:FUNction:BPOWer:SPAN.....	673
CALCulate<n>:DELTamarker<m>:FUNction:BPOWer[:STATe].....	673
CALCulate<n>:MARKer<m>:FUNction:BPOWer:RESult?.....	673
CALCulate<n>:MARKer<m>:FUNction:BPOWer:SPAN.....	674
CALCulate<n>:MARKer<m>:FUNction:BPOWer:MODE.....	674
CALCulate<n>:MARKer<m>:FUNction:BPOWer[:STATe].....	675

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

This command 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.

*RST: POWER

Manual operation: See "Power Mode" on page 378

CALCulate<n>:DELTamarker<m>:FUNction:BPOWer:RESult?

This command 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 **

This command defines the bandwidth around the delta marker position.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

 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 378

CALCulate<n>:DELTaMarker<m>:FUNCTion:BPOWer[:STATe] <State>

This command 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

*RST: OFF

Manual operation: See ["Band Power Measurement State"](#) on page 378
See ["Switching All Band Power Measurements Off"](#) on page 379

CALCulate<n>:MARKer<m>:FUNCTion:BPOWer:RESult?

This command 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 **

This command defines the bandwidth around the marker position.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

 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 378

CALCulate<n>:MARKer<m>:FUNction:BPOWer:MODE <Mode>

This command selects the way the results for a band power 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.

*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 378

CALCulate<n>:MARKer<m>:FUNction:BPOWer[:STATe] <State>

This command turns markers for band power measurements on and off.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

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 378

See ["Switching All Band Power Measurements Off"](#) on page 379

Marker Demodulation

[CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTInuous](#)..... 675

[CALCulate<n>:MARKer<m>:FUNction:DEModulation:HOLDoff](#).....675

[CALCulate<n>:MARKer<m>:FUNction:DEModulation:SElect](#).....676

[CALCulate<n>:MARKer<m>:FUNction:DEModulation\[:STATe\]](#)..... 676

[\[SENSe:\]DEMod:SQUelch:LEVel](#).....676

[\[SENSe:\]DEMod:SQUelch\[:STATe\]](#)..... 677

CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTInuous <State>

This command turns continuous demodulation of the signal at the marker position in the frequency domain on and off.

In the time domain continuous demodulation is always on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

CALC2:MARK3:FUNC:DEM:CONT ON

Switches on the continuous demodulation.

Manual operation:

See ["Continuous Demodulation"](#) on page 380

CALCulate<n>:MARKer<m>:FUNction:DEModulation:HOLDoff <Duration>

This command defines for how long the the signal at the marker position is demodulated.

In the time domain continuous demodulation is always on.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<Duration> Range: 10 ms to 1000 s
 *RST: Marker demodulation = OFF

Example: `CALC:MARK:FUNC:DEM:HOLD 3s`**Manual operation:** See "[Marker Stop Time](#)" on page 380**CALCulate<n>:MARKer<m>:FUNction:DEModulation:SElect <DemodMode>**

This command selects the demodulation mode at the marker position.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<DemodMode> **AM**
 AM demodulation
FM
 FM demodulation
 *RST: AM

Example: `CALC:MARK:FUNC:DEM:SEL FM`**Manual operation:** See "[Modulation](#)" on page 380**CALCulate<n>:MARKer<m>:FUNction:DEModulation[:STATe] <State>**

This command turns the audio demodulator on and off when the measurement reaches a marker position.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<State> ON | OFF
 *RST: OFF

Example: `CALC:MARK3:FUNC:DEM ON`
 Switches on the demodulation for marker 3.**Manual operation:** See "[Marker Demodulation State](#)" on page 380**[SENSe:]DEMod:SQUelch:LEVel <Threshold>**

This command defines the threshold for selective demodulation.

All signals below the threshold are not demodulated.

Parameters:

<Threshold> Percentage of the display height.
 Range: 0 to 100
 *RST: 50

Example:

DEM:SQU:LEV 80
 Sets the squelch level to 80% of the displayed signal.

Manual operation: See "[Squelch level](#)" on page 380

[SENSe:]DEMod:SQUelch[:STATe] <State>

This command 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 other triggers or gates off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

DEM:SQU ON
 Signals below the level threshold are not sent to the audio output.

Manual operation: See "[Squelch](#)" on page 380

Marker Peak List

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:ANNotation:LABel[:STATe]	677
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:COUNT?	678
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks[:IMMEDIATE]	678
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:LIST:SIZE	679
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:SORT	679
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:STATE	679
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:X?	680
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:Y?	680
MMEMory:STORe<n>:PEAK	680

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:ANNotation:LABel[:STATe]
 <State>

This command turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

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 ["Displaying Marker Numbers"](#) on page 382

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:COUNT?

This command queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

Suffix:

<n>, <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>

This command 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>

This command defines the maximum number of peaks that the R&S ESW looks for during a peak search.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<MaxNoPeaks> Maximum number of peaks to be determined.

Range: 1 to 200

*RST: 50

Example:

CALC:MARK:FUNC:FPE:LIST:SIZE 10

The marker peak list will contain a maximum of 10 peaks.

Manual operation: See "[Maximum Number of Peaks](#)" on page 382

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:SORT <SortMode>

This command 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 381

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:STATe <State>

This command turns a peak search on and off.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:FUNC:FPE:STAT ON`
 Activates marker peak search

Manual operation: See "[Peak List State](#)" on page 381

CALCulate<n>:MARKer<m>:FUNction:FPEaks:X?

This command queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNction:FPEaks:SORT`.

Suffix:
 <n>, <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?

This command queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNction:FPEaks:SORT`.

Suffix:
 <n>, <m> irrelevant

Return values:
 <PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Usage: Query only

MMEMory:STORe<n>:PEAK <FileName>

This command 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 full" error can occur although the hard disk indicates that storage space is still available.

To store data permanently, select an external storage location such as a USB memory device.

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S ESW User Manual.

Suffix:
 <n> [Window](#)

Parameters:

<FileName> String containing the path,name and extension of the target file.

Example:

M MEM:STOR:PEAK 'test.dat'

Saves the current marker peak list in the file test.dat.

Usage:

Event

Manual operation: See "Exporting the Peak List" on page 382

5.9.4 Lines

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5.9.4.1 Display Lines

CALCulate<n>:DLINe<k>	681
CALCulate<n>:DLINe<k>:STATe	681
CALCulate<n>:FLINe<k>	682
CALCulate<n>:FLINe<k>:STATe	682
CALCulate<n>:TLINe<k>	682
CALCulate<n>:TLINe<k>:STATe	683

CALCulate<n>:DLINe<k> <Position>

This command defines the (vertical) position of a display line.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

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)

Example:

CALC:DLIN -20dBm

Positions the display line at -20 dBm.

Manual operation: See "Horizontal Line 1/2" on page 392

CALCulate<n>:DLINe<k>:STATe <State>

This command turns a display line on and off

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:DLIN2:STAT ON
 Turns on display line 2.

CALCulate<n>:FLINe<k> <Frequency>

This command defines the position of a frequency line.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<Frequency> Note that you can not set a frequency line to a position that is outside the current span.
 Range: 0 Hz to Fmax
 *RST: (STATe to OFF)

Example:

CALC:FLIN2 120MHz
 Sets frequency line 2 to a frequency of 120 MHz.

Manual operation: See "[Vertical Line 1/2](#)" on page 392

CALCulate<n>:FLINe<k>:STATe <State>

This command turns a frequency line on and off

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

CALC:FLIN2:STAT ON
 Turns frequency line 2 on.

CALCulate<n>:TLINe<k> <Time>

This command defines the position of a time line.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<Time>

Note that you can not set a time line to a position that is higher than the current sweep time.

Range: 0 s to 1600 s

*RST: (STATe to OFF)

Example:

CALC:TLIN 10ms

Sets the first time line to 10 ms.

Manual operation: See "[Vertical Line 1/2](#)" on page 392**CALCulate<n>:TLINe<k>:STATe <State>**

This command turns a time line on and off

Suffix:<n> [Window](#)<k> [Limit line](#)**Parameters:**

<State> ON | OFF

*RST: OFF

Example:

CALC:TLIN:STAT ON

Turns the first time line on.

5.9.4.2 Limit Lines

CALCulate<n>:LIMit<k>:ACTive?	684
CALCulate<n>:LIMit<k>:CLEar[:IMMEDIATE]	684
CALCulate<n>:LIMit<k>:COMMeNt	684
CALCulate<n>:LIMit<k>:CONTRol[:DATA]	685
CALCulate<n>:LIMit<k>:CONTRol:DOMain	685
CALCulate<n>:LIMit<k>:CONTRol:MODE	685
CALCulate<n>:LIMit<k>:CONTRol:OFFSet	686
CALCulate<n>:LIMit<k>:CONTRol:SHIFt	686
CALCulate<n>:LIMit<k>:CONTRol:SPACing	686
CALCulate<n>:LIMit<k>:COPY	687
CALCulate<n>:LIMit<k>:DELeTe	687
CALCulate<n>:LIMit<k>:FAIL?	687
CALCulate<n>:LIMit<k>:LOWer[:DATA]	688
CALCulate<n>:LIMit<k>:LOWer:MARGin	688
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CALCulate<n>:LIMit<k>:LOWer:OFFSet	689
CALCulate<n>:LIMit<k>:LOWer:SHIFt	689
CALCulate<n>:LIMit<k>:LOWer:SPACing	690
CALCulate<n>:LIMit<k>:LOWer:STATe	690
CALCulate<n>:LIMit<k>:LOWer:THReshold	690
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CALCulate<n>:LIMit<k>:TRACe<t>:CHECK.....	692
CALCulate<n>:LIMit<k>:UNIT.....	692
CALCulate<n>:LIMit<k>:UPPer[:DATA].....	693
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CALCulate<n>:LIMit<k>:UPPer:MODE.....	694
CALCulate<n>:LIMit<k>:UPPer:OFFSet.....	694
CALCulate<n>:LIMit<k>:UPPer:SHIFt.....	694
CALCulate<n>:LIMit<k>:UPPer:SPACIng.....	695
CALCulate<n>:LIMit<k>:UPPer:STATe.....	695
CALCulate<n>:LIMit<k>:UPPer:THReshold.....	695

CALCulate<n>:LIMit<k>:ACTive?

This command queries the names of *all* active limit lines.

Suffix:

<n>, <k> 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 394

CALCulate<n>:LIMit<k>:CLEar[:IMMediate]

This command deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time.

Suffix:

<n>, <k> irrelevant

Example:

CALC:LIM:CLE

Deletes the result of the limit check.

Usage:

SCPI confirmed

CALCulate<n>:LIMit<k>:COMMent <Comment>

This command defines a comment for a limit line.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<Comment> String containing the description of the limit line. The comment may have up to 40 characters.

Manual operation: See "[Comment](#)" on page 396

CALCulate<n>:LIMit<k>:CONTrol[:DATA] <LimitLinePoints>

This command defines the horizontal definition points of a limit line.

Suffix:

<n> irrelevant

<k> [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<k>:LOWer\[:DATA\]](#) or [CALCulate<n>:LIMit<k>:UPPer\[:DATA\]](#). If not, the R&S ESW either adds missing values or ignores surplus values.
 The unit is Hz or s.

*RST: -

Usage: SCPI confirmed

Manual operation: See "[Data points](#)" on page 397

CALCulate<n>:LIMit<k>:CONTrol:DOMain <SpanSetting>

This command selects the domain of the limit line.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<SpanSetting> FREQuency | TIME

*RST: FREQuency

Manual operation: See "[X-Axis](#)" on page 397

CALCulate<n>:LIMit<k>:CONTrol:MODE <Mode>

This command selects the horizontal limit line scaling.

Suffix:

<n> irrelevant

<k> [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

CALCulate<n>:LIMit<k>:CONTrol:OFFSet <Offset>

This command defines an offset for a complete limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:

<n> irrelevant

<k> [Limit line](#)**Parameters:**

<Offset>

Numeric value.

The unit depends on the scale of the x-axis.

*RST: 0

Manual operation: See "[X-Offset](#)" on page 395**CALCulate<n>:LIMit<k>:CONTrol:SHIFt <Distance>**

This command moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> irrelevant

<k> [Limit line](#)**Parameters:**

<Distance>

Numeric value.

The unit depends on the scale of the x-axis.

Manual operation: See "[Shift x](#)" on page 398**CALCulate<n>:LIMit<k>:CONTrol:SPACing <InterpolMode>**

This command selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

Suffix:<n> [Window](#)

<k> [Limit line](#)

Parameters:

<InterpolMode> LINear | LOGarithmic
*RST: LIN

Example: CALC:LIM:CONT:SPAC LIN

CALCulate<n>:LIMit<k>:COPY <Line>

This command copies a limit line.

Suffix:

<n> [Window](#)

<k> [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 395

CALCulate<n>:LIMit<k>:DELeTe

This command deletes a limit line.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Usage:

Event

Manual operation: See "[Delete Line](#)" on page 395

CALCulate<n>:LIMit<k>:FAIL?

This command queries the result of a limit check in the specified window.

Note that for SEM measurements, the limit line suffix <k> is irrelevant, as only one specific SEM limit line is checked for the currently relevant power class.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

Suffix:<n> [Window](#)<k> [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
 SCPI confirmed

Manual operation:See "[Spectrum Emission Mask](#)" on page 17See "[Limit Check <n>](#)" on page 118See "[Limit Check](#)" on page 151**CALCulate<n>:LIMit<k>:LOWer[:DATA] <LimitLinePoints>**

This command defines the vertical definition points of a lower limit line.

Suffix:

<n> irrelevant

<k> [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<k>:CONTrol\[:DATA\]](#). If not, the R&S ESW either adds missing values or ignores surplus values.
 The unit depends on [CALCulate<n>:LIMit<k>:UNIT](#) on page 692.

*RST: Limit line state is OFF

Usage:

SCPI confirmed

Manual operation:See "[Data points](#)" on page 397**CALCulate<n>:LIMit<k>:LOWer:MARGin <Margin>**

This command defines an area around a lower limit line where limit check violations are still tolerated.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<Margin> **numeric value**
 *RST: 0
 Default unit: dB

Manual operation: See "[Margin](#)" on page 396

CALCulate<n>:LIMit<k>:LOWer:MODE <Mode>

This command selects the vertical limit line scaling.

Suffix:

<n> [Window](#)

<k> [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 "[X-Axis](#)" on page 397

CALCulate<n>:LIMit<k>:LOWer:OFFSet <Offset>

This command defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<Offset> **Numeric value.**
 *RST: 0
 Default unit: dB

Manual operation: See "[Y-Offset](#)" on page 395

CALCulate<n>:LIMit<k>:LOWer:SHIFt <Distance>

This command moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<Distance> Defines the distance that the limit line moves.
The unit depends on [CALCulate<n>:LIMit<k>:UNIT](#) on page 692.

Manual operation: See "[Shift y](#)" on page 398

CALCulate<n>:LIMit<k>:LOWer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<InterpolType> LINear | LOGarithmic
*RST: LIN

Manual operation: See "[X-Axis](#)" on page 397
See "[Y-Axis](#)" on page 397

CALCulate<n>:LIMit<k>:LOWer:STATe <State>

This command turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with [CALCulate<n>:LIMit<k>:NAME](#) on page 691.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<State> ON | OFF
*RST: OFF

Usage: SCPI confirmed

Manual operation: See "[Visibility](#)" on page 394

CALCulate<n>:LIMit<k>:LOWer:THReshold <Threshold>

This command 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

<k> [Limit line](#)

Parameters:

<Threshold> Numeric value.
The unit depends on [CALCulate<n>:LIMit<k>:UNIT](#) on page 692.

*RST: -200 dBm

Manual operation: See "[Threshold](#)" on page 396

CALCulate<n>:LIMit<k>:NAME <Name>

This command selects a limit line that already exists or defines a name for a new limit line.

Suffix:

<n> [Window](#)

<k> [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 396

CALCulate<n>:LIMit<k>:STATe <State>

This command turns the limit check for a specific limit line on and off.

To query the limit check result, use [CALCulate<n>:LIMit<k>: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<k>:TRACe<t>:CHECK](#) on page 692).

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<State> ON | OFF

*RST: OFF

Example:

CALC:LIM:STAT ON

Switches on the limit check for limit line 1.

Usage:

SCPI confirmed

Manual operation: See ["Disable All Lines"](#) on page 395

CALCulate<n>:LIMit<k>:TRACe <TraceNumber>

This command 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<k>:TRACe<t>:CHECK](#) on page 692).

Suffix:

<n> [Window](#)
 <k> [Limit line](#)

Parameters:

<TraceNumber> 1 to 6
 *RST: 1

Example: `CALC:LIM2:TRAC 3`
 Assigns limit line 2 to trace 3.

CALCulate<n>:LIMit<k>:TRACe<t>:CHECK <State>

This command turns the limit check for a specific trace on and off.

To query the limit check result, use [CALCulate<n>:LIMit<k>:FAIL?](#).

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- [CALCulate<n>:LIMit<k>:TRACe](#) on page 692
- [CALCulate<n>:LIMit<k>:STATe](#) on page 691

Suffix:

<n> [Window](#)
 <k> [Limit line](#)
 <t> [Trace](#)

Parameters:

<State> ON | OFF
 *RST: OFF

Example: `CALC:LIM3:TRAC2:CHEC ON`
 Switches on the limit check for limit line 3 on trace 2.

Manual operation: See ["Traces to be Checked"](#) on page 394

CALCulate<n>:LIMit<k>:UNIT <Unit>

This command defines the unit of a limit line.

Suffix:

<n> irrelevant

<k> [Limit line](#)**Parameters:**

<Unit> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DB | DBUV_M | DBUA_M | (unitless)

If you select dB as the limit line unit, the command automatically turns the limit line into a relative limit line.

*RST: DBM

Manual operation: See "[Y-Axis](#)" on page 397**CALCulate<n>:LIMit<k>:UPPer[:DATA] <LimitLinePoints>**

This command defines the vertical definition points of an upper limit line.

Suffix:

<n> irrelevant

<k> [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<k>:CONTRol\[:DATA\]](#). If not, the R&S ESW either adds missing values or ignores surplus values.The unit depends on [CALCulate<n>:LIMit<k>:UNIT](#) on page 692.

*RST: Limit line state is OFF

Usage: SCPI confirmed**Manual operation:** See "[Data points](#)" on page 397**CALCulate<n>:LIMit<k>:UPPer:MARGin <Margin>**

This command defines an area around an upper limit line where limit check violations are still tolerated.

Suffix:

<n> irrelevant

<k> [Limit line](#)**Parameters:**<Margin> **numeric value**

*RST: 0

Default unit: dB

Manual operation: See "[Margin](#)" on page 396

CALCulate<n>:LIMit<k>:UPPer:MODE <Mode>

This command selects the vertical limit line scaling.

Suffix:

<n> [Window](#)

<k> [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 ["X-Axis"](#) on page 397

CALCulate<n>:LIMit<k>:UPPer:OFFSet <Offset>

This command defines an offset for a complete upper limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<Offset>

Numeric value.

*RST: 0

Default unit: dB

Manual operation: See ["Y-Offset"](#) on page 395

CALCulate<n>:LIMit<k>:UPPer:SHIFt <Distance>

This command moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<Distance>

Defines the distance that the limit line moves.

The unit depends on [CALCulate<n>:LIMit<k>:UNIT](#) on page 692.

Usage: Event

Manual operation: See ["Shift y"](#) on page 398

CALCulate<n>:LIMit<k>:UPPer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

Suffix:

<n> [Window](#)

<k> [Limit line](#)

Parameters:

<InterpolType> LINear | LOGarithmic

*RST: LIN

Manual operation: See ["X-Axis"](#) on page 397

See ["Y-Axis"](#) on page 397

CALCulate<n>:LIMit<k>:UPPer:STATe <State>

This command turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with [CALCulate<n>:LIMit<k>:NAME](#) on page 691.

Suffix:

<n> irrelevant

<k> [Limit line](#)

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual operation: See ["Visibility"](#) on page 394

CALCulate<n>:LIMit<k>:UPPer:THReshold <Limit>

This command 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

<k> [Limit line](#)

Parameters:

<Limit>

Numeric value.

The unit depends on [CALCulate<n>:LIMit<k>:UNIT](#) on page 692.

*RST: -200

Default unit: dBm

Manual operation: See "[Threshold](#)" on page 396

6 Maintenance

The R&S ESW does not require regular maintenance. Maintenance is essentially restricted to cleaning the R&S ESW. It is however advisable to check the nominal data from time to time.

NOTICE**Instrument damage caused by cleaning agents**

Cleaning agents contain substances that may damage the instrument. For example, cleaning agents that contain a solvent may damage the front panel labeling, plastic parts, or the display.

Never use cleaning agents such as solvents (thinners, acetone, etc), acids, bases, or other substances.

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth.

The storage temperature range for the R&S ESW is specified in the data sheet. The instrument must be protected against dust if it is to be stored for a long period.

When transporting or shipping the instrument, it is advisable to use the original packing material (especially the two protective covers for the front and rear panel).

7 Optimizing and Troubleshooting

If the results do not meet your expectations, the following sections may contain helpful hints and information.

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- [Error Messages in Remote Control Mode](#).....699
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7.1 Error Information

If errors or irregularities are detected, a keyword and an error message, if available, are displayed in the status bar.



Depending on the type of message, the status message is indicated in varying colors.

Table 7-1: Status bar information - color coding

Color	Type	Description
Red	Error	An error occurred at the start or during a measurement, e.g. due to missing data or wrong settings, so that the measurement cannot be started or completed correctly.
Orange	Warning	An irregular situation occurred during measurement, e.g. the settings no longer match the displayed results, or the connection to an external device was interrupted temporarily.
Gray	Information	Information on the status of individual processing steps.
No color	No errors	No message displayed - normal operation.
Green	Measurement successful	Some applications visualize that the measurement was successful by showing a message.



If any error information is available for a measurement channel, an exclamation mark is displayed next to the channel name (❗). This is particularly useful when the MultiView tab is displayed, as the status bar in the MultiView tab always displays the information for the currently selected measurement only.

Furthermore, a status bit is set in the `STATUS:QUESTIONABLE:EXTENDED:INFO` register for the application concerned. Messages of a specific type can be queried using the `SYSTEM:ERROR:EXTENDED?` command. For more information, see the R&S ESW User Manual.

The following keywords are used:

AC COUP	This label is displayed when a measurement is configured to be AC coupled, but information in the DC range is detected. This situation can yield inaccurate measurement results. You can avoid this error message by changing the input coupling type.
IF OVLD	Overload of the IF signal path in the A/D converter or in the digital IF. <ul style="list-style-type: none"> • Increase the reference level.
INPUT OVLD	The signal level at the RF input connector exceeds the maximum. The RF input is disconnected from the input mixer to protect the device. To re-enable measurement, decrease the level at the RF input connector and reconnect the RF input to the mixer input.
LOUNL	Error in the instrument's frequency processing hardware was detected.
NO REF	Instrument was set to an external reference but no signal was detected on the reference input.
OVEN	The optional OCXO reference frequency has not yet reached its operating temperature. The message usually disappears a few minutes after power has been switched on.
RF OVLD	Overload of the input mixer or of the analog IF path. <ul style="list-style-type: none"> • Increase the RF attenuation (for RF input). • Reduce the input level (for digital input)
UNCAL	One of the following conditions applies: <ul style="list-style-type: none"> • Correction data has been switched off. • No correction values are available, for example after a firmware update. • Record the correction data by performing a self alignment
WRONG_FW	The firmware version is out-of-date and does not support the currently installed hardware. Until the firmware version is updated, this error message is displayed and self-alignment fails. (For details refer to the R&S ESW User Manual).

7.2 Error Messages in Remote Control Mode

In remote control mode error messages are entered in the error/event queue of the status reporting system and can be queried with the command `SYSTem:ERRor?`. The answer format of R&S ESW to the command is as follows:

```
<error code>, "<error text with queue query>; <remote control command concerned>"
```

The indication of the remote control command with prefixed semicolon is optional.

Example:

The command `TEST:COMMAND` generates the following answer to the query

```
SYSTem:ERRor?
```

```
-113, "Undefined header;TEST:COMMAND"
```

There are two types of error messages:

- Error messages defined by SCPI are marked by negative error codes. These messages are defined and described in the SCPI standard and not listed here.

- Device-specific error messages use positive error codes. These messages are described below.

Table 7-2: Device-specific error messages

Error code	Error text in the case of queue poll Error explanation
1052	Frontend LO is Unlocked This message is displayed when the phase regulation of the local oscillator fails in the RF front-end.
1060	Trigger-Block Gate Delay Error- gate length < Gate Delay This message is displayed when the gate signal length is not sufficient for the pull-in delay with a predefined gate delay.
1064	Tracking LO is Unlocked This message is displayed when the phase regulation of the local oscillator fails on the external generator module.
2028	Hardcopy not possible during measurement sequence This message is displayed when a printout is started during scan sequences that cannot be interrupted. Such sequences are for example: <ul style="list-style-type: none"> • Recording the system error correction data (alignment) • Instrument self-test In such cases synchronization to the end of the scan sequence should be performed prior to starting the printout.
2033	Printer Not Available This message is displayed when the selected printer is not included in the list of available output devices. A possible cause is that the required printer driver is missing or incorrectly installed.
2034	CPU Temperature is too high This message is displayed when the temperature of the processor exceeds 70 °C.

7.3 Troubleshooting Remote Operation

If problems arise during measurement in remote operation, try the following methods to solve them.

Incompleted sequential commands - blocked remote channels

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

To regain control over a blocked remote channel

Usually, if you wait a minute for the VISA connection to detect the lost connection and clear the control channel by itself, you can then re-establish the connection again. If this fails, try the following:

1. Press "Local" on the front panel of the R&S ESW to return to manual operation (if not disabled). Then re-establish the connection.
2. Send a "Device Clear" command from the control instrument to the R&S ESW to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:
 - **Visa:** `viClear()`The remote channel currently processing the incompleting command is then ready to receive further commands again.
3. On the remote channel performing the measurement, send the SCPI command `ABORT` to abort the current measurement and reset the trigger system.
4. If the R&S ESW still does not react to the remote commands, switch it off and back on.

Ignored commands

When a remote command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the `*RST` command) and then implement the required settings.

Detecting false commands

If a remote program does not provide the expected results and you are using a GPIB connection, you can log the commands and any errors that may occur. To activate the SCPI error log function, in the "Network + Remote" dialog box, in the "GPIB" tab, select "I/O Logging".

All remote control commands received by the R&S ESW are recorded in the following log file:

```
C:\R_S\instr\ScpiLogging\ScpiLog.txt
```

Logging the commands may be extremely useful for debug purposes, e.g. in order to find misspelled keywords in control programs. However, remember to turn off the logging function after debugging to avoid unnecessary access to the hard drive and use of storage space.

7.4 Minimizing the Measurement Duration

If you want to minimize the measurement duration, try the following methods to optimize the measurement:

- Reduce the **span** of the measurement to the relevant parts of the signal only.

- Increase the **RBW** to minimize the measurement time; however, consider the requirements of the standard if you need to measure according to standard!
- Reduce the **sweep time** and thus the amount of data to be captured and calculated; however, consider the requirements regarding the standard deviation.
- To determine average (or peak) values, use an **RMS detector (or peak detector) with a higher sweep time** instead of trace averaging to obtain better average power results in less time. Furthermore, enforce the use of the **sweep type "FFT"** (as opposed to "Auto"; in Sweep mode, the averaging effect of the RMS detector may be less efficient).
- When performing multiple measurements, use **multiple measurement channels** to switch between measurements rather than changing the settings within one channel repeatedly.

7.5 Improving Averaging Results

Instead of **trace averaging**, use an RMS detector with a higher sweep time to obtain better average power results in less time. Furthermore, enforce the use of the **sweep type "FFT"** (as opposed to "Auto"; in Sweep mode, the averaging effect of the RMS detector may be less efficient).

In FFT mode, FFTs are calculated per bin and combined using the RMS detector. For trace averaging, on the other hand, the local oscillator must be switched repeatedly for each trace, which takes additional time.

Generally, a higher **sweep time** leads to more data to be averaged and thus stabilizes the results. In FFT mode, a higher sweep time means more FFTs are calculated and combined per bin.

Thus, in the same capture time, the FFT mode with an RMS detector can provide better results than an averaged trace.

7.6 Miscellaneous Troubleshooting Hints

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Power levels for low frequency signals not correct

By default, the R&S ESW uses AC coupling for RF input. For very low frequencies, the input signal may be distorted with this setting. In this case, use DC coupling instead. To change the setting, select INPUT/OUPUT > "Input Source Config > Radio Frequency > Input Coupling > DC".

Invalid trace display

If output to the IF 2 GHZ OUT connector is activated, the measured values are no longer sent to the display; thus, the trace data currently displayed on the R&S ESW becomes invalid. A message in the status bar indicates this situation.

List of Commands

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