

R&S®EPL1000

Spectrum Analyzer

User Manual



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Version 02

ROHDE & SCHWARZ
Make ideas real



This manual applies to the following R&S®EPL1000 models with firmware version 1.10 and higher:

- R&S®EPL1000 (1350.4444K10)

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

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1 Preface

This chapter provides safety-related information, an overview of the user documentation and the conventions used in the documentation.

1.1 Conventions used in the documentation

1.1.1 Typographical conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
[Keys]	Key and knob names are enclosed by square brackets.
Filenames, commands, program code	Filenames, commands, coding samples and screen output are distinguished by their font.
<i>Input</i>	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.1.2 Conventions for procedure descriptions

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

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

1.1.3 Notes on screenshots

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

possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

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

2 Welcome to the spectrum application

The spectrum application is a firmware application that adds functionality to perform signal and spectrum analysis to the R&S EPL1000. The application is part of the R&S EPL1000 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 EPL1000 user manual. The latest versions of the manuals are available for download at the product homepage.

<http://www.rohde-schwarz.com/product/epl.html>.

Installation

Find detailed installing instructions in the getting started or the release notes of the R&S EPL1000.

- [Starting the application](#).....7
- [Understanding the display information](#).....8
- [R&S multiview](#).....9

2.1 Starting the application


Access: [MODE] > "Spectrum"

Multiple Measurement Channels and Sequencer Function

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

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

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

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

For details on the Sequencer function see the R&S EPL1000 user manual.

2.2 Understanding the display information

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

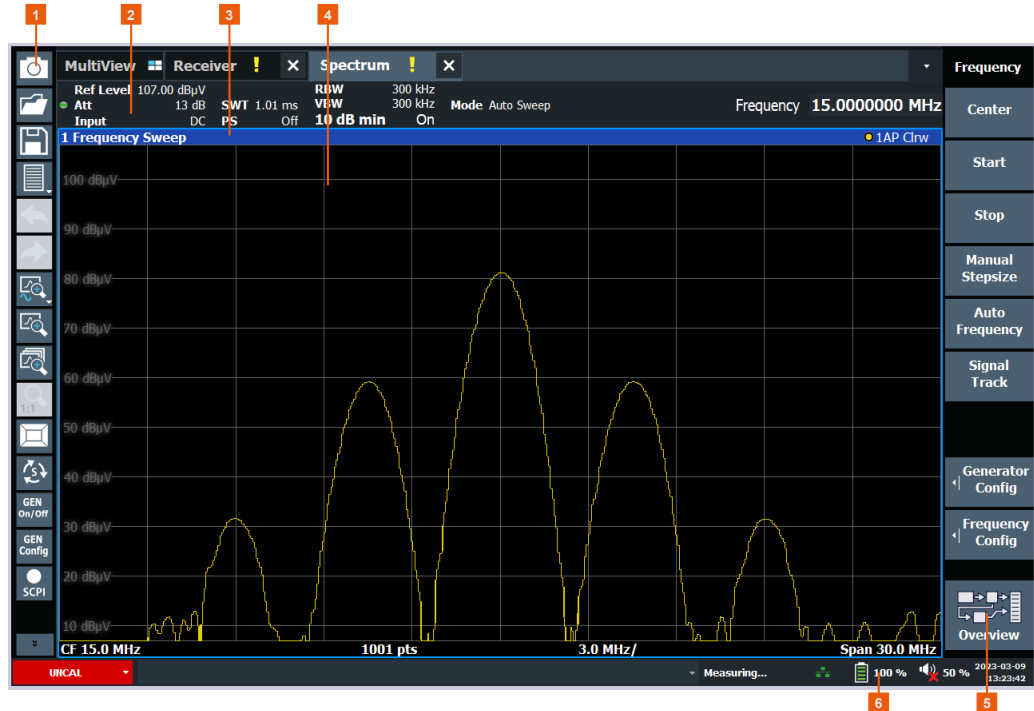


Figure 2-1: Screen layout of the spectrum application

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

Channel bar information

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

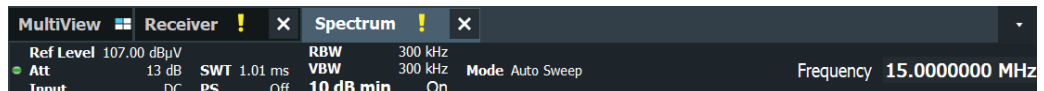


Figure 2-2: Channel bar of the spectrum application

Ref Level	Reference level of the R&S EPL1000.
Att	Attenuation of the R&S EPL1000.
Input	Input and input coupling

SWT	Sweep time
PS	Preselector state
RBW	Resolution bandwidth
VBW	Video bandwidth
10 dB Min	State of the 10 dB minimum attenuation protection mechanism
Mode	Currently selected sweep mode, including the sweep count.
Frequency	Center frequency

Window title bar information

For each diagram, the header provides the following information:



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

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

Status bar information

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

2.3 R&S multiview

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



Remote command:

DISPlay:FORMat on page 383

3 Measurements and results

Access: "Overview" > "Select Measurement"

Or: [MEAS]

In the Spectrum application, the R&S EPL1000 provides a variety of different measurement functions.

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

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

The measurement function determines which settings, functions and evaluation methods are available in the R&S EPL1000. The various measurement functions are described in detail here.

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

The easiest way to configure measurements is using the configuration "Overview", see [Chapter 4.1, "Configuration overview"](#), on page 184.

In addition to the measurement-specific parameters, the general parameters can be configured as usual, see [Chapter 4, "Configuration"](#), on page 184. Many measurement functions provide special result displays or evaluation methods; however, in most cases the general evaluation methods are also available, see [Chapter 5, "Common analysis and display functions"](#), on page 255.

The remote commands required to retrieve measurement results are described in [Chapter 6.9.2.1, "Trace data retrieval"](#), on page 564.

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3.1 Basic measurements

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

If no other measurement function is selected, or if all measurement functions are switched off, the R&S EPL1000 performs a basic frequency or time sweep.

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 4, "Configuration"](#), on page 184).

3.1.1 Basic measurement types

Frequency Sweep.....	12
Zero Span.....	12
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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.

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

Examples for frequency sweep measurements are:

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

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 4, "Configuration"](#), on page 184).

Remote command:

[SENSe:]FREQuency:START on page 533, [SENSe:]FREQuency:STOP on page 534

INITiate<n>[:IMMediate] on page 392

INITiate<n>:CONTinuous on page 393

Zero Span

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

Use the general measurement settings to configure the measurement, e.g. via the "Overview" (see [Chapter 4, "Configuration"](#), on page 184).

Most result evaluations can also be used for zero span measurements, although some functions (e.g. markers) may work slightly differently and some may not be available. If so, this will be indicated in the function descriptions (see [Chapter 5, "Common analysis and display functions"](#), on page 255).

Remote command:

[\[SENSe:\]FREQuency:SPAN](#) on page 533

[INITiate<n>\[:IMMediate\]](#) on page 392

[INITiate<n>:CONTInuous](#) on page 393

Power Sweep

In a power sweep, the measured power levels at the RF input are displayed versus the provided power levels of the internal generator output.

For a power sweep, the internal generator signal provides an output signal at a fixed frequency, and increases its power level within a specified range over time.

The power sweep measurement is available in the Spectrum application only, and only if the internal generator is installed.

For details see

Remote command:

[SOURce<si>:POWer:MODE](#) on page 528

All Functions Off

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

Selecting "Frequency Sweep" has the same effect.

3.1.2 How to perform a basic sweep measurement

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



For remote operation, see [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513.

To perform one or more single sweeps

1. Configure the frequency and span to be measured ("Frequency" dialog box, see [Chapter 4.3, "Frequency and span configuration"](#), on page 208).
2. Configure the number of sweeps to be performed in a single measurement ("Sweep Config" dialog box, see ["Sweep/Average Count"](#) on page 235).
3. If necessary, configure a trigger for the measurement ("Trigger/ Gate Config" dialog box.
See [Chapter 4.6, "Trigger and gate configuration"](#), on page 239

4. Define how the results are evaluated for display ("Trace" dialog box, see [Chapter 5.3.2.1, "Trace settings"](#), on page 290).
5. If necessary, configure the vertical axis of the display ("Amplitude" dialog box, see [Chapter 4.4.3, "Scaling the y-axis"](#), on page 223).
6. To start the measurement, select one of the following:
 - [RUN SINGLE]
 - "Single Sweep" in the "Sweep" menu

The defined number of sweeps are performed, then the measurement is stopped. While the measurement is running, the [RUN SINGLE] key is highlighted. To abort the measurement, press [RUN SINGLE] again. The key is no longer highlighted. The results are not deleted until a new measurement is started.
7. To repeat the same number of sweeps without deleting the last trace, select "Continue Single Sweep" in the "Sweep" menu.

To start continuous sweeping

1. If you want to average the trace or search for a maximum over more (or less) than 10 sweeps, configure the "Sweep/Average Count" ("Sweep Config" dialog box, see ["Sweep/Average Count"](#) on page 235).
2. To start the measurement, select one of the following:
 - [RUN CONT]
 - "Continuous Sweep" in the "Sweep" menu

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

3.1.3 Measurement examples - measuring a sinusoidal signal

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

Test setup

1. Configure the signal generator (e.g. R&S SMW):
 - **Frequency:** 128 MHz
 - **Level:** -30 dBm
2. **NOTICE!** Signal levels exceeding 30 dBm can damage the RF attenuator or the input mixer. When calculating the expected power level, consider the total power of all occurring signals.

If you measure signals higher than +30 dBm (=1 W), insert a power attenuator before the RF input of the analyzer.

3. Connect the RF output of the signal generator to the RF input of the R&S EPL1000.

- [Measuring the level and frequency using markers](#).....15
- [Measuring the signal frequency using the signal counter](#)..... 16

3.1.3.1 Measuring the level and frequency using markers

The level and frequency of a sinusoidal signal can be measured easily using the marker function. The R&S EPL1000 always displays its amplitude and frequency at the marker position. The frequency measurement uncertainty is determined by the reference frequency of the R&S EPL1000, the resolution of the marker frequency display and the number of sweep points.

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Connect the signal to be measured to the "RF INPUT" connector on the R&S EPL1000.
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 presettings.

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

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

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

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

Increasing the frequency resolution

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

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

Reducing the frequency span to 10 kHz

- ▶ Reduce the frequency span to *10 kHz*.

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

Setting the reference level

The reference level is the level at the upper limit of the diagram. To achieve the widest dynamic range possible for a spectrum measurement, use the entire level span of the R&S EPL1000. 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 EPL1000 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 [MKR ->].
2. Select "Ref Lvl = Mkr Lvl".

The reference level is set to the current marker level.

3.1.3.2 Measuring the signal frequency using the signal counter

The built-in signal counter allows you to measure the frequency more accurately than measuring it with the marker. The frequency sweep is stopped at the marker, and the R&S EPL1000 measures the frequency of the signal at the marker position (see also [Chapter 5.4.4.1, "Precise frequency \(signal count\) marker"](#), on page 332).

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

Prerequisite

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

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

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

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

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

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



Prerequisites for using the internal signal counter

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

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

The minimum signal level a signal analyzer can measure is limited by its intrinsic noise. Small signals can be swamped by noise and therefore cannot be measured. For signals that are just above the intrinsic noise, the accuracy of the level measurement is influenced by the intrinsic noise of the R&S EPL1000.

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 223
- [Chapter 4.4.1.2, "Reference level"](#), on page 219
- [Chapter 4.5.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 226

- [Chapter 4.5.1.2, "Smoothing the trace using the video bandwidth"](#), on page 227
- [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 269

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

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

Frequency	128 MHz
Level	-95 dBm

1. Preset the R&S EPL1000.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *128 MHz*.
4. Set the span to *100 MHz*.
5. Set the reference level to *-30 dBm*.

The signal is measured with the auto peak detector and is completely hidden in the intrinsic noise of the R&S EPL1000.

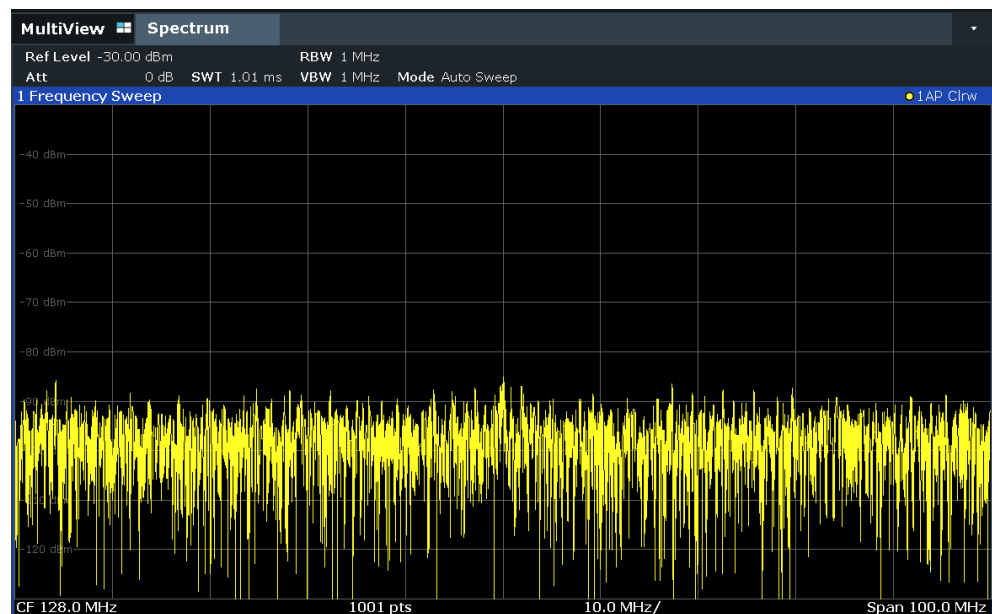


Figure 3-1: Sine wave signal with low S/N ratio

6. To suppress noise spikes, average the trace. In the "Traces" configuration dialog, set the "Trace Mode" to "Average" (see ["Trace Mode"](#) on page 291).

The traces of consecutive sweeps are averaged. To perform averaging, the R&S EPL1000 automatically switches on the sample detector. The RF signal, therefore, can be more clearly distinguished from noise.

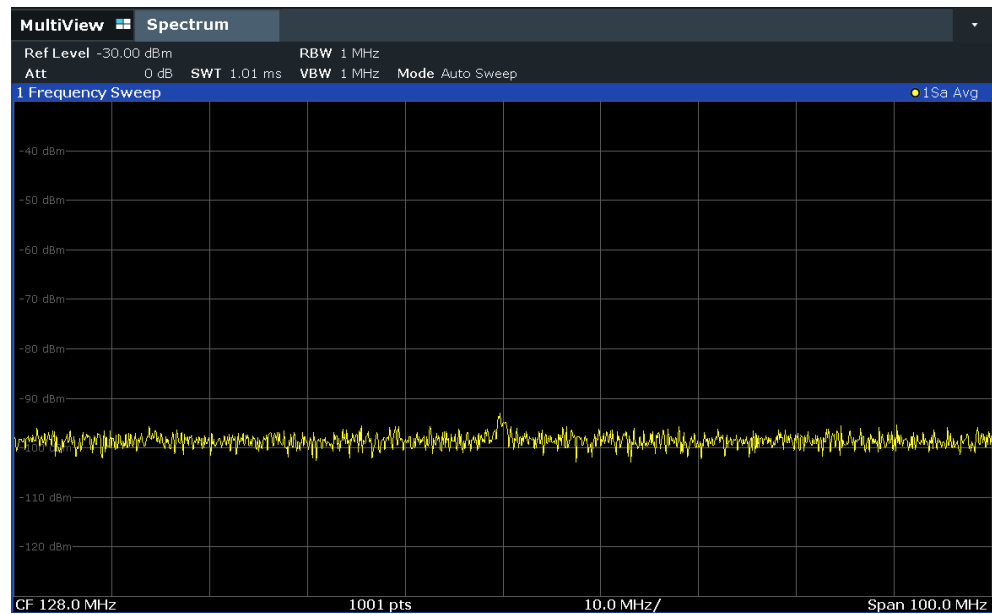


Figure 3-2: RF sine wave signal with low S/N ratio with an averaged trace

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

The RF signal can be distinguished from noise more clearly.

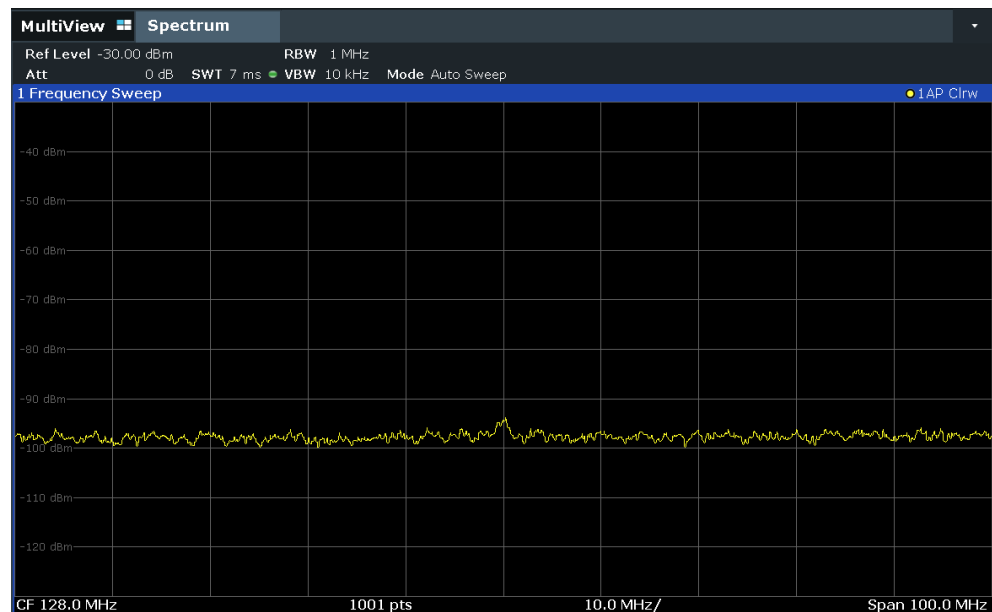


Figure 3-3: RF sine wave signal with low S/N ratio with a smaller video bandwidth

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

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

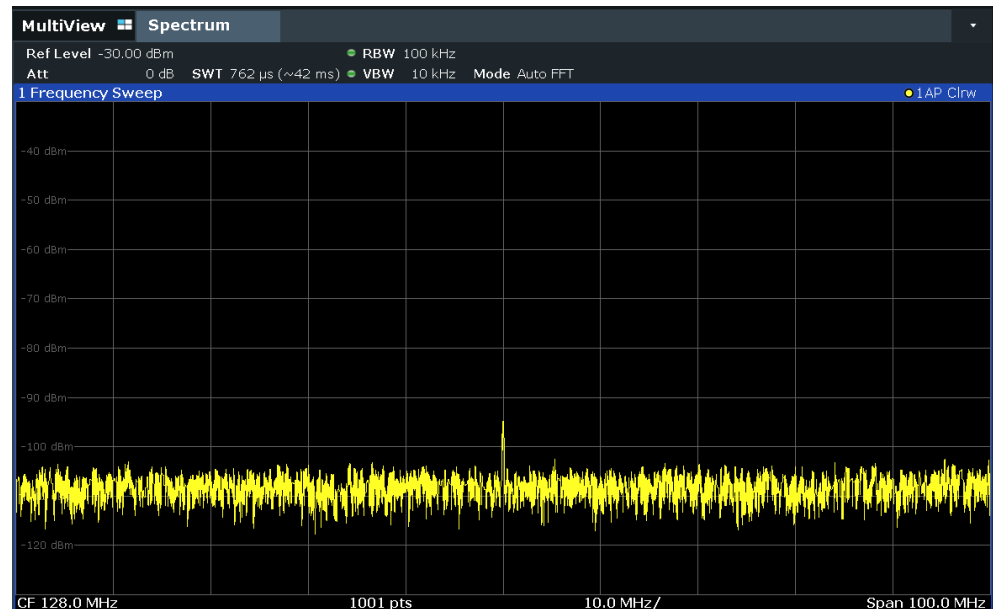


Figure 3-4: Reference signal at a smaller resolution bandwidth

3.1.5 Measurement examples - measuring signal spectra with multiple signals

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- [Measuring the modulation depth of an AM-modulated carrier in the frequency domain](#)..... 24
- [Measuring AM-modulated signals](#).....25

3.1.5.1 Separating signals by selecting the resolution bandwidth

A basic feature of a Signal and Spectrum Analyzer is the ability to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component (see also [Chapter 4.5.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 226).

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

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

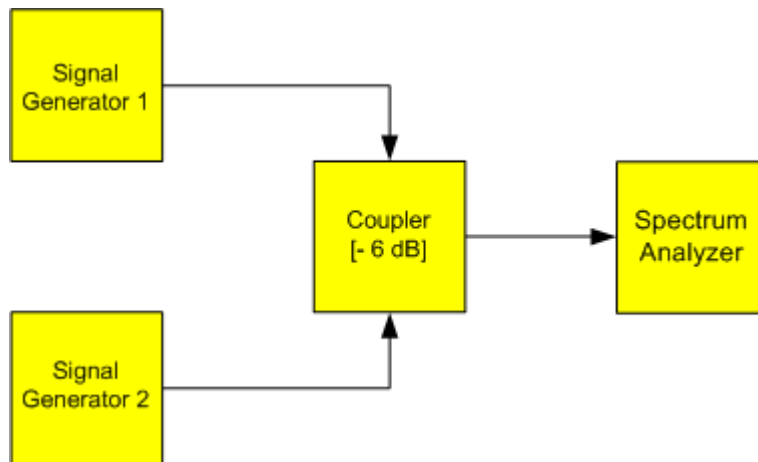


Figure 3-5: Test setup

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

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

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

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

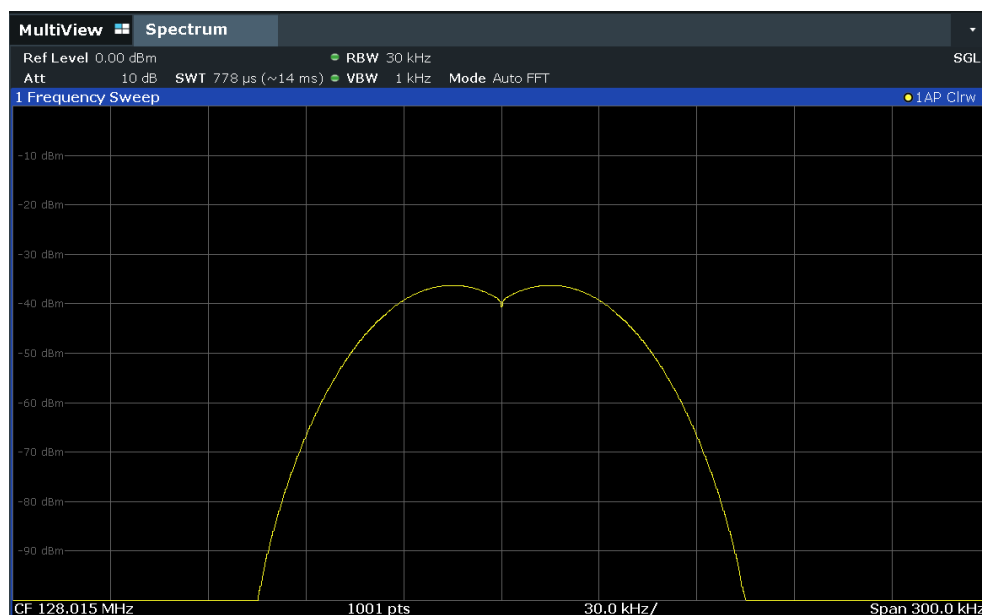


Figure 3-6: Measurement of two equally-leveled RF sinusoidal signals with the resolution bandwidth which corresponds to the frequency spacing of the signals

Matching generator and R&S EPL1000 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 EPL1000 exactly. To achieve exact matching, the frequencies of the generators and the R&S EPL1000 must be synchronized.

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

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

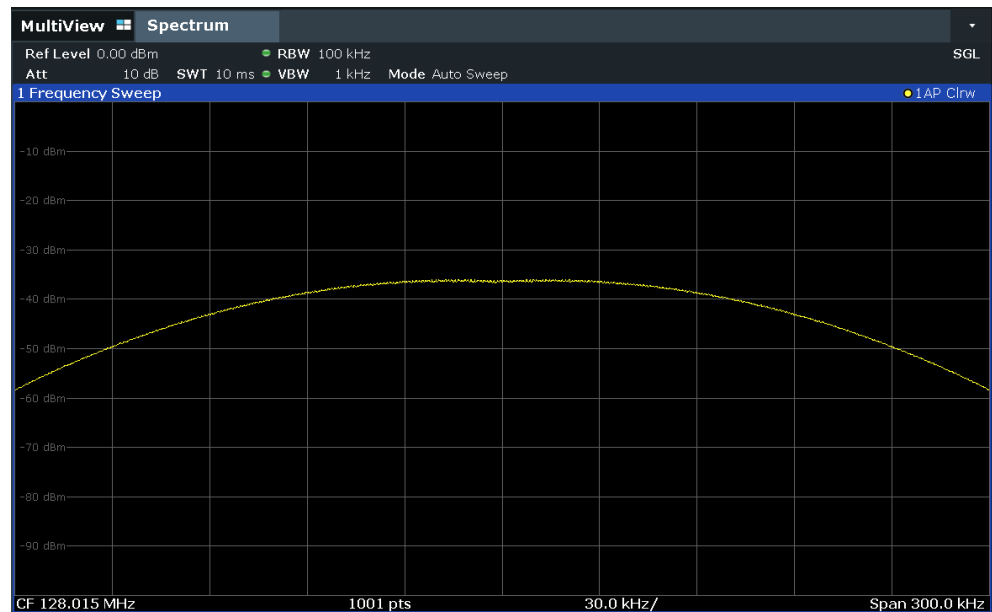


Figure 3-7: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth which is larger than their frequency spacing

7. Set the resolution bandwidth to 1 kHz.

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

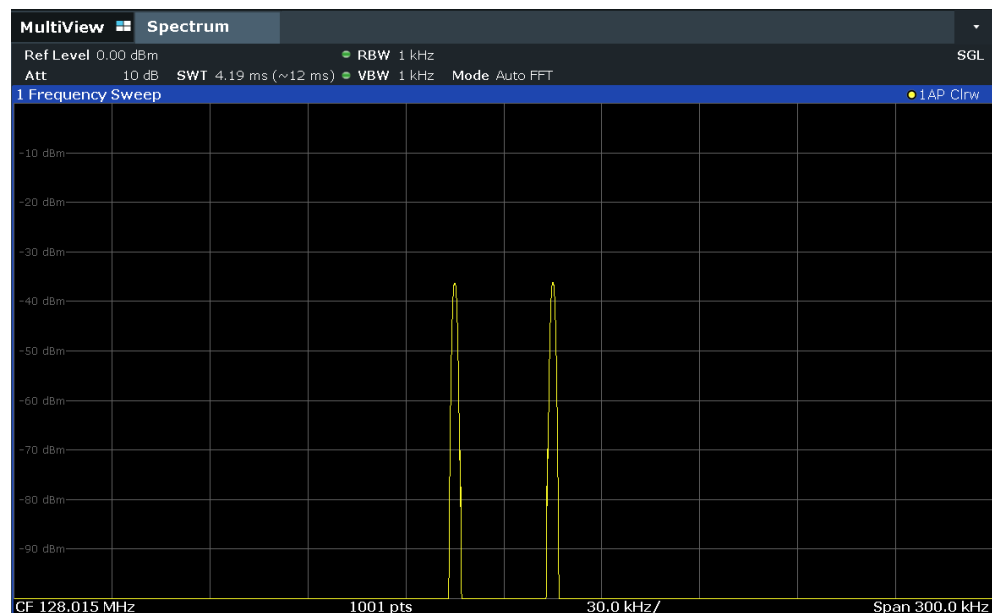


Figure 3-8: Measurement of two equally-leveled RF sinusoidal signals with a resolution bandwidth (1 kHz) which is significantly smaller than their frequency spacing

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

In the frequency range display, the AM side bands can be resolved with a narrow bandwidth and measured separately. The modulation depth of a carrier modulated with a sinusoidal signal can then be measured. Since the dynamic range of a signal analyzer is very large, extremely small modulation depths can also be measured precisely. For this purpose, the R&S EPL1000 provides measurement routines that output the modulation depth numerically in percent directly.

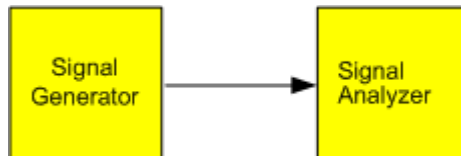


Figure 3-9: Test setup

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

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

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *128 MHz*.
4. Set the frequency span to *50 kHz*.
5. Select [MEAS] > "AM Modulation Depth" to activate the modulation depth measurement.

The R&S EPL1000 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 EPL1000 calculates the AM modulation depth from the level differences of the delta markers to the main marker and outputs the numeric value in the marker information.

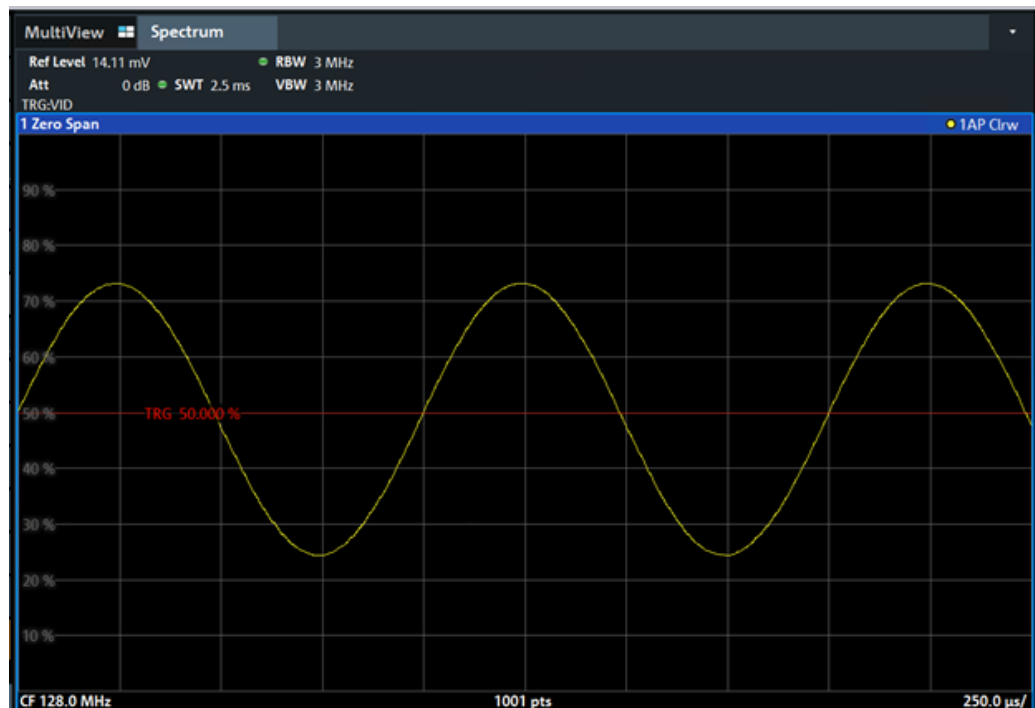


Figure 3-10: Measurement of the AM modulation depth

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

3.1.5.3 Measuring AM-modulated signals

The R&S EPL1000 rectifies the RF input signal (that is, removes the negative parts) and displays it as a magnitude spectrum. The rectification also demodulates AM-modulated signals. The AF voltage can be displayed in zero span if the modulation sidebands fall within the resolution bandwidth.

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

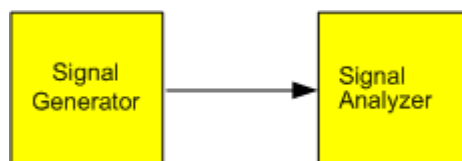


Figure 3-11: Test setup

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

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

1. Select [PRESET] to reset the instrument.

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

The trigger level is displayed as a horizontal line across the entire measurement diagram. The R&S EPL1000 displays the 1 kHz AF signal as a static image in zero span.

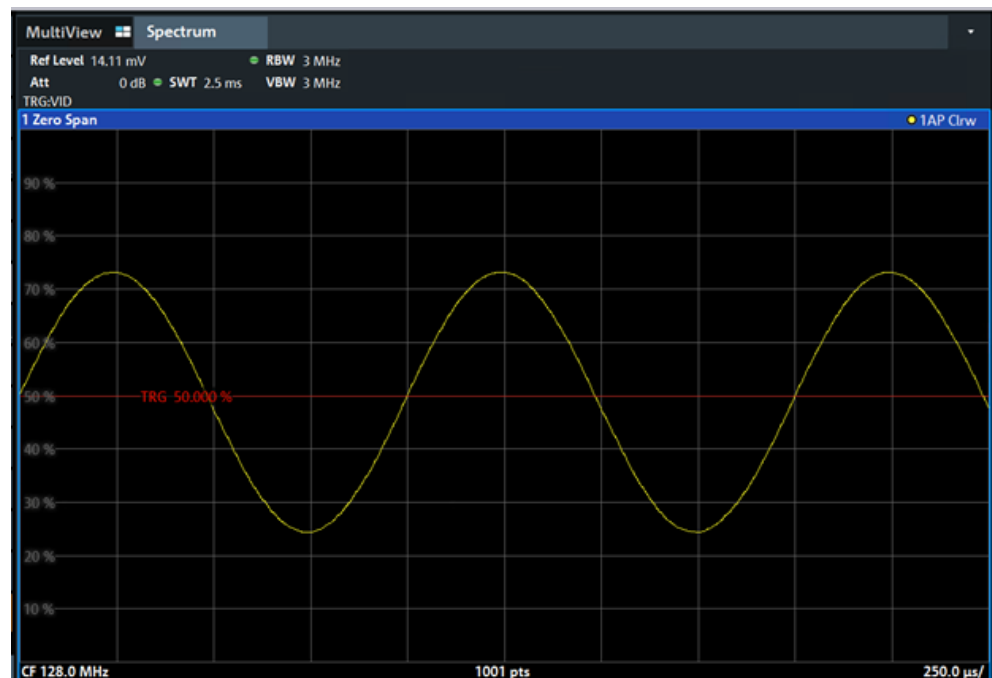


Figure 3-12: Measurement of the AF signal of a carrier that is AM-modulated with 1 kHz

10. Activate the internal AM demodulator to output the audio signal.
 - a) Press [MKR FUNC].

- b) Select "Marker Demodulation".

The R&S EPL1000 automatically switches on the AM audio demodulator. A 1 kHz tone can be heard over headset (via the headphones connector). If necessary, use the volume control to turn up the volume.

3.1.6 Measurement examples in zero span

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

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

- [Measuring the power characteristic of burst signals](#)..... 27
- [Measuring the signal-to-noise ratio of burst signals](#)..... 31

3.1.6.1 Measuring the power characteristic of burst signals

To measure power in zero span, the R&S EPL1000 offers easy-to-use functions that measure the power over a predefined time.

Measuring the power of a GSM burst during the activation phase

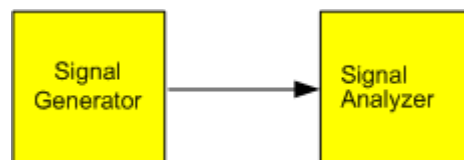


Figure 3-13: Test setup

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

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

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

7. Set the resolution bandwidth to 1 MHz ([BW] > "Res BW").
8. Set the sweep time to 1 ms ([SWEEP] > "Sweep Time Manual").

The R&S EPL1000 shows the GSM burst continuously across the display.

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

The R&S EPL1000 shows a static image with the GSM burst at the start of the trace. The trigger level is displayed as a horizontal line labeled with the absolute level for the trigger threshold in the measurement diagram.

10. Activate power measurement within the activation phase of the burst in zero span.
 - a) Press [MEAS].
 - b) Select "Time Domain Power".
 - c) Select "Time Dom Power Config".
 - d) Set the "Limits" state to "On".
 - e) Select the "Left Limit" input field.
 - f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
 - g) Select the "Right Limit" input field.
 - h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.

The R&S EPL1000 displays the average (mean) power during the activation phase of the burst.

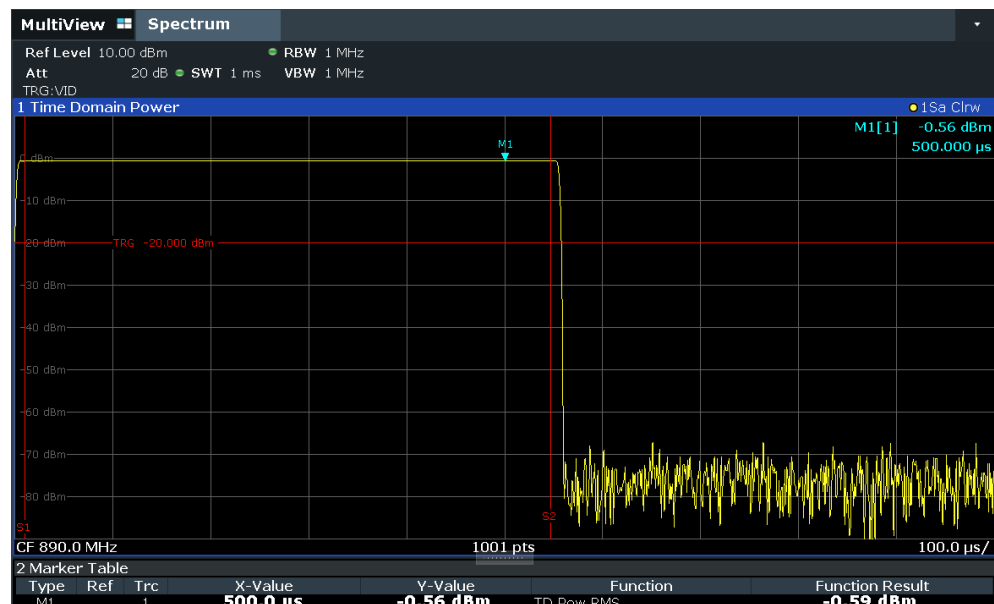


Figure 3-14: Measurement of the average power during the burst of a GSM signal

Measuring the edges of a GSM burst with high time resolution

Due to the high time resolution of the R&S EPL1000 at the 0 Hz display range, the edges of TDMA bursts can be measured precisely. The edges can be shifted to the display area using the trigger offset.

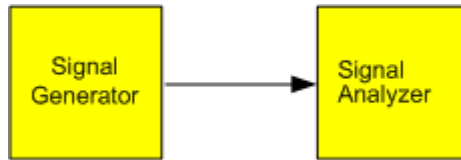


Figure 3-15: Test setup

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

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

The measurement is based on the example ["Measuring the power of a GSM burst during the activation phase"](#) on page 27.

1. Switch off the power measurement.
 - a) Press [MEAS].
 - b) Select "Zero Span".
2. Increase the time resolution by setting the sweep time to $100 \mu\text{s}$ ([SWEEP] > "Sweep Time Manual").
3. Shift the rising edge of the GSM burst to the center of the display by defining a trigger offset.
 - a) Press [TRIG].
 - b) Select "Trigger Offset".

- c) By turning the rotary knob counterclockwise, reduce the trigger offset until the burst edge is displayed in the center of the display, or enter $-50 \mu\text{s}$.
The R&S EPL1000 displays the rising edge of the GSM burst.

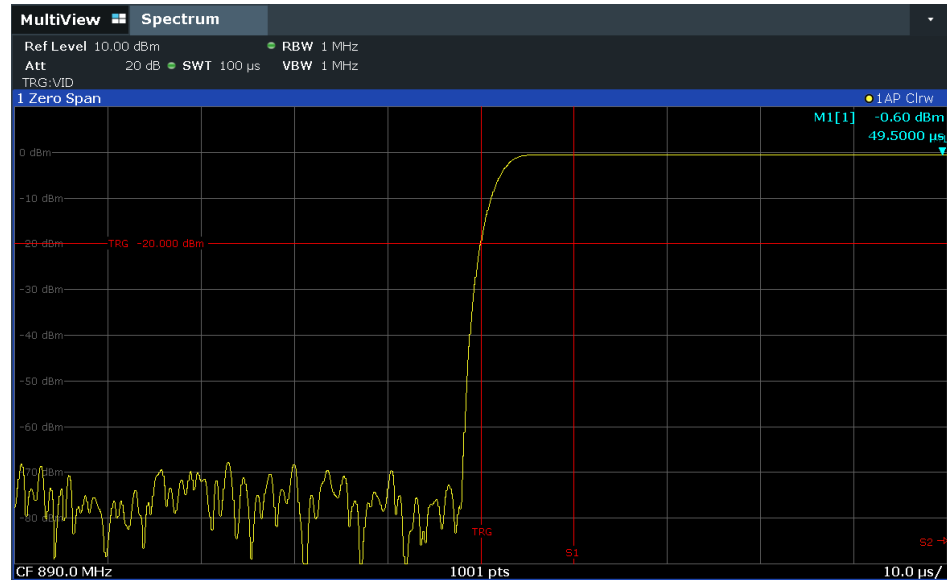


Figure 3-16: Rising edge of the GSM burst displayed with high time resolution

4. Move the falling edge of the burst to the center of the display. To do so, switch the trigger "Slope" to "Falling" ([TRIG] > "Trigger/ Gate Config").

The R&S EPL1000 displays the falling edge of the GSM burst.

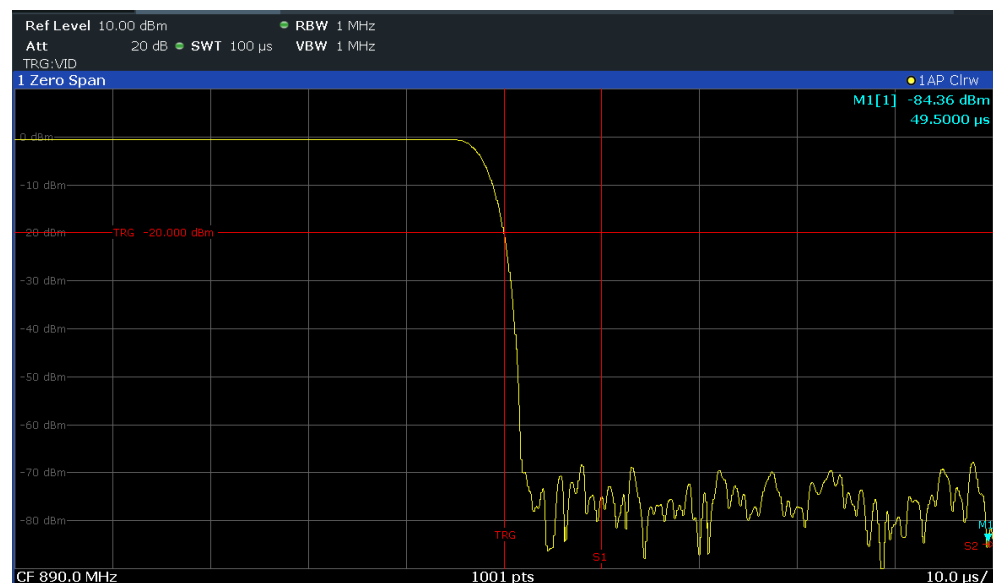


Figure 3-17: Falling edge of the GSM burst displayed with high time resolution

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

When TDMA transmission methods are used, the signal-to-noise ratio or the dynamic range for deactivation can be measured by comparing the power values during the activation phase and the deactivation phase of the transmission burst. Therefore, the R&S EPL1000 provides a measurement for absolute and relative power in zero span. In the following example, the measurement is performed using a GSM burst.

Signal-to-Noise Ratio of a GSM Signal

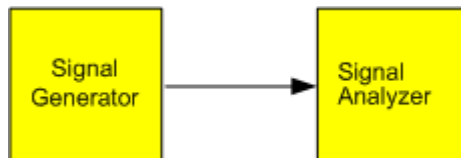


Figure 3-18: Test setup

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

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

1. Select [PRESET] to reset the instrument.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *890 MHz*.
4. Set the frequency span to *0 Hz*.
5. Set the resolution bandwidth to *1 MHz*.
6. Set the reference level to *0 dBm* (= level of the signal generator).
7. Set the sweep time to *2 ms* ([SWEEP] > "Sweep Time Manual").
The R&S EPL1000 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 29).
9. Activate power measurement within the activation phase of the burst in zero span.
 - a) Press [MEAS].
 - b) Select "Time Domain Power".
 - c) Select "Time Dom Power Config".
 - d) Set the "Limits" state to "On".
 - e) Select the "Left Limit" input field.
 - f) By turning the rotary knob clockwise, move the vertical line "S1" to the start of the burst.
 - g) Select the "Right Limit" input field.

- h) By turning the rotary knob clockwise, move the vertical line "S2" to the end of the burst.
 - i) Note down the power result for the burst, indicated by the "TD Pow RMS" result in the marker table.
10. Measure the power during the deactivation phase of the burst by switching the trigger slope to "Falling" ([TRIG] > "Trigger/ Gate Config").

The R&S EPL1000 initiates triggering in response to the falling edge of the burst. This shifts the burst to the left-hand side of the measurement diagram. The power is measured in the deactivation phase.

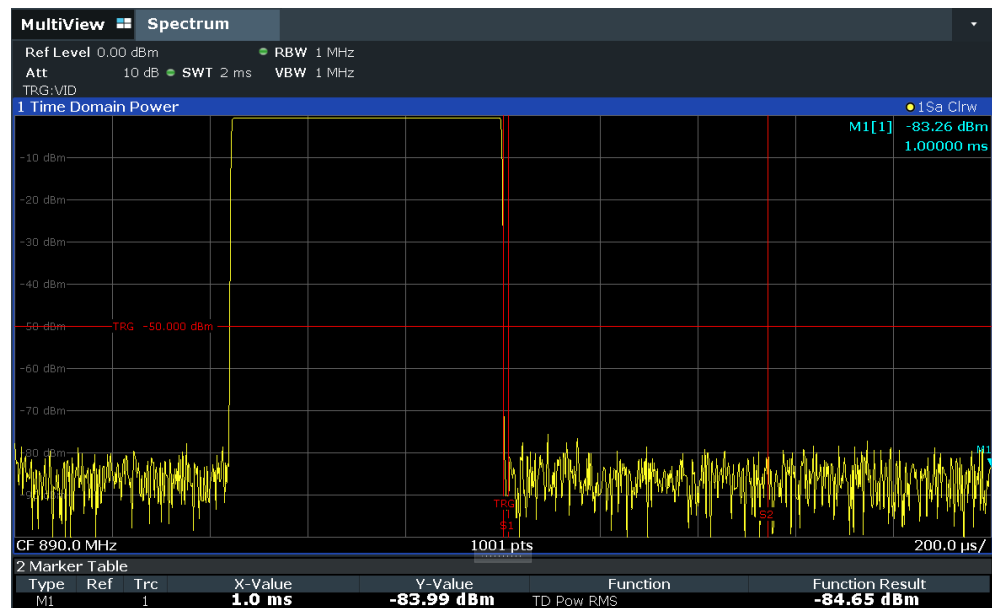


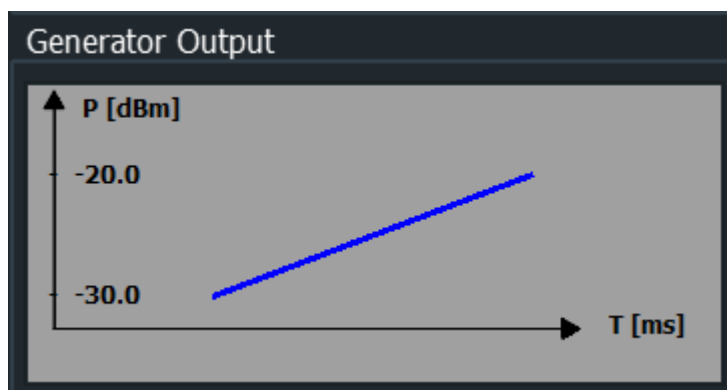
Figure 3-19: Measurement of the signal-to-noise ratio of a GSM burst signal in zero span

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

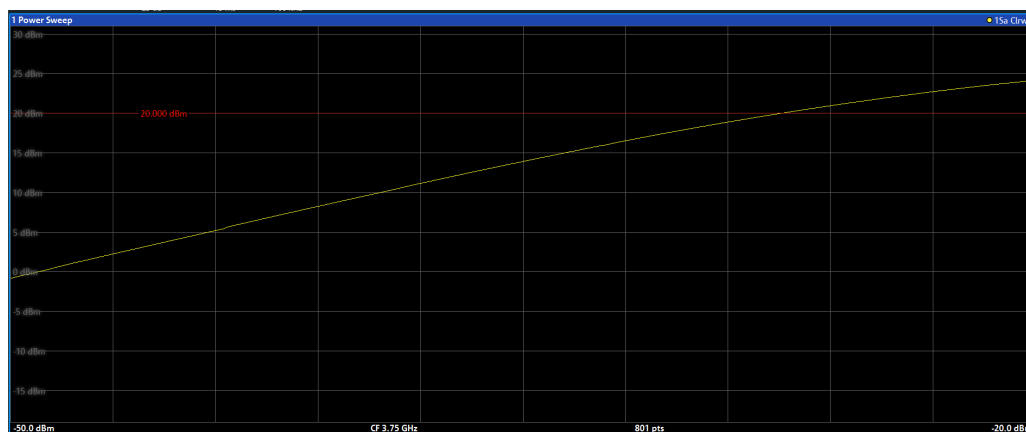
Subtract the measured noise power from the burst power to obtain the signal-to-noise ratio of the burst signal.

3.2 Power sweep measurements

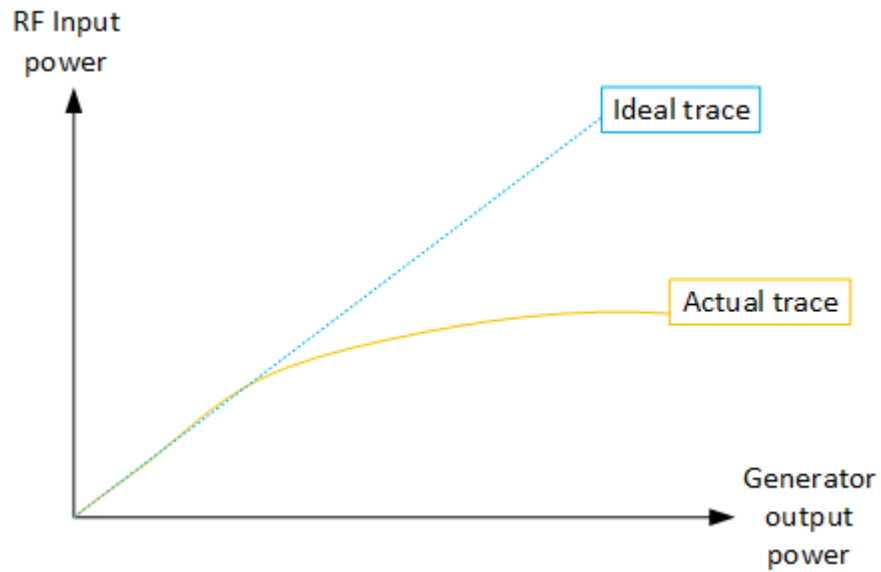
For a power sweep measurement, the internal generator signal remains at a fixed frequency, but increases its power level within a specified range over time. The default frequency of the internal generator is coupled to the (center) frequency of the analyzer and can be set from 5 kHz to the maximum frequency of the R&S EPL1000. However, you can define an offset for the internal generator frequency.



As a result, the measured power levels at the RF input are displayed versus the provided power levels of the internal generator output.



Thus, you can use the internal generator signal as a reference input signal for your power-converting DUT. Then you can compare the DUT input to its output at the RF input of the analyzer. Ideally, the result is a linear trace, that is: the output is directly proportional to the input power. Any distortion to the linear trace indicates the effects of the DUT. This result is useful, for example, to determine the compression point for amplifiers.



The settings for a power sweep measurement are described in "Power sweep settings" on page 204.

- [About the power sweep compression point measurement](#)..... 34
- [Power sweep compression point results](#).....36
- [Power sweep compression point settings](#).....37
- [How to determine compression points](#).....39

3.2.1 About the power sweep compression point measurement

The compression point refers to the power level at which a power-converting device deviates from a linear input to output relation. The compression point of an amplifier defines the upper limit of its dynamic range. Using an optional internal generator, the R&S EPL1000 can perform a power sweep to determine the compression point of a device under test.

In a power sweep compression point measurement, you use the internal generator signal as a reference input signal for your power-converting DUT. Then you compare the DUT input to its output, which is measured at the RF input of the analyzer.

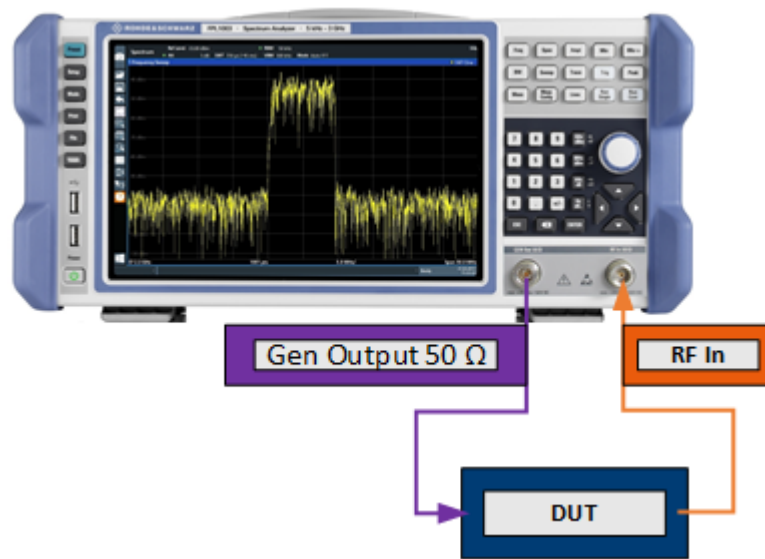


Figure 3-20: Test setup for compression point measurement using an internal generator

The compression point is defined as the power level at which the relationship between the input power and output power deviates from the linear trace. Various compression points can be defined, depending on the amount of deviation. For example, the 1 dB compression point indicates when the output power deviates from the linear response by 1 dB.

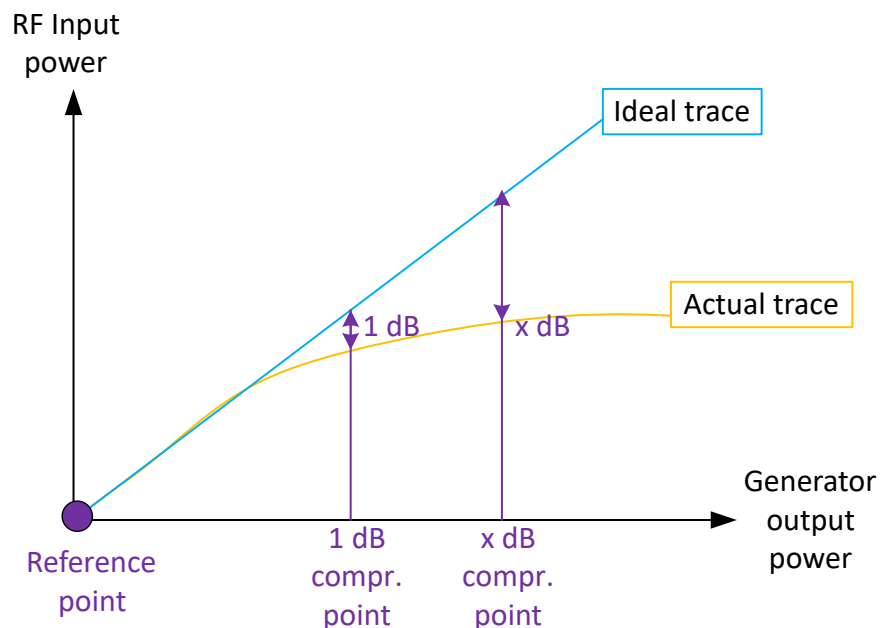


Figure 3-21: Compression point calculation

Level offset

In an ideal measurement setup, the relation between the output power of the DUT to the input power is linear throughout the measured power range. However, due to cable

loss, for instance, a level offset can occur. By defining a known level offset for the measurement, you can shift the x-axis scale to compensate for the loss. Nevertheless, you define the correct power start level and stop level to be applied to the DUT and swept by the measurement.

Reference point

By default, the linear trace describing the relation between the output power of the DUT to the input power is assumed to start at the defined start power level. The starting point is referred to as the reference point for the compression measurement.

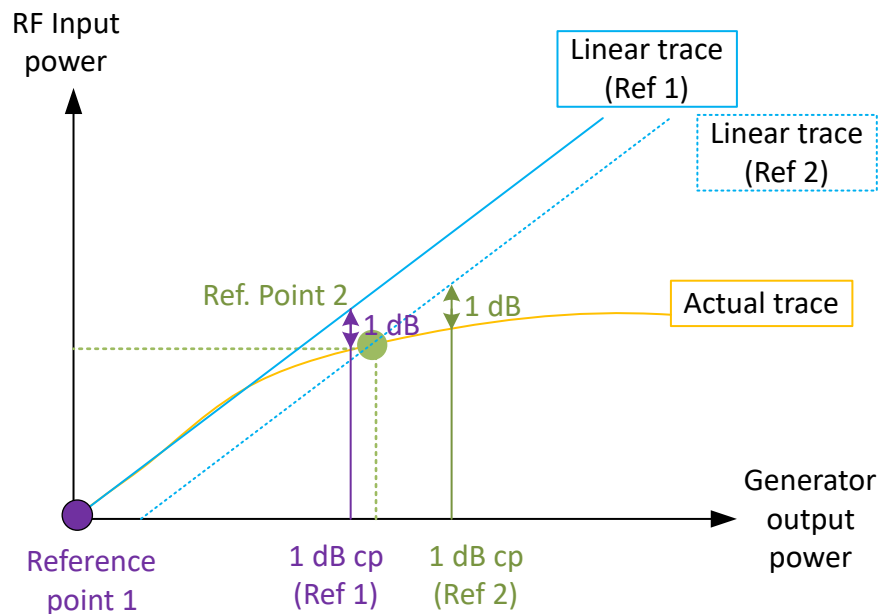
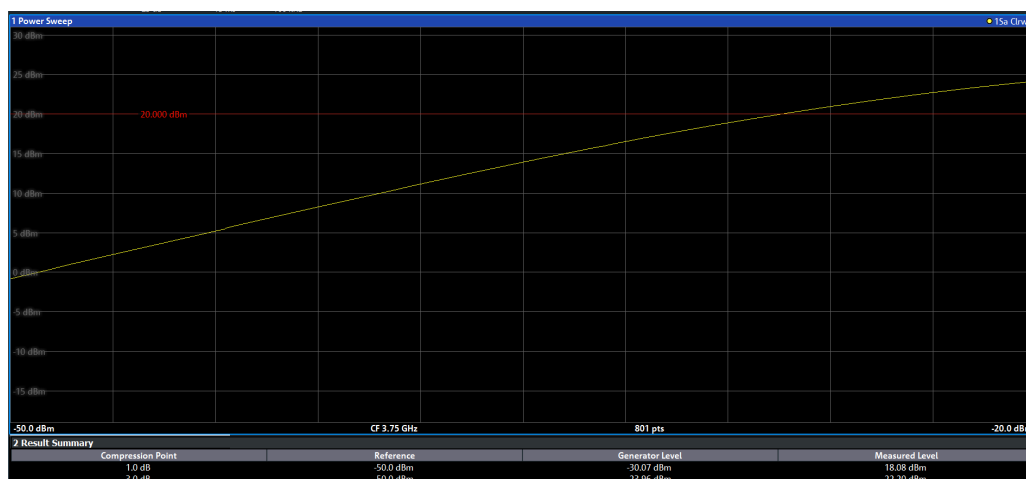


Figure 3-22: Reference point offset

However, you can shift the reference point anywhere within the specified power sweep range. In this case, the linear trace on which the deviation or compression calculation is based is also shifted. In the compression measurement results, the used reference point is also indicated.

3.2.2 Power sweep compression point results

As a result of the compression point measurement, in addition to the power sweep diagram, a result table is displayed.



The result summary contains the following results:

- "Compression Point": Level of compression
- "Reference": Used reference point for calculation
- "Generator Level": Input level of the DUT at which the compression occurs
- "Measured Level": Output level of the DUT at which the compression occurs

Remote commands:

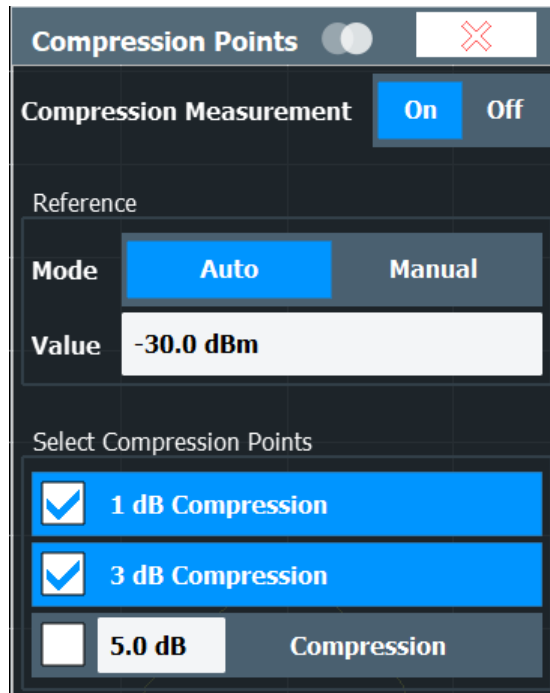
`FETCh:CMMeasurement:P1DB[:RESult]?` on page 401

`FETCh:CMMeasurement:P3DB[:RESult]?` on page 401

`FETCh:CMMeasurement:PNDB[:RESult]?` on page 401

3.2.3 Power sweep compression point settings

Access: "Overview" > "Select Measurement" > "Power Sweep" > "Compr Points"



General power sweep settings are described in ["Power sweep settings"](#) on page 204.

Compression Measurement State	38
Reference	38
Compression Points	38

Compression Measurement State

Enables or disables the compression point measurement.

Remote command:

[CONFigure:CMMeasurement\[:STATe\]](#) on page 401

Reference

Determines the reference point for the linear trace on which the deviation or compression calculation is based.

By default, the reference point is automatically set to the start level of the power sweep (see ["Level Start / Level Stop"](#) on page 205). In manual mode, define the reference point as required.

For details, see ["Reference point"](#) on page 36.

Remote command:

[CONFigure:CMMeasurement:REference\[:MODE\]](#) on page 399

[CONFigure:CMMeasurement:REference:VALue](#) on page 398

Compression Points

Selects which compression points to calculate. For the user-defined compression point, define the distance from the linear trace to the reference trace to base the calculation on. For details, see [Chapter 3.2.1, "About the power sweep compression point measurement"](#), on page 34.

Remote command:

Enable calculation:

`CONFigure:CMESasurement:RESult:P1DB[:STAT]` on page 399

`CONFigure:CMESasurement:RESult:P3DB[:STAT]` on page 400

`CONFigure:CMESasurement:RESult:PNDB[:STAT]` on page 400

`CONFigure:CMESasurement:RESult:CVALue` on page 399

Query results:

`FETCh:CMESasurement:P1DB[:RESult]?` on page 401

`FETCh:CMESasurement:P3DB[:RESult]?` on page 401

`FETCh:CMESasurement:PNDB[:RESult]?` on page 401

3.2.4 How to determine compression points

The following step-by-step instructions demonstrate how to determine the compression point of an amplifier.

To configure the internal generator for a power sweep measurement

Before you connect your DUT to the R&S EPL1000, perform a reference power sweep measurement with the internal generator.

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select the "Power Sweep" measurement function.
3. Select "GEN Config".
4. Set the "State" to "On".
5. Define the output power range to be provided to the DUT by the generator as the "Level Start" and "Level Stop".
6. Connect your DUT to the R&S EPL1000.
7. Perform a new measurement.

The input power vs. the output power of the DUT are displayed.

8. If the power sweep shows a constant deviation to the trace without the DUT due to cable loss or similar, define a "Level Offset" in the "Internal Generator" settings.

To configure the compression point measurement

1. Select "Compr Points".
2. In the "Compression Points" dialog box, select the compression levels to calculate.
3. Set the "Compression Measurement" state to "On."

The power levels of the DUT input and the DUT output are indicated in the power sweep diagram. The power levels at which the selected compression occurs are indicated in the result summary.

3.3 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](#).....40
- [Channel power results](#)..... 41
- [Channel power basics](#).....42
- [Channel power configuration](#)..... 46
- [How to perform channel power measurements](#)..... 54
- [Measurement examples](#).....58
- [Optimizing and troubleshooting the measurement](#).....59
- [Reference: predefined CP/ACLR standards](#)..... 60

3.3.1 About channel power measurements

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

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

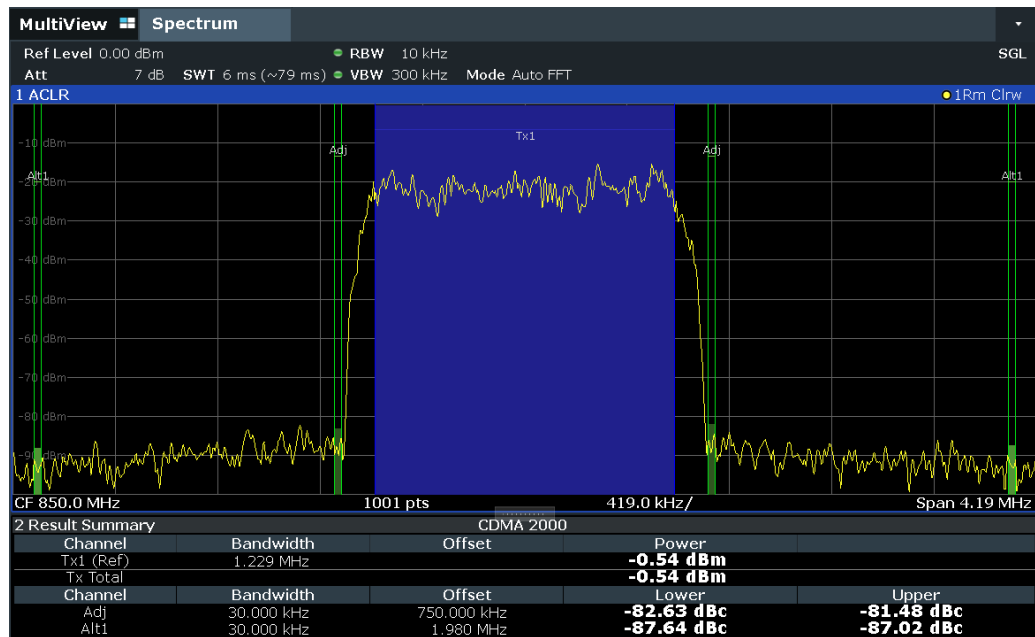
Apart from this common method, the R&S EPL1000 also has a true power detector, i.e. an RMS detector. It displays the power of the test signal within the selected resolution bandwidth correctly, irrespective of the amplitude distribution, without additional correction factors being required.

The R&S EPL1000 software allows you to perform ACLR measurements on input containing multiple signals for different communication standards. A measurement standard is provided that allows you to define multiple discontinuous transmit channels at specified frequencies, independent from the selected center frequency. The ACLR measurement determines the power levels of the individual transmit, adjacent, and gap channels, as well as the total power for each sub block of transmit channels.

A detailed measurement example is provided in [Chapter 3.3.6, "Measurement examples"](#), on page 58.

3.3.2 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", "Alt %1", "Tx %1", etc., or a user-defined name) is indicated above the bar (separated by a line which has no further meaning).



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

Number of adj. chan.	Measurement results
0	Channel powers
1	<ul style="list-style-type: none"> 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)

Channel power and adjacent-channel power (ACLR) measurement



In the R&S EPL1000 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 54).
Bandwidth	Configured channel bandwidth (see "Channel Bandwidth" on page 52)
Offset	Offset of the channel to the TX channel (configured channel spacing, see "Channel Bandwidth" on page 52)
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 395). 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 564). In this case, the measured power value for each sweep point (by default 1001) is returned.

For a full list of remote commands for ACLR measurements, see [Chapter 6.7.4, "Channel power and ACLR"](#), on page 402.

3.3.3 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.

- [Recommended common measurement parameters](#).....42

3.3.3.1 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 51).

The easiest way to configure a measurement is using the configuration "Overview", see [Chapter 4.1, "Configuration overview"](#), on page 184.

• Sweep Time	43
• Frequency span.....	44
• Resolution bandwidth (RBW).....	44
• Video bandwidth (VBW).....	45
• Detector.....	45
• Trace averaging.....	46
• Reference level.....	46

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 Time" s can affect the repeatability of the measurement results. Repeatability is increased at longer "Sweep Time" s.

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).

Channel power and adjacent-channel power (ACLR) measurement

The "Sweep Time" can be defined using the softkey in the "Ch Power" menu or in the "Sweep" configuration dialog box (see "[Sweep Time](#)" on page 51).

Frequency span

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

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

The frequency span for the defined channel settings can be optimized. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see "[Optimized Settings \(Adjust Settings\)](#)" on page 51). You can set the frequency span manually in the "Frequency" configuration dialog box.

(See [Chapter 4.3.4, "How to define the frequency range"](#), on page 214.)

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

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

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

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

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

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

Resolution bandwidth (RBW)

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

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

Channel power and adjacent-channel power (ACLR) measurement

You can optimize the resolution bandwidth for the defined channel settings. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 51). You can set the RBW manually in the "Bandwidth" configuration dialog box, see ["RBW"](#) on page 174.

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

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

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

Video bandwidth (VBW)

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

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

For FFT sweeps, instead of increasing the VBW, you can also select the trace average mode "Power" to ensure correct power measurements (see ["Average Mode"](#) on page 293). Note that in power measurements this setting affects the VBW regardless of whether or not a trace is actually averaged.

The video bandwidth for the defined channel settings can be optimized. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 51). You can set the VBW manually in the "Bandwidth" configuration dialog box, see ["VBW"](#) on page 233.

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.

For details, see ["RMS average detector"](#) on page 275.

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

You can set the RMS detector for the defined channel settings automatically. Use the "Adjust Settings" function in the "Ch Power" menu or the "General Settings" tab of the "ACLR Setup" dialog box (see ["Optimized Settings \(Adjust Settings\)"](#) on page 51).

You can set the detector manually in the "Traces" configuration dialog box, see ["Detector"](#) on page 292.

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 293.

Reference level

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



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

3.3.4 Channel power configuration

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

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

Channel power and adjacent-channel power (ACLR) measurement

The screenshot shows the "ACLR Setup" dialog box with the "Channel Settings" tab selected. The "Standard" dropdown is set to "None" with a "Manage User Standards" button below it. The "Channel Count" section has "Tx" set to 1 and "Adj" set to 0. The "Reference Channel" dropdown is set to "Max Power Tx Channel". The "ACLR Mode" has "Abs" selected over "Rel". The "Selected Trace" field contains "1". The "Power Unit" has "Abs" selected over "/Hz". The "Power Mode" has "CLRW" selected over "Max Hold". At the bottom, there are "Set CP Reference" and "Adjust Settings" buttons.

The remote commands required to perform these tasks are described in [Chapter 6.7.4, "Channel power and ACLR"](#), on page 402.

- [General CP/ACLR measurement settings](#)..... 47
- [Channel setup](#)..... 51

3.3.4.1 General CP/ACLR measurement settings

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

Standard	48
L Predefined Standards	48
L User Standards	48
Number of channels: Tx, Adj	49
Reference Channel	49
Selected Trace	50
Absolute and Relative Values (ACLR Mode)	50
Channel power level and density (Power Unit)	50
Power Mode	50
Setting a fixed reference for Channel Power measurements (Set CP Reference)	50
Optimized Settings (Adjust Settings)	51
Sweep Time	51

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 EPL1000. However, the settings can be changed. Predefined standards are available for standard measurements, but standard files with user-defined configurations can also be created.

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 EPL1000. However, you can change the settings.

The predefined standards contain the following settings:

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

For details on the available standards, see [Chapter 3.3.8, "Reference: predefined CP/ACLR standards"](#), on page 60.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:PRESet` on page 402

User Standards ← Standard

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

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

`C:\ProgramData\Rohde-Schwarz\ZNL-FPL\acp_std` directory.

Note: User standards created on an analyzer of the R&S FSP family are compatible to the R&S EPL1000. User standards created on an R&S EPL1000, 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

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

Channel power and adjacent-channel power (ACLR) measurement

For details see [Chapter 3.3.5.3, "How to manage user-defined configurations"](#), on page 56.

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

Remote command:

To query all available standards:

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

on page 403

To load a standard:

`CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:PRESet` on page 402

To save a standard:

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

on page 404

To delete a standard:

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

on page 403

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 49).

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

For more information on how the number of channels affects the measured powers, see [Chapter 3.3.2, "Channel power results"](#), on page 41.

Remote command:

Number of Tx channels:

`[SENSe:] POWER:ACHannel:TXChannel:COUNT` on page 407

Number of Adjacent channels:

`[SENSe:] POWER:ACHannel:ACPairs` on page 404

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.
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.

Channel power and adjacent-channel power (ACLR) measurement

Remote command:

[\[SENSe:\] POWER:ACHannel:REFERENCE:TXChannel:MANual](#) on page 410

[\[SENSe:\] POWER:ACHannel:REFERENCE:TXChannel:AUTO](#) on page 410

Selected Trace

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

Remote command:

[\[SENSe:\] POWER:TRACe](#) on page 398

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 419

Channel power level and density (Power Unit)

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

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

"channel power density = channel power – 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<sb>:RESult:PHZ](#) on page 418

[CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult:UNIT](#) on page 418

Power Mode

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

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE](#) on page 394

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.

Channel power and adjacent-channel power (ACLR) measurement

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 49), thus, this function is not available.

Remote command:

[SENSe:] POWER:ACHannel:REFerence:AUTO ONCE 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 44
- ["Resolution bandwidth \(RBW\)"](#) on page 44
- ["Video bandwidth \(VBW\)"](#) on page 45
- ["Detector"](#) on page 45
- ["Trace averaging"](#) on page 46

Remote command:

[SENSe:] POWER:ACHannel:PRESet on page 397

Sweep Time

With the RMS detector, a longer "Sweep Time" increases the stability of the measurement results. For recommendations on setting this parameter, see ["Sweep Time"](#) on page 43.

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

Remote command:

[SENSe:] SWEEP:TIME on page 549

3.3.4.2 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 49).

For details on setting up channels, see [Chapter 3.3.5.2, "How to set up the channels"](#), on page 55.



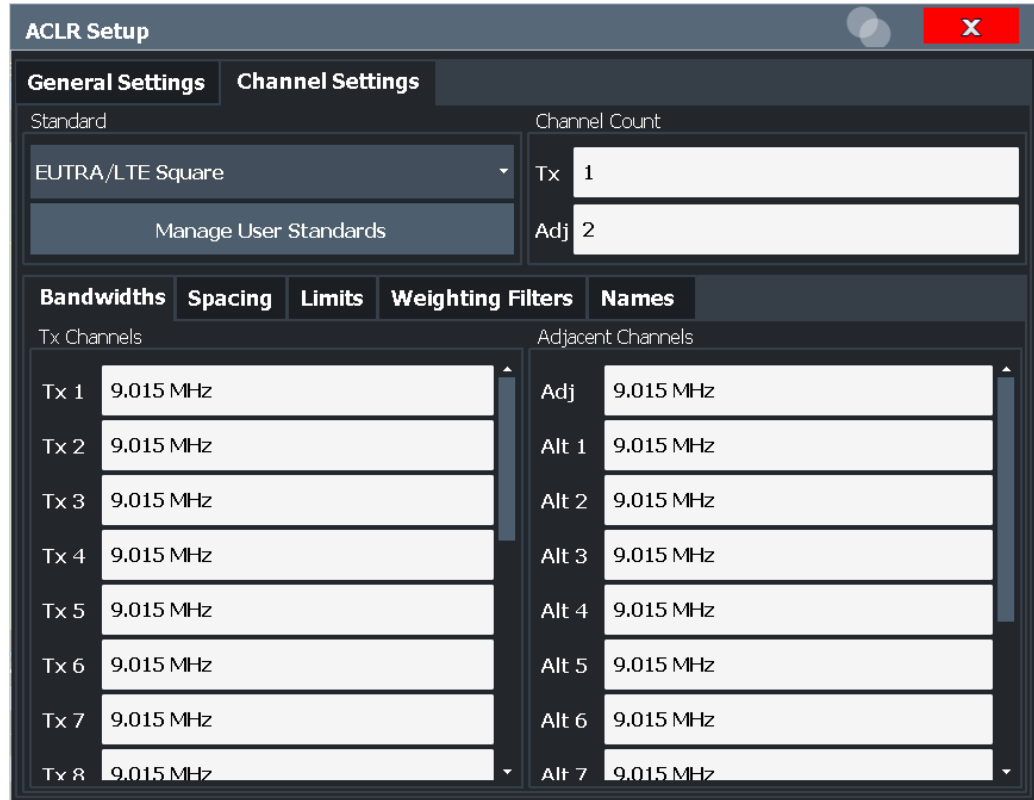
In addition to the specific channel settings, the general settings ["Standard"](#) on page 48 and ["Number of channels: Tx, Adj"](#) on page 49 are also available in this tab.

Channel power and adjacent-channel power (ACLR) measurement

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

Channel Bandwidth..... 52
 Channel Spacings..... 53
 Limit Check..... 53
 Weighting Filters..... 54
 Channel Names..... 54

Channel Bandwidth



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.

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

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

Remote command:

[SENSE:] POWER:ACHannel:BANDwidth[:CHANnel<ch>] on page 405

[SENSE:] POWER:ACHannel:BANDwidth:ACHannel on page 404

[SENSE:] POWER:ACHannel:BANDwidth:ALternate<ch> on page 405

Channel power and adjacent-channel power (ACLR) measurement

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:

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

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

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

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

For details, see [Chapter 3.3.5.2, "How to set up the channels"](#), on page 55

Remote command:

[SENSe:] POWER:ACHannel:SPACing:CHANnel<ch> on page 406

[SENSe:] POWER:ACHannel:SPACing[:ACHannel] on page 407

[SENSe:] POWER:ACHannel:SPACing:ALternate<ch> on page 406

Limit Check

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

2 Result Summary		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	2.10290 GHz*	-57.29 dBm*	-87.83 dB*	-7.27 dB*	
3.515 MHz	4.000 MHz	30.000 kHz	2.10355 GHz	-51.94 dBm	-82.48 dB	-19.44 dB	
4.000 MHz	8.000 MHz	1.000 MHz	2.10725 GHz	-40.01 dBm	-70.55 dB	-20.51 dB	
8.000 MHz	12.750 MHz	1.000 MHz	2.10911 GHz	-40.28 dBm	-70.82 dB	-16.78 dB	

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

Channel power and adjacent-channel power (ACLR) measurement

Remote command:

[CALCulate<n>:LIMit:ACPower\[:STATe\]](#) on page 417

[CALCulate<n>:LIMit:ACPower:ACHannel:ABSolute:STATe](#) on page 411

[CALCulate<n>:LIMit:ACPower:ACHannel:ABSolute](#) on page 411

[CALCulate<n>:LIMit:ACPower:ACHannel\[:RELative\]:STATe](#)
on page 412

[CALCulate<n>:LIMit:ACPower:ACHannel\[:RELative\]](#) on page 412

[CALCulate<n>:LIMit:ACPower:ALTernate<ch>:ABSolute:STATe](#)
on page 414

[CALCulate<n>:LIMit:ACPower:ALTernate<ch>:ABSolute](#) on page 414

[CALCulate<n>:LIMit:ACPower:ALTernate<ch>\[:RELative\]:STATe](#)
on page 415

[CALCulate<n>:LIMit:ACPower:ALTernate<ch>\[:RELative\]](#)
on page 415

[CALCulate<n>:LIMit:ACPower:ACHannel:RESult?](#) on page 413

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 409

[\[SENSe:\] POWER:ACHannel:FILTer\[:STATe\]:ACHannel](#) on page 408

[\[SENSe:\] POWER:ACHannel:FILTer\[:STATe\]:ALTernate<ch>](#) on page 409

Alpha value:

[\[SENSe:\] POWER:ACHannel:FILTer:ALPHa:CHANnel<ch>](#) on page 408

[\[SENSe:\] POWER:ACHannel:FILTer:ALPHa:ACHannel](#) on page 407

[\[SENSe:\] POWER:ACHannel:FILTer:ALPHa:ALTernate<ch>](#) on page 408

Channel Names

In the R&S EPL1000'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 405

[\[SENSe:\] POWER:ACHannel:NAME:ALTernate<ch>](#) on page 405

[\[SENSe:\] POWER:ACHannel:NAME:CHANnel<ch>](#) on page 406

3.3.5 How to perform channel power measurements

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



For remote operation, see [Chapter 6.7.4.9, "Programming examples for channel power measurements"](#), on page 419.

- [How to perform a standard channel power measurement](#)..... 55
- [How to set up the channels](#).....55
- [How to manage user-defined configurations](#).....56
- [How to compare the TX channel power in successive measurements](#).....57

3.3.5.1 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 EPL1000.

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select "Channel Power ACLR".
The measurement is started immediately with the default settings.
3. Select "CP / ACLR Standard".
4. Select a standard from the list.
The measurement is restarted with the predefined settings for the selected standard.
5. If necessary, edit the settings for your specific measurement as described in [Chapter 3.3.5.2, "How to set up the channels"](#), on page 55, or load a user-defined configuration (see ["To load a user-defined configuration"](#) on page 57).

3.3.5.2 How to set up the channels

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

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

Channel setup consists of the following settings:

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

- Optionally: limits for a limit check on the measured power levels



Changes to an existing standard can be stored as a user-defined standard, see [Chapter 3.3.5.3, "How to manage user-defined configurations"](#), on page 56.

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



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

To define channel spacings

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

- ▶ In the "Channel Settings" tab of the "ACLR Setup" dialog box, select the "Spacing" subtab.

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

If the channel spacing for the adjacent or an alternate channel is changed, all higher alternate channel spacings are multiplied by the same factor (new spacing value/old spacing value). The lower adjacent-channel spacings remain unchanged. Only enter one value for equal channel spacing.

Example: Defining channel spacing

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

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

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

3.3.5.3 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 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 EPL1000. User standards created on an R&S EPL1000, however, are not necessarily compatible to the analyzers of the R&S FSP family and may not work there.

To store a user-defined configuration

1. In the "Ch Power" menu, select "CP / ACLR Config" to display the "ACLR Setup" dialog box.
2. Configure the measurement as required (see also [Chapter 3.3.5.2, "How to set up the channels"](#), on page 55).
3. In the "General Settings" tab, select "Manage User Standards" to display the "Manage" dialog box.
4. Define a filename and storage location for the user standard.
By default, the XML file is stored in
C:\ProgramData\Rohde-Schwarz\ZNL-FPL\acp_std\. However, you can define any other storage location.
5. Select "Save".

To load a user-defined configuration

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

The stored settings are automatically set on the R&S EPL1000 and the measurement is restarted with the new parameters.

3.3.5.4 How to compare the TX channel power in successive measurements

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

1. Configure a measurement with only one TX channel and no adjacent channels (see also [Chapter 3.3.5.2, "How to set up the channels"](#), on page 55).
2. In the "ACLR Setup" dialog box, select "Set CP Reference".
The channel power currently measured on the TX channel is stored as a fixed reference power. The reference value is displayed in the "Reference" field of the result table (in relative ACLR mode).
3. Start a new measurement.
The resulting power is indicated relative to the fixed reference power.
4. Repeat this for any number of measurements.
5. To start a new measurement without the fixed reference, temporarily define a second channel or preset the instrument.

3.3.6 Measurement examples

The R&S EPL1000 has test routines for simple channel and adjacent channel power measurements. These routines give quick results without any complex or tedious setting procedures.



A programming example demonstrating an ACLR measurement in a remote environment is provided in [Chapter 6.7.4.9, "Programming examples for channel power measurements"](#), on page 419.

- [Measurement example 3 – measuring the intrinsic noise of the R&S EPL1000 with the channel power function](#)..... 58

3.3.6.1 Measurement example 3 – measuring the intrinsic noise of the R&S EPL1000 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 EPL1000 open-circuited or terminate it with 50 Ω.

Procedure:

1. Preset the R&S EPL1000.
2. Set the center frequency to *1 GHz* and the span to *1 MHz*.
3. To obtain maximum sensitivity, set RF attenuation to *0 dB* and the reference level to *-40 dBm*.
4. Select the "Channel Power ACLR" measurement function from the "Select Measurement" dialog box.
5. In the "ACLR Setup" dialog box, set up a single TX channel with the channel bandwidth *1.23 MHz*.
6. Select "Adjust Settings".

Channel power and adjacent-channel power (ACLR) measurement

The settings for the frequency span, the bandwidth (RBW and VBW) and the detector are automatically set to the optimum values required for the measurement.

7. Stabilize the measurement result by increasing the "Sweep Time" .
Set the "Sweep Time" to 1 s.

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

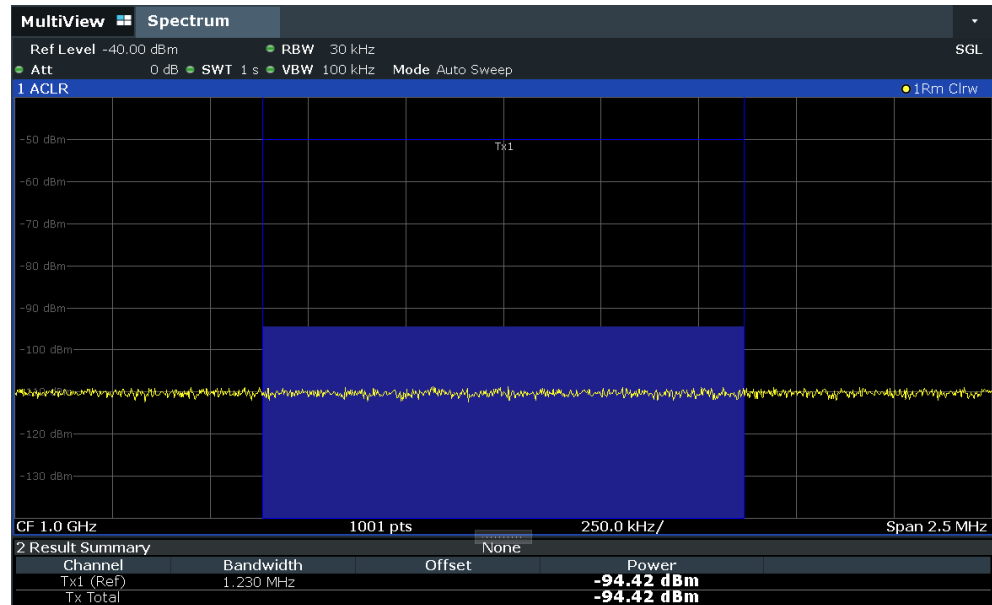


Figure 3-23: Measurement of the R&S EPL1000's intrinsic noise power in a 1.23 MHz channel bandwidth.

3.3.7 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 236).
- Reduce the "**Sweep Time**" and thus the amount of data to be captured and calculated; however, consider the requirements regarding the standard deviation.
- To improve the **stability of the measured results**, increase the "Sweep Time" , which also leads to more averaging steps.
- Instead of **trace averaging**, use an RMS detector with a higher "Sweep Time" to obtain better average power results in less time.

- To determine a **channel power level** quickly, use the **Time domain power measurement** (TDP) rather than a Channel Power measurement. The TDP measurement is a zero span measurement where the sweep time determines the measurement time. Due to the FFT measurement, duplicate averaging is performed, providing very stable results very quickly.
Note, however, that for TDP measurements, channel filters are not available and a fixed RBW is used. Thus, the measurement may not be according to standard for some test cases.

3.3.8 Reference: predefined CP/ACLR standards

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

You can select a predefined standard via "CP / ACLR Standard" in the "Ch Power" menu or the selection list in the "General Settings" tab of the "ACLR Setup" dialog box (see "Standard" on page 48).

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

Standard	Remote parameter
None	NONE
RFID 14443	RFID14443

3.4 Carrier-to-noise measurements

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

- [About the measurement](#).....60
- [Carrier-to-noise results](#).....61
- [Carrier-to-noise configuration](#).....62
- [How to determine the carrier-to-noise ratio](#).....63

3.4.1 About the measurement

The largest signal in the frequency span is the carrier. When you activate the C/N or C/N₀ function, the R&S EPL1000 searches the (unmodulated) carrier using a peak detector. The carrier is marked using a fixed reference marker ("FXD").

To determine the noise power, the R&S EPL1000 analyzes a channel with a defined bandwidth at the defined center frequency. The R&S EPL1000 integrates the power within this channel to obtain the noise power level. If the carrier is within this channel, you have to switch off the carrier to determine the correct noise power level. To determine the noise power, the R&S EPL1000 requires an RMS detector. To switch detectors, you must adjust the settings between the two measurements (see "Adjust Settings" on page 63).

The R&S EPL1000 subtracts the noise power of the channel from the maximum carrier signal level. For a C/N_0 measurement, the R&S EPL1000 normalizes the result to a 1 Hz bandwidth.



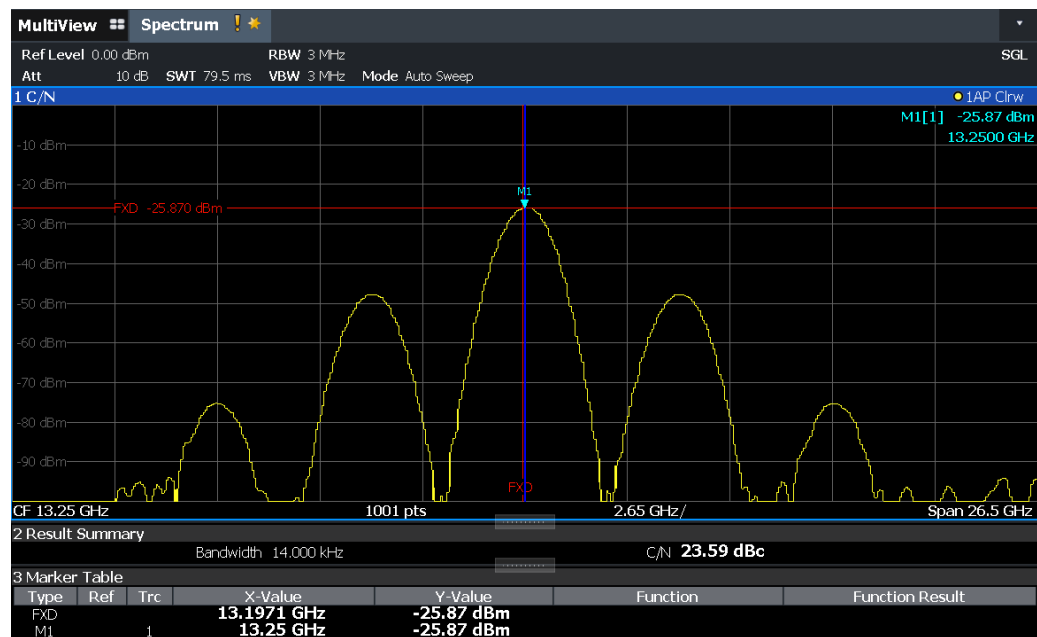
The carrier-to-noise measurements are only available in the frequency domain (span >0).

Frequency Span

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

3.4.2 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 for the (unmodulated) carrier is indicated in the diagram.



Remote command:

CALC:MARK:FUNC:POW:RES? CN

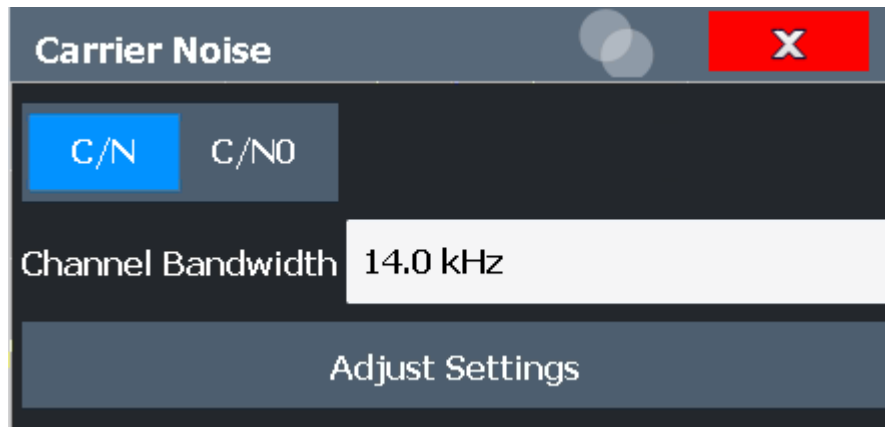
CALC:MARK:FUNC:POW:RES? CN0

See [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?](#) on page 395.

3.4.3 Carrier-to-noise configuration

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

Both a carrier-to-noise ratio (C/N) and a carrier-to-noise ratio in relation to the bandwidth (C/N₀) measurement are available.



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



The easiest way to configure a measurement is using the configuration "Overview", see [Chapter 4.1, "Configuration overview"](#), on page 184.

The remote commands required to perform these tasks are described in [Chapter 6.7.5, "Carrier-to-noise ratio"](#), on page 422.

C/N.....	62
C/N0.....	62
Channel Bandwidth.....	63
Adjust Settings.....	63

C/N

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

The measurement is performed on the trace that marker 1 is assigned to. To shift marker 1 and measure another trace, use "Marker To Trace" in the "Marker" menu (see ["Assigning the Marker to a Trace"](#) on page 171).

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:SElect` on page 396

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?` on page 395

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>[:STATe]` on page 397

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 "Marker To Trace" in the "Marker" menu (see ["Assigning the Marker to a Trace"](#) on page 171).

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:SElect` on page 396

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?` on page 395

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>[:STATe]` on page 397

Channel Bandwidth

Defines the channel bandwidth.

The default setting is 14 kHz.

Remote command:

`[SENSe:]POWER:ACHannel:BANDwidth[:CHANnel<ch>]` on page 405

Adjust Settings

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

$2 * \text{channel bandwidth}$

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

Remote command:

`[SENSe:]POWER:ACHannel:PRESet` on page 397

3.4.4 How to determine the carrier-to-noise ratio

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



For remote operation, see ["Programming example: Measuring the carrier-to-noise ratio"](#) on page 422.

1. Select [MEAS].
2. To configure the measurement without reference to the bandwidth, select "C/N".
To configure the measurement with reference to the bandwidth, select "C/N₀".
3. To change the channel bandwidth to be analyzed, select "Channel Bandwidth".
4. Select [RUN SINGLE].
The fixed reference marker for the (unmodulated) carrier is indicated in the diagram.
5. If the carrier signal is located within the analyzed channel bandwidth, switch off the carrier signal so that only the noise is displayed in the channel.
6. To optimize the settings for the selected channel configuration and use the RMS detector, select "Adjust Settings".

7. Select [RUN SINGLE] to perform a second measurement.

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

3.5 Occupied bandwidth measurement (OBW)

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

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- [OBW results](#).....66
- [OBW configuration](#).....66
- [How to determine the occupied bandwidth](#).....68
- [Measurement example](#).....70

3.5.1 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.

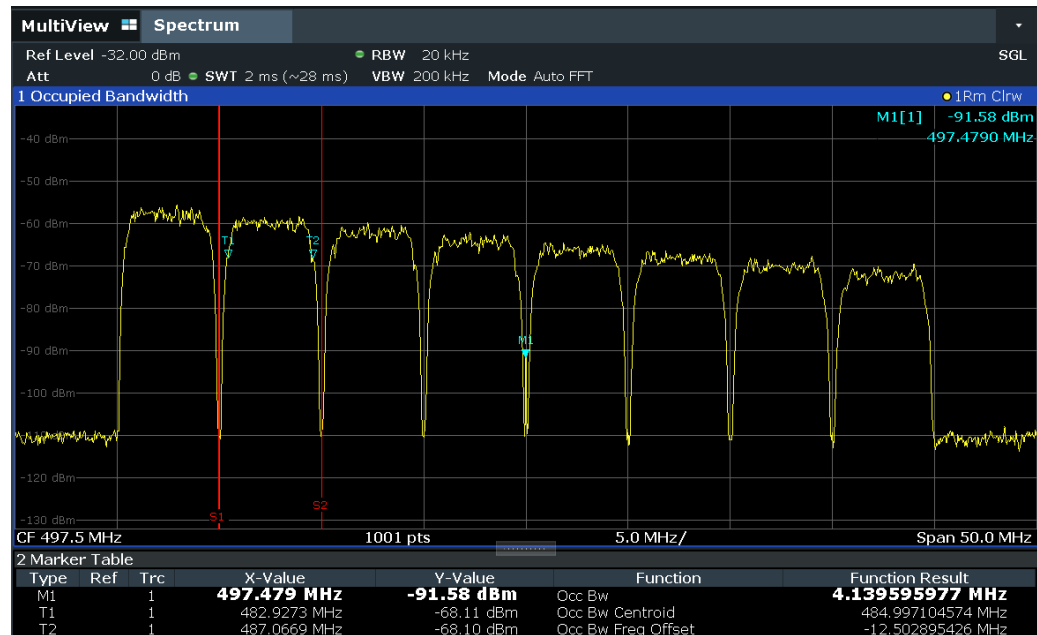
Measurement principle

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 recalculated for the new range.



For step-by-step instructions, see ["How to determine the OBW for a multicarrier signal using search limits"](#) on page 69.

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 EPL1000 has to be changed accordingly then.

3.5.2 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.

Centroid frequency

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

Frequency offset

The offset of the calculated centroid frequency to the defined center frequency of the R&S EPL1000 is indicated as a function result ("Occ Bw Freq Offset") in the marker table.

Remote command:

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

`CALC:MARK:FUNC:POW:SEL OBW`, see [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:SElect](#) on page 396

[CALCulate<n>:MARKer<m>:FUNction:POWer<sb>\[:STATe\]](#) on page 397

`CALC:MARK:FUNC:POW:RES? OBW`, see [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?](#) on page 395

`CALC:MARK:FUNC:POW:RES? COBW`, see [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?](#) on page 395

3.5.3 OBW configuration

Access: "Overview" > "Select Measurement" > "OBW" > "OBW Config"

This measurement is not available in zero span.



Configuring search limits for OBW measurement

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

The remote commands required to perform these tasks are described in [Chapter 6.7.6, "Occupied bandwidth"](#), on page 422.

% Power Bandwidth	67
Channel Bandwidth	67
Adjust Settings	68
Search Limits (Left / Right)	68
Search Limits Off	68

% Power Bandwidth

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

Remote command:

`[SENSe:]POWER:BANDwidth` on page 423

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 68). The default setting is 14 kHz.

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

For multicarrier measurements, this setting is irrelevant.

Remote command:

`[SENSe:] POWER:ACHannel:BANDwidth[:CHANnel<ch>]` on page 405

Adjust Settings

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

This function is only useful for single carrier measurements.

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

- Frequency span: $3 \times$ channel bandwidth
- RBW $\leq 1/40$ of channel bandwidth
- VBW $\geq 3 \times$ RBW
- Detector: RMS

The reference level is not affected by "Adjust Settings". For an optimum dynamic range, select the reference level such that the signal maximum is close to the reference level.

(See ["Setting the Reference Level Automatically \(Auto Level\)"](#) on page 222).

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

Remote command:

`[SENSe:] POWER:ACHannel:PRESet` on page 397

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 348.

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 600

`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 598

`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 599

Search Limits Off

Deactivates the search range limits.

Remote command:

`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 600

`CALCulate<n>:THReshold:STATe` on page 600

3.5.4 How to determine the occupied bandwidth

The following step-by-step instructions demonstrate how to determine the occupied bandwidth.



For remote operation, see [Chapter 6.7.6.2, "Programming example: OBW measurement"](#), on page 423.

How to determine the OBW for a single signal

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select the "OBW" measurement function.
The measurement is started immediately with the default settings.
3. Select "OBW Config".
The "Occupied Bandwidth" configuration dialog box is displayed.
4. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
5. If necessary, change the channel bandwidth for the transmission channel.
6. To optimize the settings for the selected channel configuration, select "Adjust Settings".
7. Start a sweep.
The result is displayed as OBW in the marker results.

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

1. Press [MEAS] or select "Select Measurement" in the "Overview".
2. Select the "OBW" measurement function.
3. Select "OBW Config".
4. Define the percentage of power ("% Power Bandwidth") that defines the bandwidth to be determined.
5. Define search limits so the search area contains only the first carrier signal:
 - a) Enter values for the left or right limits, or both.
 - b) Enable the use of the required limits.
6. Start a sweep.
The result for the first carrier is displayed as OBW in the marker results.
7. Change the search limits so the search area contains the next carrier signal as described in [step 5](#).
The OBW is recalculated and the result for the next carrier is displayed. A new sweep is not necessary!
8. Continue in this way until all carriers have been measured.

3.5.5 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.



A programming example demonstrating an OBW measurement in a remote environment is provided in [Chapter 6.7.6.2, "Programming example: OBW measurement"](#), on page 423.

1. Preset the R&S EPL1000.
2. Enter the Spectrum application via [MODE].
3. Set the "Center Frequency" to *800 MHz*.
4. Set the "Reference Level" to *-10 dBm*.
5. Press [MEAS] or select "Select Measurement" in the "Overview".
6. Select the "OBW" measurement function.
7. Select "OBW Config".
8. Set the "% Power Bandwidth" to *99 %*.
9. Set the "Channel Bandwidth" to *21 kHz* as specified by the PDC standard.
10. Optimize the settings for the selected channel configuration by selecting "Adjust Settings".
11. Adjust the reference level to the measured total power by selecting "Auto Level" in the [Auto set] menu.
12. The PDC standard requires the peak detector for OBW measurement. In the "Traces" configuration dialog, set the trace detector to "PositivePeak".
13. Start a sweep.

The result is displayed as OBW in the marker results.

3.6 Spectrum emission mask (SEM) measurement

Spectrum Emission Mask (SEM) measurements monitor compliance with a spectral mask.

- [About the measurement](#).....71
- [Typical applications](#).....71
- [SEM results](#).....71
- [SEM basics](#).....74
- [SEM configuration](#).....84
- [How to perform a spectrum emission mask measurement](#).....98
- [Measurement example: multi-sem measurement](#).....102
- [Reference: SEM file descriptions](#).....104

3.6.1 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 EPL1000 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 EPL1000 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 EPL1000 for spectrum emission mask measurements, a "Fast SEM" mode is available.

A special limit check for SEM measurements allows for monitoring compliance of the spectrum.

3.6.2 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.

3.6.3 SEM results

As a result of the Spectrum Emission Mask measurement, the following results are displayed in a diagram (see also [Chapter 3.6.4.2, "Limit lines in SEM measurements"](#), on page 77):

- 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 3-24](#), "31 < P < 39" is indicated as the used power class is defined from 31 to 39.

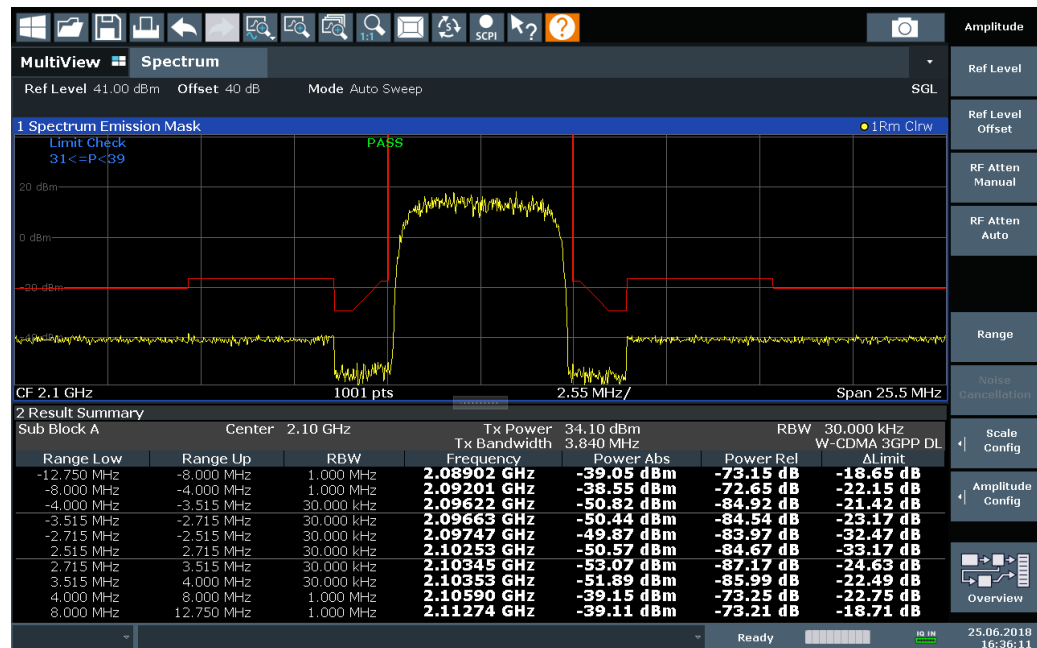


Figure 3-24: Spectrum Emission Mask result displays

In addition to the graphical results of the SEM measurement displayed in the diagram, a result summary is displayed to evaluate the limit check results (see also [Chapter 3.6.4.2, "Limit lines in SEM measurements"](#), on page 77).

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

Spectrum emission mask (SEM) measurement

Label	Description
"RBW"	RBW of the range
"Frequency"	Frequency of the peak power level
"Power Abs"	Absolute peak power level within the range
"Power Rel"	Peak power level within the range, relative to the "Tx Power"
"ΔLimit"	Deviation of the peak power level from the limit line

You can define in which detail the data is displayed in the result summary in the "List Evaluation" settings (see [Chapter 3.6.5.6, "List evaluation \(results configuration\)"](#), on page 96). By default, one peak per range is displayed. However, you can change the settings to display only peaks that exceed a threshold ("Margin").

Detected peaks are not only listed in the Result Summary, they are also indicated by colored squares in the diagram (optionally, see [Show Peaks](#) in the "List Evaluation" settings).

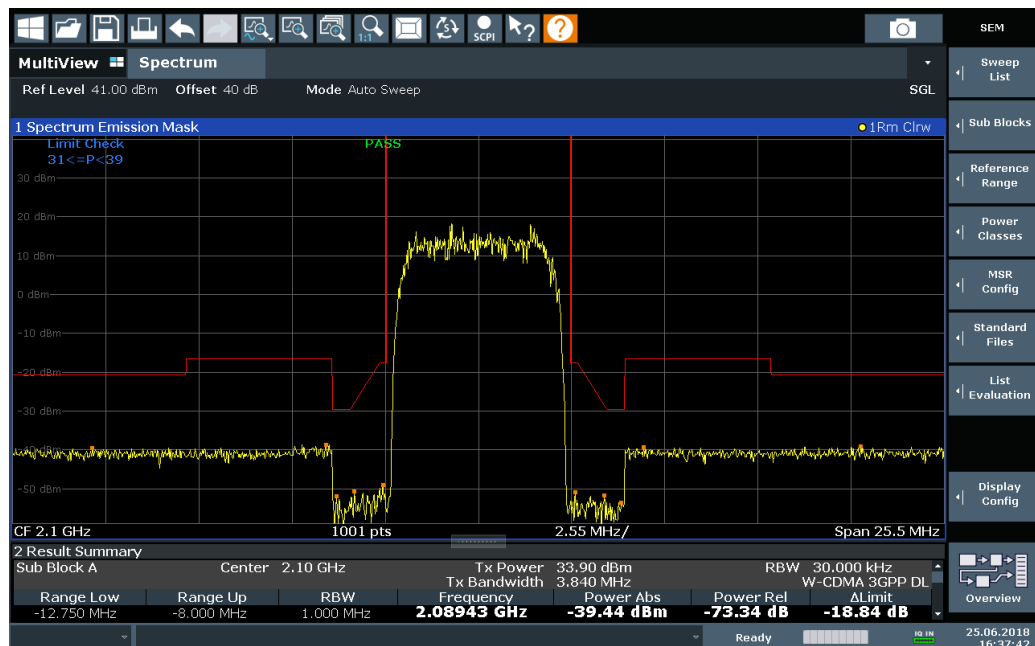


Figure 3-25: Detected peak display in SEM measurement

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 3.6.4.4, "SEM with multiple sub blocks \("Multi-SEM\)"](#), on page 80 for details). Up to 2 sub blocks (with 1 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

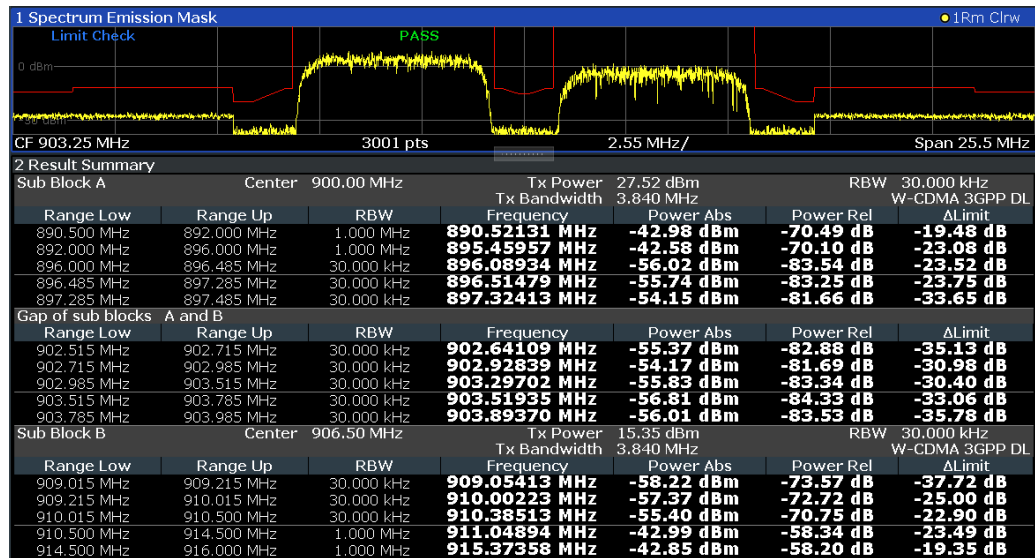


Figure 3-26: SEM results for multiple sub blocks

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:FAIL?` on page 650 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 395.

The measured *power trace* can be queried using `TRAC:DATA?` and `TRAC:DATA:X?`, see `TRACe<n>[:DATA]` on page 564 and `TRACe<n>[:DATA]:X?` on page 566:

The measured *peak power list* can be queried using `TRAC:DATA? LIST`, see `TRACe<n>[:DATA]` on page 564.

3.6.4 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](#).....75
- [Limit lines in SEM measurements](#).....77
- [Fast SEM measurements](#).....79
- [SEM with multiple sub blocks \("Multi-SEM"\)](#).....80

3.6.4.1 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
- Transducer settings
- Limit values

Via the sweep list, you define the ranges and their settings. For details on settings, refer to [Chapter 3.6.5.1, "Sweep List"](#), on page 85.

For details on defining the limits (masks), see [Chapter 3.6.4.2, "Limit lines in SEM measurements"](#), on page 77.

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 101).

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 92).
- 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 [SPAN]. 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 EPL1000 adjusts the global number of [Sweep Points](#) accordingly. By default, each range has a minimum of one sweep point.

This allows you to increase the resolution within a specific range for detailed analysis. You do not have to increase the overall number of sweep points and thus the measurement time for the SEM measurement.

Symmetrical ranges

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

Symmetrical ranges fulfill the conditions required for "Fast SEM" mode (see [Chapter 3.6.4.3, "Fast SEM measurements"](#), on page 79).

Power classes

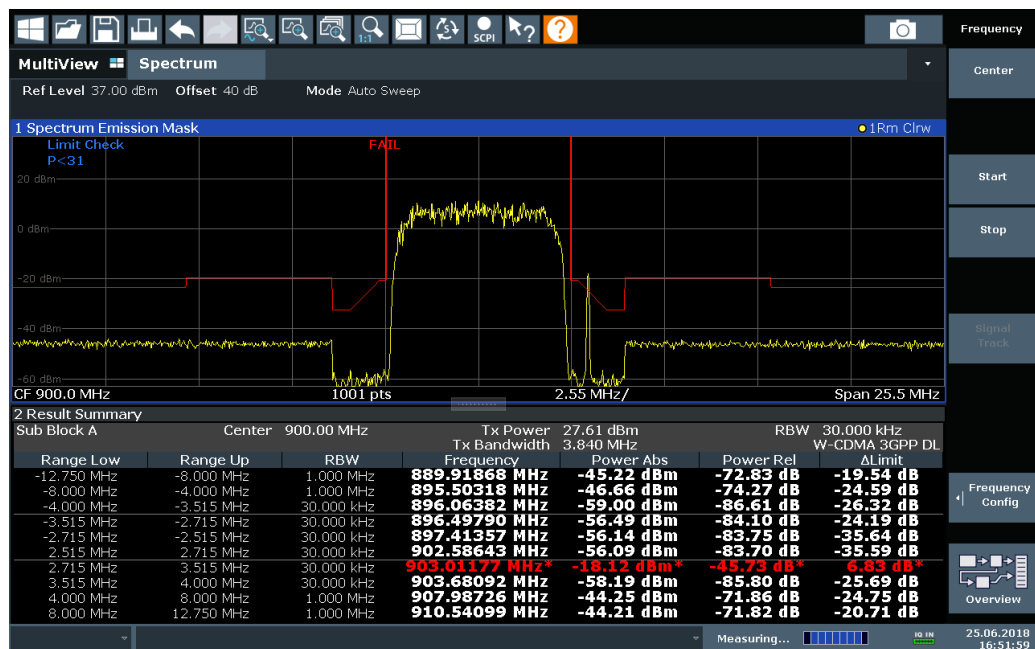
If the signal power level to be monitored varies and the limits vary accordingly, you can define power classes, which can then be assigned to the frequency ranges. Thus, the limits for the signal levels can be defined differently for varying input levels. For instance, for higher input levels a transmission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

3.6.4.2 Limit lines in SEM measurements

For the R&S EPL1000, 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 application using the [Lines] function. For SEM measurements, however, special limit lines are available via the "Sweep List" , and it is strongly recommended that you use only these limit line definitions.

In the "Sweep List" , you can define a limit line for each power class that varies its level according to the specified frequency ranges. Special limit lines are automatically defined for each power class according to the current "Sweep List" settings every time the settings change. These limit lines are labeled "_SEM_LINE_<xxx>_ABS<0...3>" and "_SEM_LINE_<xxx>_REL<0...3>", where <xxx> is an index to distinguish limit lines between different channel setups.

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



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

Table 3-10: Limit check types

Limit check type	Pass/fail criteria	Limit line definition
"Absolute"	Absolute power levels must not exceed limit line	Defined by the "Abs Limit Start"/ "Abs Limit Stop" values for each range
"Relative"	Power deviations relative to the TX channel power must not exceed limit line	Defined by the "Rel Limit Start"/ "Rel Limit Stop" values (relative to the TX channel power), fixed for each range.

Spectrum emission mask (SEM) measurement

Limit check type	Pass/fail criteria	Limit line definition
"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 3-10](#)).

Limit check results in the result summary

For each range, the peak measured value and the deviation of these values from the limit line are displayed in the result summary. If the limit check is passed for the range, the deviation represents the closest value to the limit line. If the limit check is passed for the range, the deviation represents the closest value to the limit line. If the limit check for the range fails, the deviation represents the maximum violation against the limit line. Furthermore, the absolute power levels and the relative deviation of the peaks from the TX channel power are displayed. Values that exceed the limit are indicated in red and by an asterisk (*).

A2 Spectrum Emission Mask				W-CDMA 3GPP (31,39)dBm DL		
Tx Power -28.10 dBm		Tx Bandwidth 3.840 MHz		RBW 1.000 MHz		
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-12.750 MHz	-8.000 MHz	1.000 MHz	13.24173 GHz*	-47.08 dBm*	-18.98 dB*	35.52 dB*
-8.000 MHz	-4.000 MHz	1.000 MHz	13.24364 GHz*	-25.01 dBm*	3.09 dB*	53.59 dB*
-4.000 MHz	-3.515 MHz	30.000 kHz	13.24619 GHz	-100.18 dBm	-72.08 dB	-8.58 dB
-3.515 MHz	-2.715 MHz	30.000 kHz	13.24668 GHz	-105.92 dBm	-77.83 dB	-17.23 dB



Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the Result Summary can be defined. (In the "List Evaluation" settings, see [Chapter 3.6.5.6, "List evaluation \(results configuration\)"](#), on page 96).

3.6.4.3 Fast SEM measurements

To improve the performance of the R&S EPL1000 for spectrum emission mask measurements, a "Fast SEM" mode is available. If this mode is activated, several consecutive ranges with identical sweep settings are combined to one sweep internally, which makes the measurement considerably faster. The displayed results remain unchanged and still consist of several ranges. Thus, measurement settings that apply only to the results, such as limits, can nevertheless be defined individually for each range.

Prerequisites

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

- The frequency ranges are consecutive, without frequency gaps
- The following sweep settings are identical (for details see [Chapter 3.6.5.1, "Sweep List"](#), on page 85):
 - "Filter Type"
 - "RBW"
 - "VBW"
 - "Sweep Time Mode"
 - "Reference Level"
 - "RF Attenuation Mode"
 - "RF Attenuation"

Activating Fast SEM mode

"Fast SEM" mode is activated in the sweep list (see [Chapter 3.6.5.1, "Sweep List"](#), on page 85) 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>:HSPEED` on page 428



Fast SEM not supported for multiple sub blocks

For SEM with multiple sub blocks, fast SEM is not available. If more than one sub block is defined and a standard is loaded which contains an active fast SEM setting, this setting is disabled.

For more information on multi-SEM measurements, see [Chapter 3.6.4.4, "SEM with multiple sub blocks \("Multi-SEM"\)"](#), on page 80.

Consequences

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



If "Symmetrical Setup" mode is active when "Fast SEM" mode is activated, not all sweep list settings can be configured symmetrically automatically (see also "Symmetrical Setup" on page 90).

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

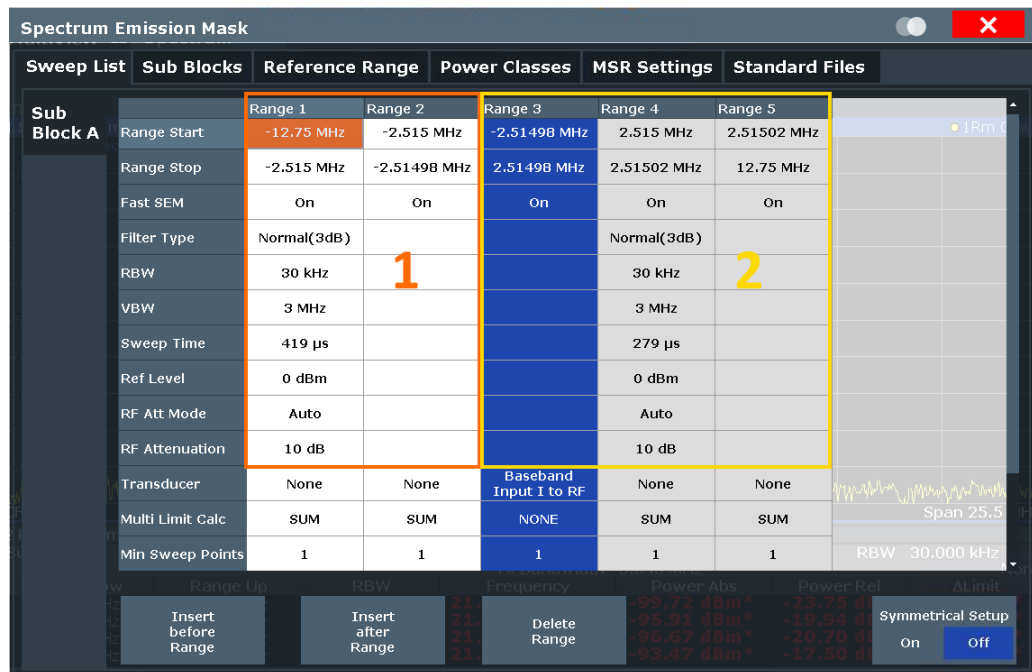


Figure 3-27: Sweep list using Fast SEM mode

In Figure 3-27, a sweep list is shown for which Fast SEM is activated. The formerly five separately defined ranges are combined to two sweep ranges internally.

3.6.4.4 SEM with multiple sub blocks ("Multi-SEM")

In the Spectrum application application only, spectrum emissions can be measured for multiple sub blocks of channels (also referred to as a "Multi-SEM" measurement). Sub blocks are a set of multiple ranges around a defined center frequency (carrier). Multiple sub blocks can include gaps or overlap, and each sub block defines a separate mask. In the overlapping masks, multi-limit lines are calculated. Up to 2 sub blocks (with 1 gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines etc. can be defined individually.

Comparison to "traditional" SEM measurement

The default SEM measurement is simply a special case of "*Multi-SEM*" - consisting of one single block. Only if the number of sub blocks in the basic SEM configuration is larger than 1, multiple sub blocks are inserted in the configuration settings and result tables.

Particular features of configuring multiple sub blocks

The sub blocks are independent of the global start, stop, center and span frequencies for the complete SEM measurement. Thus, there can be gaps that can even include other carrier ranges, but are not configured for the SEM measurement.

For each sub block, you define:

- The center frequency of the reference range of the sub block; center frequencies must be defined in ascending order for sub blocks A,B,C
- The reference range; note that although individual ranges of different sub blocks can overlap, reference ranges for different sub blocks *cannot*; they must define distinct frequency ranges
- The sweep list, including the limit lines



Fast SEM not supported for multiple sub blocks

For SEM with multiple sub blocks, fast SEM is not available. If more than one sub block is defined and a standard is loaded which contains an active fast SEM setting, this setting is disabled.

Absolute vs relative frequencies

In the default configuration with only one sub block, frequencies are defined relative to the center frequency; this is the familiar configuration.

For setups with more than one sub block, frequencies are defined relative to the center frequency of the reference ranges for the individual sub blocks. However, in the result summary, frequencies are indicated as absolute values. Relative frequencies that refer to different reference ranges would be inconvenient and difficult to analyze.

Limit check behavior for overlapping masks

Since spectrum emission masks are defined individually for each sub block, and sub blocks can overlap, the question arises what happens during the limit check in the overlapping regions? To answer this question, we must distinguish the following cases:

- For the reference range, no limit checking is performed, as the reference range contains the carrier
- For other ranges, only the limit lines defined for ranges between the carriers, that is the reference ranges to either side, are significant. In other words: if a limit line definition covers the frequency area of several carriers, only the limit lines for ranges between the corresponding reference range and the next closest reference range are significant.

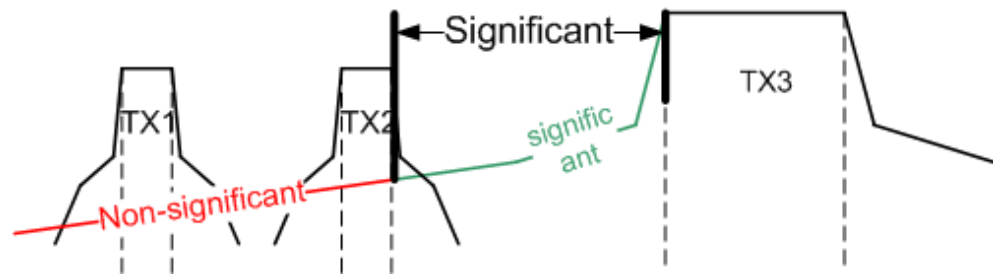


Figure 3-28: Behavior for overlapping masks

- For the ranges in which multiple limit lines are significant, a range-specific function determines the behavior of the limit check

Limit calculation for individual ranges

For each range a function can be defined that determines the behavior of the limit check if there are multiple limit lines:

- **"NONE"**: In reference ranges no limit check is performed; Reference ranges always use the function "NONE". For other ranges, see the combinations for overlapping ranges below.
- **"SUM"**: sum of the two limit lines (calculated for linear powers) is used
- **"MAX"**: maximum of the two limit lines is used

This leads to the following **combinations for overlapping ranges**:

- **"MAX"+"MAX"**: maximum of the two limit lines is used
- **"MAX"+"SUM"**: maximum of the two limit lines is used
- **"SUM"+"SUM"**: sum of the two limit lines (calculated for linear powers) is used
- **"NONE"+"MAX"/"NONE"+"SUM"**: limit line (and parameters) of the "NONE" range are ignored
- **"NONE"+"NONE"**: depends on the position of the overlapping ranges in relation to the mid-frequency between the two neighboring sub blocks:
 - Overlap is completely *below* the mid-frequency: limits and parameters of the left sub block are used
 - Overlap is completely *above* the mid-frequency: limits and parameters of the right sub block are used
 - Overlap crosses the mid-frequency: new subranges are created: one to the left of the mid-frequency, one to the right of the mid-frequency. The left subrange uses the limits and parameters of the left sub block, the right subrange uses the limits and parameters of the right sub block.



Different RBWs in overlapping ranges

If different RBWs are defined for the overlapping ranges, the following parameters from the range with the smaller RBW are considered for both ranges:

- RBW
- VBW
- Attenuation
- Reference level
- Transducer
- Filter type
- (proportional) sweep time

In the range with the higher RBW, the following offset is applied to the limit line:

$$-10 \cdot \log(RBW_{large} / RBW_{small})$$

Table 3-11: Limit lines in overlapping ranges crossing the mid-frequency

<p>The diagram shows a spectrum plot with two sub-blocks, Sub block 1 and Sub block 2, separated by a mid-frequency region (SB1-SB2). Two transmitters, TX1 and TX2, are shown. Range 3 (blue hatched) is on the left, Range 6 (orange hatched) is on the right, and the mid-frequency region is Range 4 (green hatched) and Range 5 (yellow hatched). Both Range 4 and Range 5 are labeled as "None".</p>	<p>The diagram shows the same setup as the initial situation, but the mid-frequency region is now divided into Subrange 4a (left, blue hatched) and Subrange 5a (right, yellow hatched). 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!"

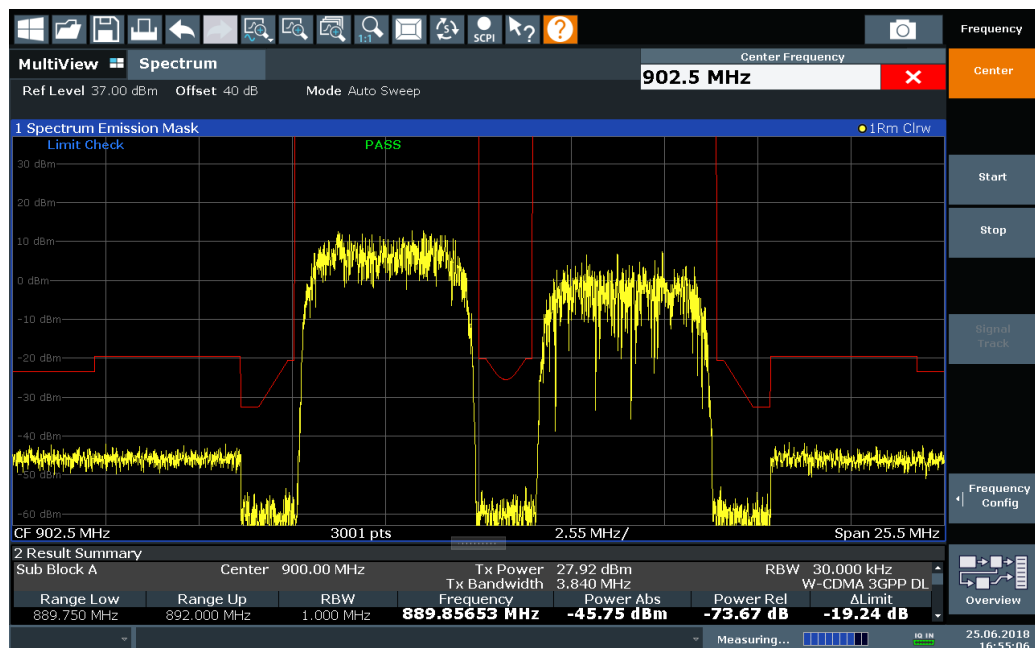


Figure 3-29: Summarized limit line for multiple sub blocks

3.6.5 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 6.7.7, "Spectrum emission mask \(SEM\)"](#), on page 424.



Global span settings

The span of the signal to be monitored is configured in the general span settings (see [Chapter 4.3.2, "Frequency and span settings"](#), on page 210). Only ranges within this global span are considered for the SEM measurement.



Multi-SEM configuration

In the Spectrum application application only, spectrum emissions can be measured for multiple sub blocks of channels (see [Chapter 3.6.4.4, "SEM with multiple sub blocks \("Multi-SEM"\)"](#), on page 80). Up to 2 sub blocks (with 1 gaps) can be defined. For each sub block, the familiar configuration settings concerning ranges, limit lines etc. can be defined in individual tabs. In addition, settings on the sub blocks themselves must be configured in the "Sub Block" tab of the "Spectrum Emission Mask" configuration dialog box (see [Chapter 3.6.5.2, "Multi-SEM \(sub block\) settings"](#), on page 90).

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

- Sweep List85
- Multi-SEM (sub block) settings.....90
- Reference range..... 91
- Power classes..... 93
- Standard files..... 94
- List evaluation (results configuration).....96

3.6.5.1 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 3.6.4.1, "Ranges and range settings"](#), on page 75.

Sub Block A	Range 1	Range 2	Range 3
Range Start	-12.75 MHz	-2.515 MHz	2.515 MHz
Range Stop	-2.515 MHz	2.515 MHz	12.75 MHz
Fast SEM	Off	Off	Off
Filter Type	Normal(3dB)	Normal(3dB)	Normal(3dB)
RBW	30 kHz	30 kHz	30 kHz
VBW	3 MHz	3 MHz	3 MHz
Sweep Time Mode	Auto	Auto	Auto
Sweep Time	140 µs	140 µs	140 µs
Ref Level	0 dBm	0 dBm	0 dBm
RF Att Mode	Auto	Auto	Auto
RF Attenuation	10 dB	10 dB	10 dB
Preamp	Off	Off	Off
Transducer	None	None	None
Multi Limit Calc	SUM	NONE	SUM
Min Sweep Points	1	1	1
Limit Check 1	Relative	Relative	Relative
Rel Limit Start 1	-50 dBc	300 dBc	-50 dBc

- Range Start / Range Stop..... 86
- Fast SEM..... 86
- Filter Type..... 86
- RBW..... 86
- VBW..... 87
- Sweep Time Mode 87
- Sweep Time 87
- Ref Level..... 87

RF Att Mode.....	87
RF Attenuation.....	87
Preamp.....	88
Transducer Factor.....	88
Limit Check <n>.....	88
Abs Limit Start / Stop <n>.....	88
Rel Limit Start / Stop <n>.....	88
Multi-Limit Calc <n>.....	89
Min Sweep Points	89
Insert before Range / Insert after Range.....	90
Delete Range.....	90
Symmetrical Setup.....	90

Range Start / Range Stop

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

To change the start/stop frequency of the first or last range, respectively, select the appropriate span in the [SPAN] configuration dialog. You can set a span that is smaller than the overall span of the ranges. In this case, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz. The first and last ranges are adapted to the given span as long as the minimum span of 20 Hz is not violated.

Define frequency values for each range relative to the center frequency. Center the reference range on the center frequency. The current "Tx Bandwidth" defines the minimum span of the reference range (see "[Channel Power Settings](#)" on page 92).

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:START on page 431

[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:STOP on page 431

Fast SEM

Activates "Fast SEM" mode for all ranges in the sweep list. For details, see [Chapter 3.6.4.3, "Fast SEM measurements"](#), on page 79.

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>:HSPEED on page 428

Filter Type

Sets the filter type for this range.

For details on filter types, see [Chapter 4.5.1.6, "Which data may pass: filter types"](#), on page 229.

Remote command:

[SENSe:]ESpectrum<sb>:RANGe<ri>:FILTer:TYPE on page 430

RBW

Sets the resolution bandwidth for this range.

For details on the RBW, see [Chapter 4.5.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 226.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:BANDwidth:RESolution` on page 429

VBW

Sets the video bandwidth for this range.

For details on the VBW, see [Chapter 4.5.1.2, "Smoothing the trace using the video bandwidth"](#), on page 227.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:BANDwidth:VIDeo` on page 429

Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

Currently, only auto mode is available for the R&S EPL1000.

For details on the sweep time mode, see [Chapter 4.5.1.7, "How long the data is measured: Sweep Time"](#), on page 230

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO` on page 440

Sweep Time

Sets the sweep time value for the range.

For details on the sweep time, see [Chapter 4.5.1.7, "How long the data is measured: Sweep Time"](#), on page 230

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME` on page 439

Ref Level

Sets the reference level for the range.

For details on the reference level, see [Chapter 4.4.1.2, "Reference level"](#), on page 219.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:RLEVel` on page 439

RF Att Mode

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation, see ["Using the RF attenuator"](#) on page 217.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO` on page 432

RF Attenuation

Sets the attenuation value for the range.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation` on page 432

Preamp

Switches the preamplifier on or off.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATe` on page 433

Transducer Factor

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

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

For details on transducers, see the user manual of the R&S EPL1000.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:TRANsducer` on page 440

Limit Check <n>

Sets the type of limit check for the n-th power class in the range. Up to four limits are possible.

For details on limit checks, see [Chapter 3.6.4.2, "Limit lines in SEM measurements"](#), on page 77.

The limit state affects the availability of all limit settings.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:STATe` on page 438
`CALCulate<n>:LIMit:FAIL?` on page 650

Abs Limit Start / Stop <n>

Sets an absolute limit value for the n-th power class at the start or stop frequency of the range [dBm].

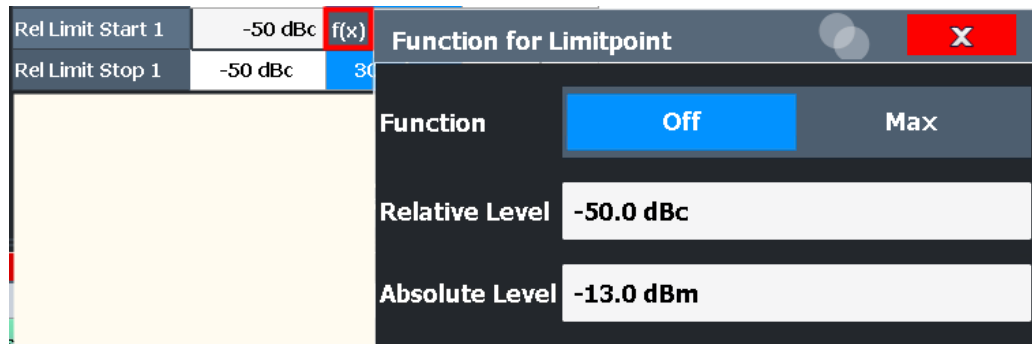
Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:ABSolute:START`
on page 433
`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:ABSolute:STOP`
on page 434

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 78.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:START`
on page 434

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP`
on page 436

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:START:FUNCTION`
on page 435

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:FUNCTION`
on page 437

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:START:ABS`
on page 435

`[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:ABS`
on page 437

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 82.

"NONE" (reference ranges only:) the limit of the reference range is used

"SUM" Sum of the two limit lines (calculated for linear powers) is used

"MAX" Maximum of the two limit lines is used

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:MLCalc` on page 426

Min Sweep Points

Defines the minimum number of sweep points for the range.

If necessary to fulfill all minimum sweep point requirements in all ranges, the global [Sweep Points](#) setting is increased. By default, each range is supplied with a minimum of one sweep point.

For details, see "[Sweep points](#)" on page 76

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:POINTs:MINimum[:VALue]` on page 439

Insert before Range / Insert after Range

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

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INSert` on page 433

Delete Range

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

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:DELete` on page 430

Symmetrical Setup

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

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

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

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

Remote command:

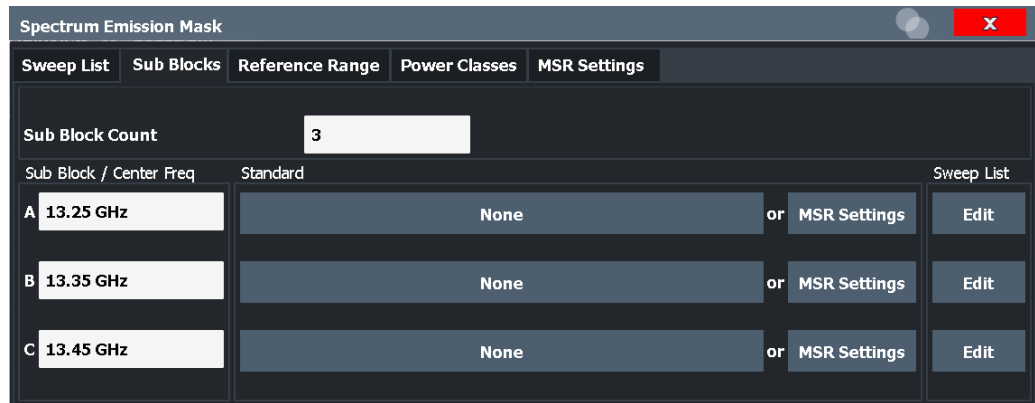
`[SENSe:]ESpectrum<sb>:SSETup` on page 441

3.6.5.2 Multi-SEM (sub block) settings

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

In the Spectrum application application only, spectrum emissions can be measured for multiple sub blocks of channels (see [Chapter 3.6.4.4, "SEM with multiple sub blocks \("Multi-SEM"\)](#)", on page 80). 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.....	91
Sub Block / Center Freq.....	91
Standard.....	91
Edit Sweep List	91

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>:SCOut` on page 427

Sub Block / Center Freq

Defines the center frequency for an individual sub block. The center frequency determines the reference range used for each block.

For measurements with only one sub block, this setting corresponds to the global setting in the "Frequency" settings (see [Center Frequency](#)).

Remote command:

`[SENSe:]ESpectrum<sb>:SCENter` on page 427

Standard

Defines the use of a standard settings file for a particular sub block. For details, see [Chapter 3.6.5.5, "Standard files"](#), on page 94.

Remote command:

`[SENSe:]ESpectrum<sb>:PRESet[:STANdard]` on page 425

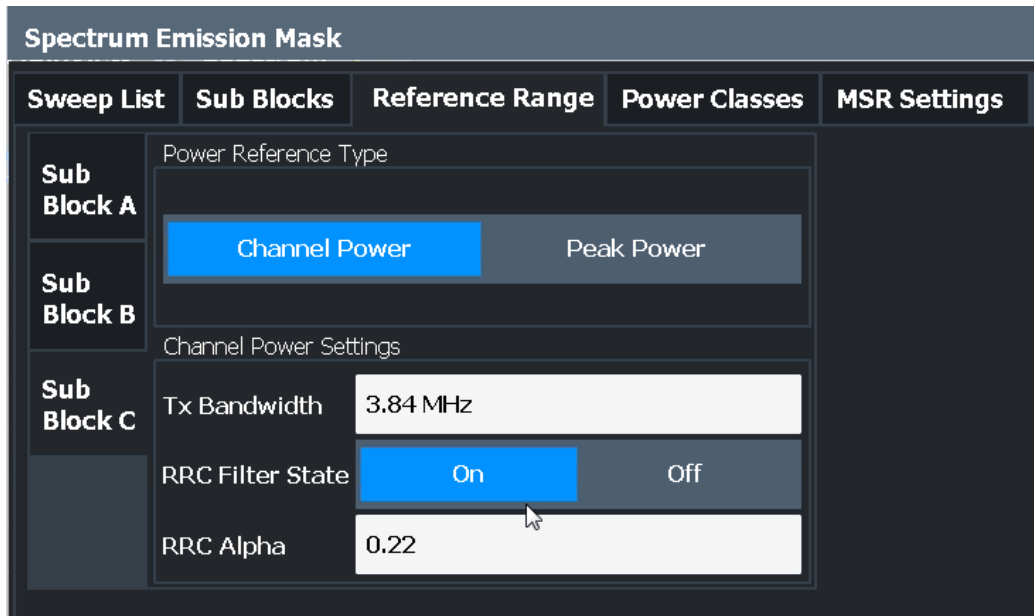
Edit Sweep List

Switches to the "Sweep List" tab of the "Spectrum Emission Mask" dialog box to configure the individual frequency ranges and mask limits for the corresponding sub block. See [Chapter 3.6.5.1, "Sweep List"](#), on page 85.

3.6.5.3 Reference range

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

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



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Power Reference Type

Defines how the reference power is calculated.

"Channel Power"

Measures the channel power within the reference range using the integration bandwidth method. Additional settings can be configured for this method.

"Peak Power"

Determines the peak power within the reference range.

Remote command:

[SENSe:]ESpectrum<sb>:RTYPE on page 442

Channel Power Settings

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

Tx Bandwidth ← Channel Power Settings

Defines the bandwidth used for measuring the channel power, with:

Minimum span ≤ "Tx Bandwidth" ≤ of reference range

Remote command:

[SENSe:]ESpectrum<sb>:BWID on page 441

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 442

Alpha: ← Channel Power Settings

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

Remote command:

[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHa on page 441

3.6.5.4 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 76.

Sweep List	Sub Blocks	Reference Range	Power Classes	MSR Settings
	Sub Block A	Used Power Classes: All		
	Sub Block B	Power Class	PMin ≤ P < PMax	
		Power Class 1	-INF	199.9 dBm Sweep List
	Sub Block C	Power Class 2	199.9 dBm	+INF Sweep List
			Add	Remove

Used Power Classes:.....	93
PMin/ PMax.....	94
Sweep List	94
Adding or Removing a Power Class.....	94

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 88 and "[Rel Limit Start / Stop <n>](#)" on page 88).

Remote command:

`CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>[:EXCLusive]`

on page 447

To define all limits in one step:

`CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:LIMit[:STATe]`

on page 445

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:ESpectrum<sb>:PCLass<pc>:MINimum`

on page 446

`CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:MAXimum`

on page 446

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 88).

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.

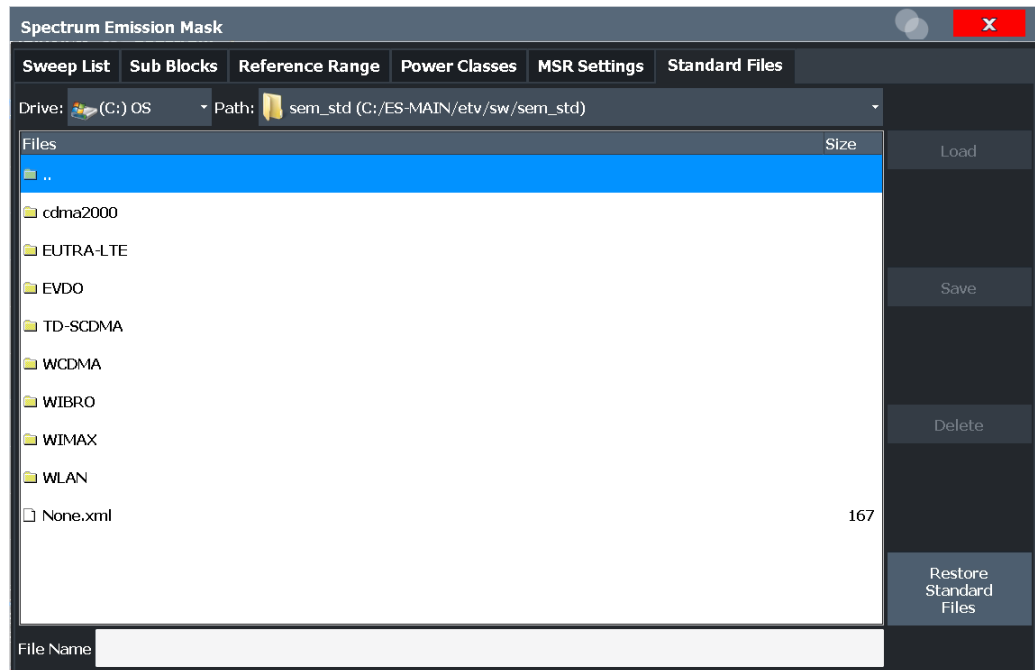
Remote command:

`CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:COUNT` on page 444

3.6.5.5 Standard files

Access: "Overview" > "Select Measurement" > "Spectrum Emission Mask" > "Standard Files"

You can save the current measurement settings as a user-defined standard (XML file), or load stored measurement settings. Furthermore, you can delete an existing settings file.



For details, see [Chapter 3.6.6.1, "How to manage SEM settings files"](#), on page 100.



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 [Multi-SEM \(sub block\) settings](#) setting in the "Sub Blocks" tab.



"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

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Selecting Storage Location - Drive/ Path/ Files

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

The default storage location for the SEM settings files is:

C:\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_std.

Remote command:

MMEemory:CATalog?

File Name

Contains the name of the data file without the path or extension.

By default, the name of a user file consists of a base name followed by an underscore. Multiple files with the same base name are extended by three numbers, e.g. `limit_lines_005`.

File names must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

For details on the filename and location, see the R&S EPL1000 User Manual.

Load Standard

Loads the selected measurement settings file.

Remote command:

`[SENSe:]ESpectrum<sb>:PRESet[:STANdard]` on page 425

File Explorer

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

Save Standard

Saves the current measurement settings for a specific standard as a file with the defined name.

Remote command:

`[SENSe:]ESpectrum<sb>:PRESet:STORe` on page 425

Delete Standard

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

Note: Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standard Files" function (see "Restore Standard Files" on page 96).

Restore Standard Files

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

The XML files from the `C:\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_backup` folder are copied to the `C:\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_std` folder.

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

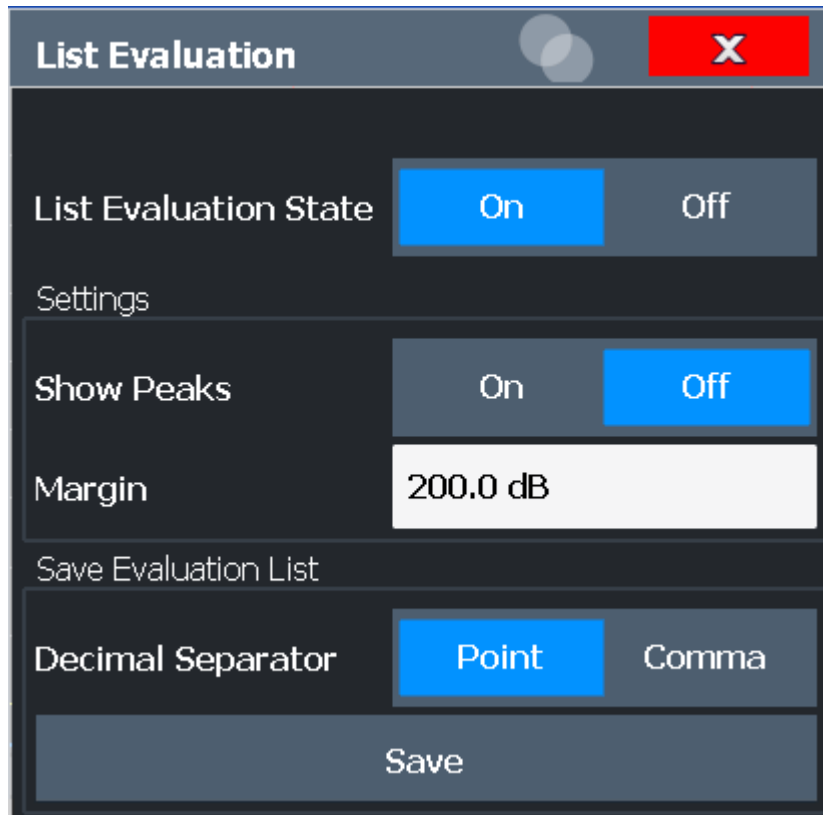
Remote command:

`[SENSe:]ESpectrum<sb>:PRESet:RESTore` on page 425

3.6.5.6 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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List Evaluation State (result summary)

Activates or deactivates the Result Summary.

Remote command:

[CALCulate<n>:ESpectrum:PEAKsearch:AUTO](#) on page 448

[TRACe<n>\[:DATA\]](#) on page 564

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 449

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 449

Saving the Result Summary (Evaluation List) to a File

Exports the Result Summary of the SEM measurement to an ASCII file for evaluation in an external application. If necessary, change the decimal separator for evaluation in other languages.

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

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

For details, see [Chapter 3.6.8.2, "ASCII file export format \(spectrum emission mask\)"](#), on page 109.

Remote command:

[MMEMory:STORe<n>:LIST](#) on page 575

[FORMat:DEXPort:DSEParator](#) on page 573

3.6.6 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 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 98
- ["To perform an SEM measurement according to a standard"](#) on page 98
- ["To configure a user-defined SEM measurement"](#) on page 98
- ["To perform a Multi-SEM measurement"](#) on page 100



For remote operation, see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

To select an SEM measurement

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

To perform an SEM measurement according to a standard

- ▶ Load the settings file as described in ["How to load an SEM settings file"](#) on page 101 and start a measurement.

To configure a user-defined SEM measurement

1. Define the span of the signal you want to monitor in the general span settings.

2. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.

Starting from the center frequency, determine which sections of the signal to the left and right can be swept and monitored using the same parameters. Criteria for such a range definition may be, for example:

- The signal power level
- The required resolution bandwidth or sweep time
- Transducer factors
- Permitted deviation from the defined signal level, i.e. the required limit values for monitoring

If the signal consists of a transmission channel and adjacent channels, the channel ranges can usually be used for the range definition.

3. If the signal power level to be monitored varies and the limits vary, define power classes. For each range of levels that can be monitored in the same way, define a power class.
 - a) Select "Overview".
 - b) Select "SEM Setup".
 - c) Switch to the "Power Classes" tab.
 - d) To add a power class, select "Add".
 - e) Enter the start and stop power levels to define the class.
 - f) Select the power classes to be used for the current measurement:
 - a specific class
 - all classes, to have the required class selected automatically according to the input level measured in the reference range
4. Select the "Sweep List" tab of the "Spectrum Emission Mask" dialog box.
5. Insert the required ranges using "Insert before Range" and "Insert after Range", which refer to the currently selected range (the reference range by default). If the signal trace is symmetric to the center frequency, activate the "Sym Setup" option to make setup easier and quicker.
6. Define the measurement parameters for each range as required. If symmetrical setup is activated, you only have to configure the ranges to one side of the center range.

In particular, define the limits for each range of the signal, i.e. the area in which the signal level can deviate without failing the limit check. If several power classes were defined (see [step 3](#)), define limits for each power class.

 - a) Define the type of limit check, i.e. whether absolute values or relative values are checked, or both. The type of limit check is identical for all power classes.
 - b) Define the limit start and stop values.
7. If the sweep list settings - other than the limit and transducer values - are identical for several adjacent ranges, activate "Fast SEM" mode to speed up the measurement. You only have to activate the mode for one range, the others are adapted automatically.

8. If necessary, change the settings for the reference power to which all SEM results refer in the "Reference Range" tab.
9. To indicate the determined peaks in the display during an SEM measurement, select "Overview" > "Analysis" > "Show Peaks".
10. To save the current SEM measurement settings to a file to re-use them later, save a settings file as described in ["How to save a user-defined SEM settings file"](#) on page 101.
11. Start a sweep.
The determined powers and limit deviations for each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.
12. To save the Result Summary, export the results to a file as described in [Chapter 3.6.6.2, "How to save SEM result files"](#), on page 102.

To perform a Multi-SEM measurement

1. Define the span of the signal to be monitored in the general span settings.
2. Select [Meas Config] > "Sub Blocks".
3. Define the number of sub blocks (up to 2) that contain the relevant carriers.
4. For each sub block, define the center frequency, that is, the frequency of the TX carrier or a frequency in the dedicated reference range.
5. For each sub block, do one of the following:
 - Select a standard settings file to be used.
 - Select "Edit" and configure the sweep list manually as defined in ["To configure a user-defined SEM measurement"](#) on page 98. Be sure to select the correct vertical tab for the corresponding sub block within each subtab of the "Spectrum Emission Mask" configuration dialog.
Define a function to be used for overlapping ranges in the "Multi-Limit Calc" field of the sweep list.
6. Start a sweep.
The determined powers and limit deviations for each sub block, each gap, and each range are indicated in the Result Summary. If activated, the peak power levels for each range are also indicated in the Spectrum diagram.
7. To save the Result Summary, export the results to a file as described in [Chapter 3.6.6.2, "How to save SEM result files"](#), on page 102.

3.6.6.1 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 EPL1000 again later. Some predefined XML files are provided that contain ranges and parameters according to the selected stan-

standard. All XML files are stored under

C:\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_std.

For details on the file format of the SEM settings file, see [Chapter 3.6.8.1, "Format description of SEM XML files"](#), on page 104.

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

How to load an SEM settings file

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

The settings from the selected file are restored to the R&S EPL1000 and you can repeat the SEM measurement with the stored settings.

How to save a user-defined SEM settings file

1. Configure the SEM measurement as required (see [Chapter 3.6.6, "How to perform a spectrum emission mask measurement"](#), on page 98).
2. In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, define a filename and storage location for the settings file.
3. Select "Save".

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

How to delete an SEM settings file

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

The settings file is removed from the R&S EPL1000.

How to restore default SEM settings files

The R&S EPL1000 is delivered with predefined settings files which can be edited and overwritten. However, you can restore the original files.

- ▶ In the "Standard Files" tab of the "Spectrum Emission Mask" dialog box, select "Restore Standard Files".

The original predefined settings files are available for selection on the R&S EPL1000.

3.6.6.2 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 3.6.8.2, "ASCII file export format \(spectrum emission mask\)"](#), on page 109.

1. Configure and perform an SEM measurement as described in [Chapter 3.6.6, "How to perform a spectrum emission mask measurement"](#), on page 98.
2. In the "Overview", select "Analysis".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select "Save".
5. In the file selection dialog box, select a storage location and filename for the result file.
6. Select "Save".

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

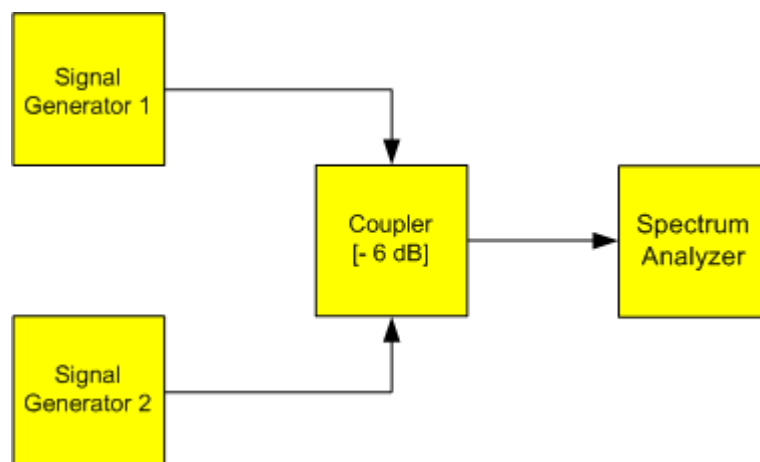
3.6.7 Measurement example: multi-sem measurement

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



A programming example demonstrating a SEM measurement in a remote environment is provided in [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Test setup:



Signal generator settings (e.g. R&S EPL1000 SMW):

Device	Standard	Center frequency	Level	Test model
SigGen 1	3GPP/FDD	900 MHz	0 dBm	1-16
SigGen 2	EUTRA/LTE	906.5 MHz	0 dBm	1_1_5MHz

Setting up the measurement

1. Preset the R&S EPL1000.
2. Enter the Spectrum application via [MODE].
3. Set the center frequency to *903.25 MHz*.
4. Set the reference level to *10 dBm* with an offset of to *30 dB*.
5. Press [MEAS] or select "Select Measurement" in the "Overview".
6. Select the "SEM" measurement function.
7. Select "Sub Blocks" and enter "Sub Block Count" of 2.
8. For "Sub Block A", define the settings for the 3GPP/FDD signal:
 - Set the "Center Frequency" to *900 MHz*
 - Set the "Base Station RF Bandwidth" to *5 MHz*.
 - Select "Apply to SEM".
9. For "Sub Block B", define the settings for the EUTRA/LTE signal:
 - Set the "Center Frequency" to *906.5 MHz*
 - Set the "Base Station RF Bandwidth" to *5 MHz*.
 - Select "Apply to SEM".
10. Select [RUN SINGLE] to perform a measurement with the new settings.

The results of the measurement for each sub block are displayed in the Result Summary. The summarized limit line is indicated in the Spectrum graph.

Spectrum emission mask (SEM) measurement

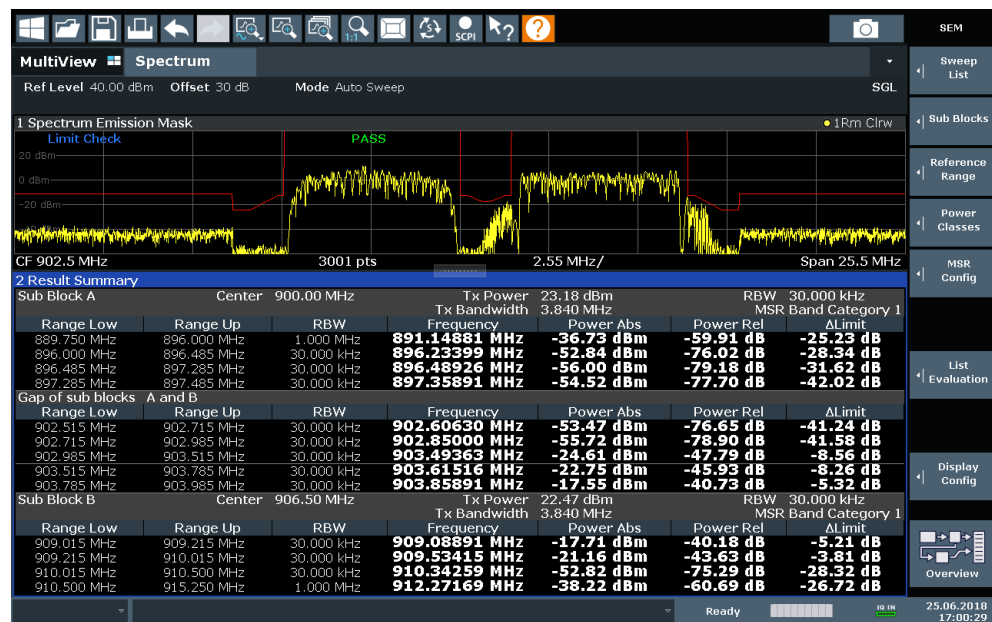


Figure 3-30: Multi-SEM measurement: results of the measurement for each sub block

3.6.8 Reference: SEM file descriptions

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

- [Format description of SEM XML files](#)..... 104
- [ASCII file export format \(spectrum emission mask\)](#)..... 109

3.6.8.1 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 EPL1000, in an external application. When creating your own XML files, be sure to comply with the following conventions because the R&S EPL1000 can only interpret XML files of a known structure. For sample files, see the `C:\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_std` directory of the R&S EPL1000.

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 101). All XML files are stored under

`C:\ProgramData\Rohde-Schwarz\ZNL-FPL\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 EPL1000 is not able to interpret the XML file and error messages are shown on the screen. It is recommended that you make a copy of an existing file and edit the copy of the file.

Basically, the file consists of three elements that can be defined:

- The `BaseFormat` element
- The `PowerClass` element
- The `Range` element

The "BaseFormat" element

It carries information about basic settings. In this element, only the `ReferencePower` child node has any effects on the measurement itself. The other attributes and child nodes are used to display information about the Spectrum Emission Mask standard on the measurement screen. The child nodes and attributes of this element are shown in [Table 3-12](#).

Example:

In the sample file `PowerClass_39_43.xml` under `C:\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_std\WCDMA\3GPP`, these attributes are defined as follows:

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

The "PowerClass" element

It is embedded in the `BaseFormat` element and contains settings information about the power classes. Up to four different power classes can be defined. For details, refer to [Chapter 3.6.5.4, "Power classes"](#), on page 93. The child nodes and attributes of this element are shown in [Table 3-13](#).

The "Range" element

This element is embedded in the `PowerClass` element. It contains the settings information of the range. There have to be at least three defined ranges: one reference range and at least one range to either side of the reference range. The maximum number of ranges is 30. Note that the R&S EPL1000 uses the same ranges in each power class. Therefore, the contents of the ranges of each defined power class have to be identical to the first power class. The `Start` and `Stop` values of the two `Limit` nodes that are used to determine the power class are an exception. Note also that you must define two limit nodes: one that defines the limit in absolute values and one in relative values. Make sure units for the `Start` and `Stop` nodes are identical for each `Limit` node.

For details, refer to [Chapter 3.6.5.1, "Sweep List"](#), on page 85. The child nodes and attributes of this element are shown in [Table 3-14](#).

The following tables show the child nodes and attributes of each element and show if a child node or attribute is mandatory for the R&S EPL1000 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 EPL1000 in the "C:

\ProgramData\Rohde-Schwarz\ZNL-FPL\sem_std" directory, or check the structure as shown below.

Below, a basic example of the structure of the file is shown, containing all mandatory attributes and child nodes. Note that the `PowerClass` element and the `Range` element are themselves elements of the `BaseFormat` element. They must be inserted where noted. They are separated here simply to provide a better overview. Also, no example values are given here to allow a quick reference to the tables above. Italic font shows the placeholders for the values.

- The `BaseFormat` element is structured as follows:
 - `<RS_SEM_ACP_FileFormat Version="1.0.0.0">`
`<Name>"Standard"</Name>`
`<Instrument>`
`<Type>"Instrument Type"</Type>`
`<Application>"Application"</Application>`
`</Instrument>`
`<LinkDirection Name="Name">`
`<ReferencePower>`
`<Method>"Method"</Method>`
`</ReferencePower>`
`<PowerClass Index="n">`
`<!-- For contents of the PowerClass node, see Table 3-13 -->`
`<!-- Define up to four PowerClass nodes -->`
`</PowerClass>`
`</LinkDirection>`
`</RS_SEM_ACP_File>`
- The "PowerClass" element is structured as follows:
 - `<PowerClass Index="n">`
`<StartPower Unit="dBm" InclusiveFlag="true" Value="StartPowerValue"/>`
`<StopPower Unit="dBm" InclusiveFlag="false" Value="StopPowerValue"/>`
`<DefaultLimitFailMode>"Limit Fail Mode"</DefaultLimitFailMode>`
`<Range Index="n">`
`<!-- For contents of the Range node, see Table 3-14 -->`
`<!-- Define up to twenty Range nodes -->`
`</Range>`
`...`
`</PowerClass>`
- The "Range" element is structured as follows:
 - `<Range Index="n">`
`<Name="Name">`
`<ChannelType>"Channel Type"</Channel Type>`
`<WeightingFilter>`
`<Type>"FilterType"</Type>`
`<RollOffFactor>"Factor"</RollOffFactor>`

```

<Bandwidth>"Bandwidth"</Bandwidth>
</WeightingFilter>
<FrequencyRange>
<Start>"RangeStart"</Start>
<Stop>"RangeStop"</Stop>
</FrequencyRange>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<Limit>
<Start Unit="Unit" Value="Value"/>
<Stop Unit="Unit" Value="Value"/>
</Limit>
<RBW Bandwidth="Bandwidth" Type="FilterType"/>
<VBW Bandwidth="Bandwidth"/>
<Detector>"Detector"</Detector>
<Sweep Mode="SweepMode" Time="SweepTime"/>
<Amplitude>
<ReferenceLevel Unit="dBm" Value="Value"/>
<RFAttenuation Mode="Auto" Unit="dB" Value="Value"/>
<Preamplifier State="State"/>
</Amplitude>
<MeasPointsMin>1</MeasPointsMin>
<CalcRuleMulti>Sum</CalcRuleMulti>
</Range>

```

Table 3-12: Attributes and child nodes of the BaseFormat element

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

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Table 3-13: Attributes and child nodes of the PowerClass element

Child Node	Attribute	Value	Parameter description	Mand.
StartPower	Value	<power in dBm>	The start power must be equal to the stop power of the previous power class. The StartPower value of the first range is -200	Yes
	Unit	dBm		Yes
	InclusiveFlag	true		Yes
StopPower	Value	<power in dBm>	The stop power must be equal to the start power of the next power class. The StopPower value of the last range is 200	Yes
	Unit	dBm		
	InclusiveFlag	false		Yes
DefaultLimitFailMode		Absolute Relative Absolute and Relative Absolute or Relative		Yes

Table 3-14: Attributes and child nodes of the Range element (normal ranges)

Child node	Attribute	Value	Parameter description	Mand.
	Index	0...19	Indices are continuous and have to start with 0	Yes
	Name	<string>	Name of the range	Only if ReferenceChannel contains a name and the range is the reference range
	Short-Name	<string>	Short name of the range	No
ChannelType		TX Adjacent		Yes
WeightingFilter				Only if ReferencePower method is TX Channel Power and the range is the reference range
Type		RRC CFilter	Type of the weighting filter	Yes
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

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Child node	Attribute	Value	Parameter description	Mand.
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 86	Yes
	Type	NORM PULS CFIL		No
VBW	Bandwidth	<bandwidth in Hz>	"VBW" on page 87	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 87	Yes
	Time	<time in sec>	" Sweep Time " on page 87	No
Amplitude				No
ReferenceLevel	Value	<power in dBm>	"Ref Level" on page 87	Yes, if the ReferenceLevel child node is used
	Unit	dBm	Defines dBm as unit	Yes, if the ReferenceLevel node is used
RFAttenuation	Mode	Manual Auto	"RF Att Mode" on page 87	Yes, if the ReferenceLevel child node is used

3.6.8.2 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.

Spectrum emission mask (SEM) measurement

File contents	Explanation
File header	
Type;EPL1000	Model
Version;1.00;	Firmware version
Date;31.Mar 17;	Storage date of data set
Mode;ANALYZER;SEM;	Operating mode and measurement function
Center Freq;1325000000.000000;Hz	X-axis settings
Freq Offset;0.000000;Hz	
Span;25500000.000000;Hz	
x-Axis;LIN;	
Start;13237250000.000000;Hz	
Stop;13262750000.000000;Hz	
Level Offset;0.000000;dB	Y-axis settings
Ref Position;100.000000;%	
y-Axis;LOG;	
Level Range;100.000000;dB	
Trace settings	
Trace Mode;CLR/WRITE;	
Detector;RMS;	
Sweep Count;0;	
Trace 1.;	
x-Unit;Hz;	
y-Unit;dBm;	
List evaluation settings	
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	

File contents	Explanation
0;-12750000;-2515000;30000;13242367500;-43.844 722747802734;-0.33028793334960938;49.6697120 66650391;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;-43.8447 22747802734;-0.33028793334960938;49.66971206 66650391;FAIL;	

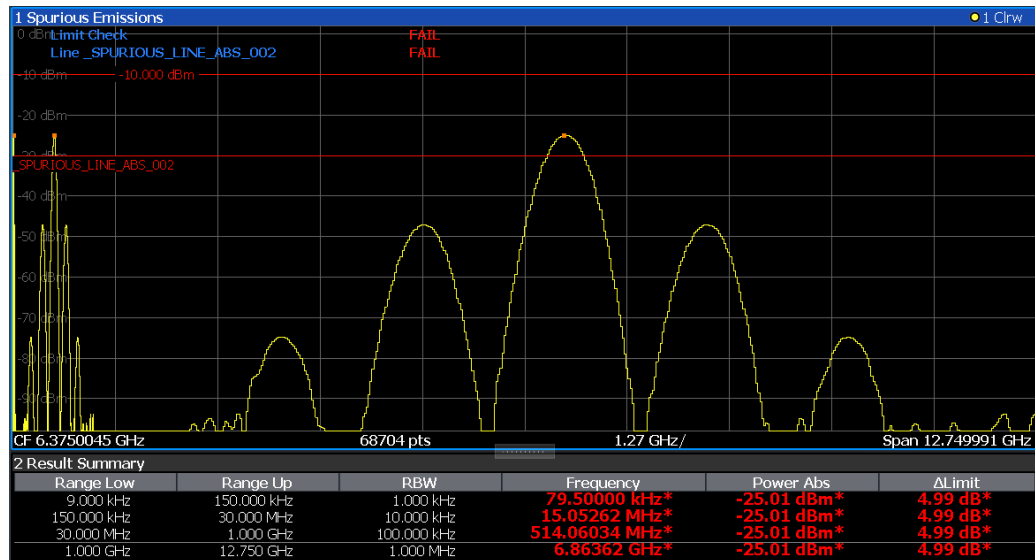
3.7 Spurious emissions measurement

Spurious Emissions measurements monitor unwanted RF products outside the assigned frequency band generated by an amplifier.

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- [Spurious emissions measurement results](#)..... 112
- [Spurious emissions basics](#)..... 113
- [Spurious emissions measurement configuration](#)..... 115
- [How to perform a spurious emissions measurement](#)..... 121
- [Reference: ASCII export file format \(spurious\)](#)..... 123

3.7.1 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.



3.7.2 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 3.7.3.2, "Limit lines in spurious measurements"](#), on page 114). 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	79,50000 kHz*	-25,01 dBm*	4,99 dB*
150,000 kHz	30,000 MHz	10,000 kHz	15,05262 MHz*	-25,01 dBm*	4,99 dB*
30,000 MHz	1,000 GHz	100,000 kHz	514,06034 MHz*	-25,01 dBm*	4,99 dB*
1,000 GHz	12,750 GHz	1,000 MHz	6,86362 GHz*	-25,01 dBm*	4,99 dB*

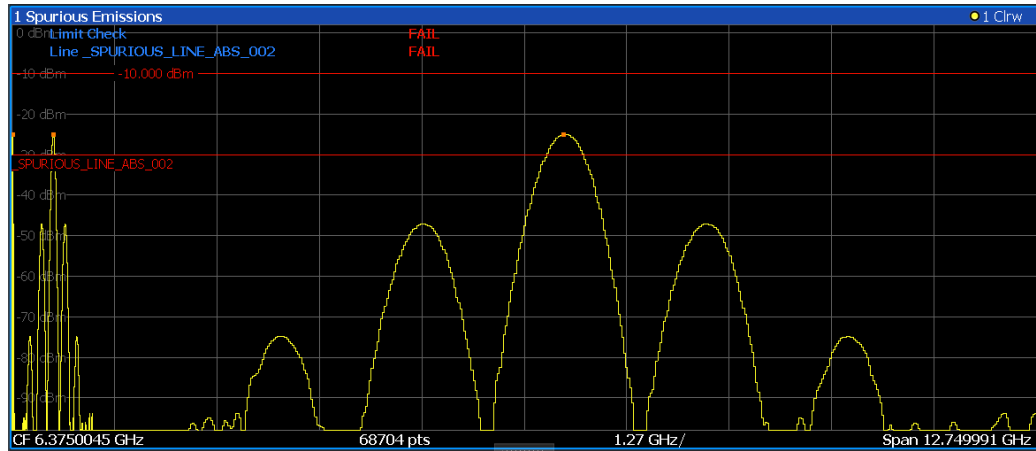
The following information is provided in the evaluation list for each range:

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

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

- Display all peaks
- Display a certain number of peaks per range
- Display only peaks that exceed a threshold ("Margin")

- Display detected peaks as blue squares in the diagram, as well as in the peak list



Furthermore, you can save the evaluation list to a file.

Retrieving Results via Remote Control

The measured spurious values of the displayed trace can be retrieved using the TRAC:DATA? SPUR command (see TRACe<n> [:DATA] on page 564).

3.7.3 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](#)..... 113
- [Limit lines in spurious measurements](#)..... 114

3.7.3.1 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.

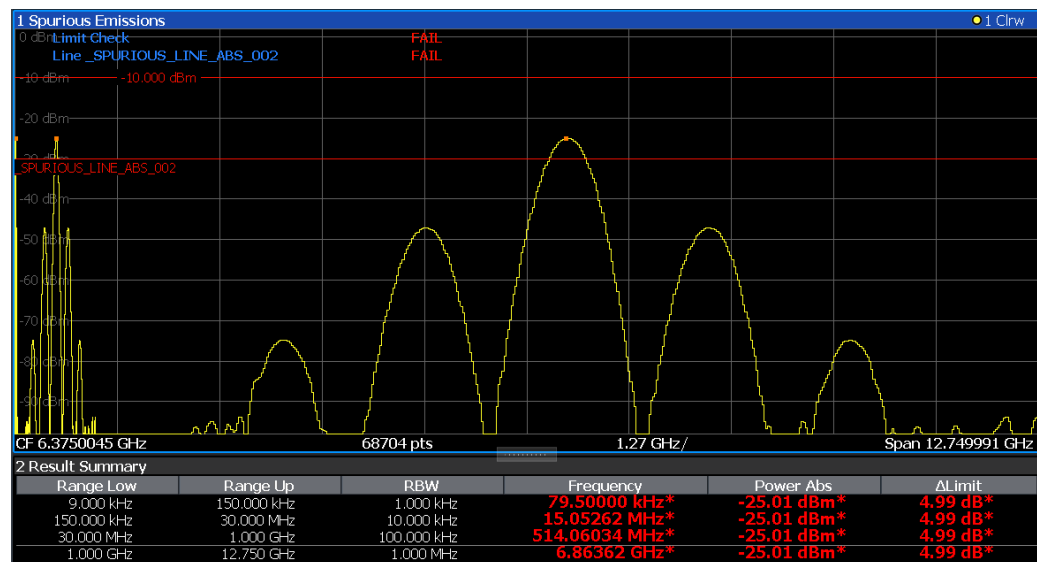
A remote command example for defining parameters and ranges in Spurious Emissions measurements is described in [Chapter 6.7.8.7, "Programming example: spurious emissions measurement"](#), on page 464.

3.7.3.2 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 [Lines]. For Spurious measurements, however, a special limit line is available via the "Sweep List", and it is strongly recommended that you use only this limit line definition.

In the "Sweep List", you can define a limit line that varies its level according to the specified frequency ranges. A distinguished limit line is automatically defined according to the current "Sweep List" settings every time the settings change. This limit line is labeled "_SPURIOUS_LINE_ABS_<xxx>", where <xxx> is an index to distinguish limit lines between different channel setups.

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



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

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

If the limit check is activated, the limit line values for each range are displayed in the evaluation list. Furthermore, the largest deviations of the absolute power from the limit line for each range are displayed. Values that exceed the limit are indicated in red and by an asterisk (*).



Although a margin functionality is not available for the limit check, a margin (threshold) for the peak values to be displayed in the evaluation list can be defined. Furthermore, you can define how many peaks per range are listed. For details, see [Chapter 3.7.4.3, "List evaluation"](#), on page 119.

3.7.4 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 6.7.8, "Spurious emissions"](#), on page 453.

- [Sweep list](#)..... 115
- [Adjusting the X-Axis to the range definitions](#)..... 119
- [List evaluation](#)..... 119

3.7.4.1 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 3.7.3.1, "Ranges and range settings"](#), on page 113.

Spurious Emissions				
	Range 1	Range 2	Range 3	Range 4
Range Start	9 kHz	150 kHz	30 MHz	1 GHz
Range Stop	150 kHz	30 MHz	1 GHz	12.75 GHz
Filter Type	Normal(3dB)	Normal(3dB)	Normal(3dB)	Normal(3dB)
RBW	1 kHz	10 kHz	100 kHz	1 MHz
VBW	3 kHz	30 kHz	300 kHz	3 MHz
Sweep Time Mode	Auto	Auto	Auto	Auto
Sweep Time	14.1 ms	29.9 ms	32.1 ms	35.3 ms
Detector	RMS	RMS	RMS	RMS
Ref Level	-10 dBm	-10 dBm	-10 dBm	-10 dBm
RF Att Mode	Auto	Auto	Auto	Auto
RF Attenuation	0 dB	0 dB	0 dB	0 dB
Preamp	Off	Off	Off	Off
Sweep Points	701	4001	32001	32001
Stop After Sweep				
Transducer	None	None	None	None
Limit Check	Absolute	Absolute	Absolute	Absolute
Abs Limit Start	-30 dBm	-30 dBm	-30 dBm	-30 dBm
Abs Limit Stop	-30 dBm	-30 dBm	-30 dBm	-30 dBm

Insert before Range
Insert after Range
Delete Range
Adjust X-Axis

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VBW.....	117
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Sweep Time	117
Detector.....	117
Reference Level.....	117
RF Attenuation Mode.....	118
RF Attenuation.....	118
Preamp.....	118
Sweep Points.....	118
Stop After Sweep.....	118
Transducer.....	118
Limit Check.....	118
Abs Limit Start/ Abs Limit Stop.....	119
Insert before Range/ Insert after Range.....	119
Delete Range.....	119

Range Start / Range Stop

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

You can define a span that is smaller than the overall span of the ranges. In this case, the measurement includes only the ranges that lie within the defined span and have a minimum span of 20 Hz.

Remote command:

[SENSe:]LIST:RANGe<ri>[:FREQuency]:START on page 456

[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP on page 457

Filter Type

Sets the filter type for this range.

For details on filter types, see [Chapter 4.5.1.6, "Which data may pass: filter types"](#), on page 229.

Remote command:

[SENSe:]LIST:RANGe<ri>:FILTer:TYPE on page 456

RBW

Sets the RBW value for this range.

For details on the RBW, see [Chapter 4.5.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 226.

Remote command:

[SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution on page 454

VBW

Sets the VBW value for this range.

For details on the VBW, see [Chapter 4.5.1.2, "Smoothing the trace using the video bandwidth"](#), on page 227.

Remote command:

[SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo on page 454

Sweep Time Mode

Activates or deactivates the auto mode for the sweep time.

For details on the sweep time mode, see [Chapter 4.5.1.7, "How long the data is measured: Sweep Time"](#), on page 230

Remote command:

[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO on page 460

Sweep Time

Sets the sweep time value for the range.

For details on the sweep time, see [Chapter 4.5.1.7, "How long the data is measured: Sweep Time"](#), on page 230

Remote command:

[SENSe:]LIST:RANGe<ri>:SWEep:TIME on page 460

Detector

Sets the detector for the range.

Remote command:

[SENSe:]LIST:RANGe<ri>:DETector on page 455

Reference Level

Sets the reference level for the range.

For details on the reference level, see [Chapter 4.4.1.2, "Reference level"](#), on page 219.

Remote command:

`[SENSe:]LIST:RANGe<ri>:RLEVEL` on page 460

RF Attenuation Mode

Activates or deactivates the auto mode for RF attenuation.

For details on attenuation, see [Chapter 4.4.1.1, "Increasing measurement sensitivity \(or avoiding an input mixer overload\)"](#), on page 216.

Remote command:

`[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO` on page 458

RF Attenuation

Sets the attenuation value for that range.

For details on attenuation, see [Chapter 4.4.1.1, "Increasing measurement sensitivity \(or avoiding an input mixer overload\)"](#), on page 216.

Remote command:

`[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation` on page 457

Preamp

Switches the preamplifier on or off.

For details on the preamplifier, see ["Preamplifier"](#) on page 223.

Remote command:

`[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATE` on page 433

Sweep Points

Sets the number of sweep points for the specified range.

For details on sweep points, see [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230.

Remote command:

`[SENSe:]LIST:RANGe<ri>:POINTs[:VALue]` on page 459

Stop After Sweep

This function is not available for the R&S EPL1000.

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 EPL1000.

Remote command:

`[SENSe:]LIST:RANGe<ri>:TRANsducer` on page 461

Limit Check

Activates or deactivates the limit check for all ranges.

For details on limit checks, see [Chapter 3.7.3.2, "Limit lines in spurious measurements"](#), on page 114.

"ABSOLUTE" Signal is checked against absolute limit values

"NONE" No limit check is performed.

Remote command:

[\[SENSe:\]LIST:RANGe<ri>:LIMit:STATe](#) on page 459

[CALCulate<n>:LIMit:FAIL?](#) on page 650

Abs Limit Start/ Abs Limit Stop

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

Remote command:

[\[SENSe:\]LIST:RANGe<ri>:LIMit:START](#) on page 458

[\[SENSe:\]LIST:RANGe<ri>:LIMit:STOP](#) on page 459

Insert before Range/ Insert after Range

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

Delete Range

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

3.7.4.2 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.

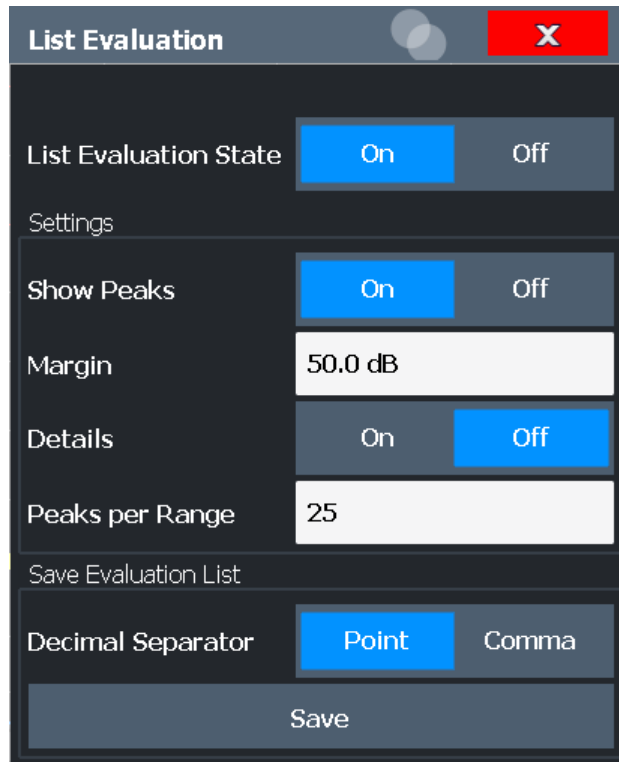
Remote command:

[\[SENSe:\]LIST:XADJust](#) on page 463

3.7.4.3 List evaluation

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

Configure the contents and display of the result list.



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List Evaluation State

Activates or deactivates the list evaluation.

Remote command:

`CALCulate<n>:PEAKsearch:AUTO` on page 462

Show Peaks

If activated, all peaks that have been detected during an active list evaluation are marked with blue squares in the diagram.

Remote command:

`CALCulate<n>:PEAKsearch:PSHow` on page 463

Margin

A margin functionality is not available for the limit check. However, you can define a margin (=threshold) for the peak values to be displayed in the evaluation list. Only peaks that exceed the margin value are displayed (also in the diagram, if activated).

Remote command:

`CALCulate<n>:PEAKsearch:MARGIN` on page 462

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 462

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 463

Save Evaluation List

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

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

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

For details, see ["How to Save the Spurious Emissions Evaluation List"](#) on page 122.

Remote command:

[MMEMory:STORe<n>:LIST](#) on page 575

[FORMat:DEXPort:DSEPARATOR](#) on page 573

3.7.5 How to perform a spurious emissions measurement

The following step-by-step instructions demonstrate how to perform spurious emissions measurements.



For remote operation, see [Chapter 6.7.8.7, "Programming example: spurious emissions measurement"](#), on page 464.

1. Press [MEAS], then select the "Spurious Emissions" measurement.
2. Define the span of the signal to be monitored in the general span settings.
3. Select "Overview", then select "Spurious Setup".
The "Spurious Emissions" dialog box is displayed.
4. Split the frequency span of the measurement into ranges for signal parts with similar characteristics.

- Define the required ranges in the "Sweep List" using "Insert before Range" and "Insert after Range", which refer to the currently selected range.
5. Define the measurement parameters for each range as required.
 6. Optionally, define a limit check.
 - a) Activate the limit check by setting "Limit Check" to "ABSOLUTE". The limit check is always activated or deactivated for all ranges simultaneously.
 - b) Define the limit line's start and stop values for each range of the signal. If a signal level higher than the defined limit is measured, the limit check fails, which may indicate a spurious emission.
 7. Configure the peak detection during a Spurious Emissions measurement: select "Evaluations" in the "Overview".
 - To indicate the determined peaks in the display, activate the "Show Peaks" option.
 - To restrict peak detection, define a "Margin". Only peaks that exceed this value are detected.
 - To allow for more peaks per range to be detected than the default 1, increase the "Peaks per Range" value and set "Details" to "On".
 8. Start a sweep.

The determined powers and limit deviations for each range are indicated in the evaluation list. If activated, the peak power levels for each range are also indicated in the diagram.
 9. To save the evaluation list, export the results to a file as described in ["How to Save the Spurious Emissions Evaluation List"](#) on page 122.

How to Save the Spurious Emissions Evaluation List

The evaluation list from a Spurious Emissions measurement can be saved to a file, which can be exported to another application for further analysis, for example.

1. Configure and perform a Spurious Emissions measurement as described in [Chapter 3.7.5, "How to perform a spurious emissions measurement"](#), on page 121.
2. Select "Evaluations" in the "Overview".
3. If necessary, change the "Decimal Separator" to "COMMA" for evaluation in other languages.
4. Select "Save".
5. In the file selection dialog box, select a storage location and file name for the result file.
6. Select "Save".

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

3.7.6 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;EPL1000	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:
0;9000;150000;1000;101022.11126961483;-47.075111389160156;-34.075111389160156;PASS;	<range number>;
0;9000;150000;1000;58380.171184022824;-47.079341888427734;-34.079341888427734;PASS;	<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)>;

3.8 Statistical measurements (APD, CCDF)

To measure the amplitude distribution, the R&S EPL1000 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.

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- [Typical applications](#)..... 125
- [APD and CCDF results](#)..... 125
- [APD and CCDF basics - gated triggering](#)..... 127
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- [How to perform an APD or CCDF measurement](#)..... 134
- [Examples](#)..... 135
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3.8.1 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 EPL1000 is set into zero span mode automatically. The R&S EPL1000 measures the statistics of the signal applied to the RF input with the defined analysis bandwidth. To avoid affecting the peak amplitudes the video bandwidth is automatically set to 10 times the analysis bandwidth. The sample detector is used for detecting the video voltage.

Statistic measurements on pulsed signals can be performed using a gated trigger. For details see [Chapter 3.8.4, "APD and CCDF basics - gated triggering"](#), on page 127.

3.8.2 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.

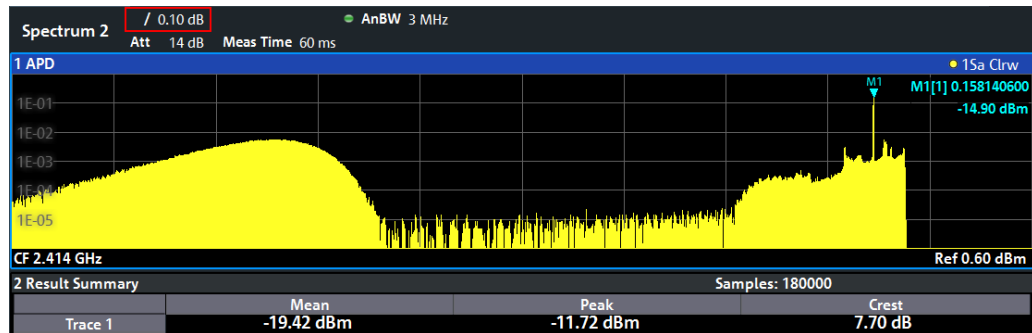
3.8.3 APD and CCDF results

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.

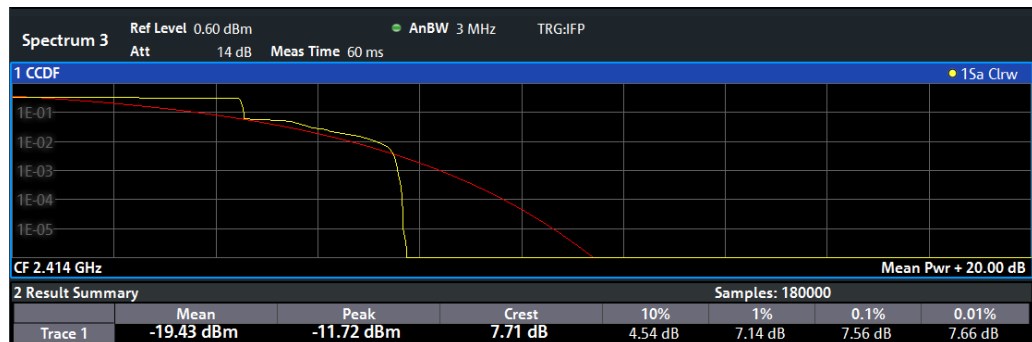


In addition to the histogram, a result table is displayed containing the following information:

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



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

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

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

- Number of samples used for calculation

- For each displayed trace:

Mean	Mean power
Peak	Peak power
Crest	Crest factor (peak power – mean power)
10 %	10 % probability that the level exceeds mean power + [x] dB
1 %	1 % probability that the level exceeds mean power + [x] dB
0,1 %	0,1 % probability that the level exceeds mean power + [x] dB
0,01 %	0,01 % probability that the level exceeds mean power + [x] dB

Percent marker

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



Percent marker

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

Diagram Scaling

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

Remote commands:

`CALCulate<n>:STATistics:CCDF:X<t>?` on page 473

`CALCulate<n>:STATistics:RESult<res>?` on page 474

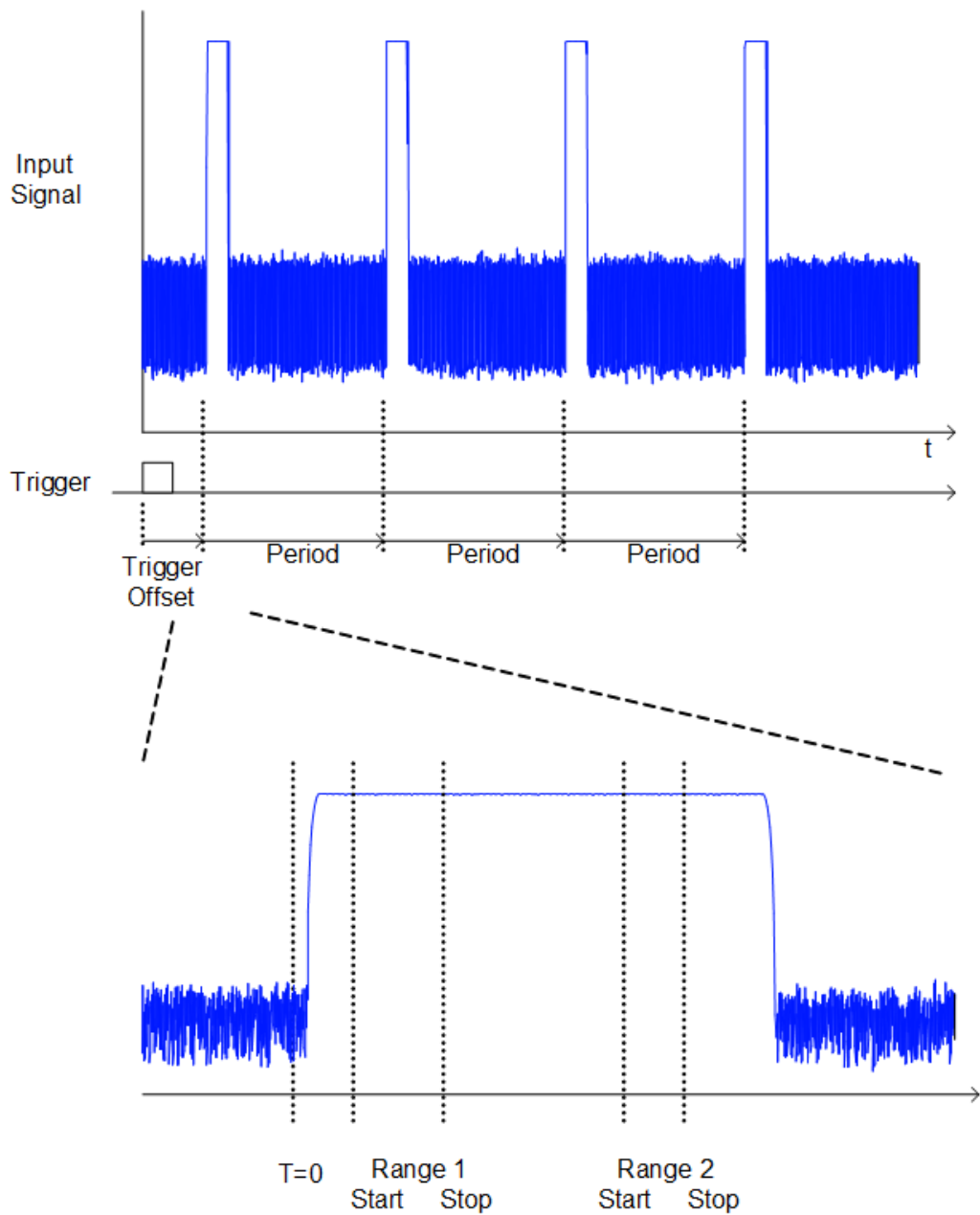
3.8.4 APD and CCDF basics - gated triggering

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

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

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

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



3.8.5 APD and CCDF configuration

Configuration consists of the following settings:

- Make sure the specified reference level is higher than the measured peak value (see "Reference Level" on page 221).
- [Basic settings](#)..... 129
- [Gate range definition for APD and CCDF](#)..... 131
- [Scaling for statistics diagrams](#)..... 132

3.8.5.1 Basic settings

Access: "Overview" > "Select Measurement" > "APD"/"CCDF" > "APD Config"/ "CCDF Config"

The remote commands required to perform these tasks are described in [Chapter 6.7.9, "Statistics"](#), on page 466.

CCDF	
Percent Marker	0.0 %
Analysis Bandwidth	80.0 MHz
Number of Samples	100 000
Gated Trigger	On Off
Normal Distribution	On Off
Edit Gate Ranges	
Adjust Settings	

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

Percent Marker (CCDF only).....	129
Analysis Bandwidth.....	129
Number of Samples.....	130
Gated Trigger.....	130
Normal Distribution.....	130
Edit Gate Ranges.....	130
Adjust Settings.....	130

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 467

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 543

Number of Samples

Defines the number of power measurements that are taken into account for the statistics.

For statistics measurements with the R&S EPL1000, 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:

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

For the R&S EPL1000, the maximum number of samples is approximately 20 million.

The maximum number of samples is limited by the hardware capability. For gated triggered APD or CCDF measurements, the maximum number is limited further, if necessary, to accommodate for very small ranges within a relatively long period. In this case, the smallest gate/period ratio is considered, and the number is adapted to capture full periods of data. If the defined number of samples exceeds the limit, it is automatically reduced to the maximum value.

Remote command:

[CALCulate<n>:STATistics:NSAMples](#) on page 467

Gated Trigger

Activates and deactivates gating for statistics functions for the ACP and the CCDF measurements. The gate ranges are defined using the [Edit Gate Ranges](#) function.

Remote command:

[\[SENSe:\]SWEep:EGATe](#) on page 554

Normal Distribution

Enables or disables the red trace in the CCDF display indicating the normal distribution.

Remote command:

[DISPlay\[:WINDow<n>\]:STATistics:CCDF:GAUSS](#) on page 468

Edit Gate Ranges

Opens a dialog box to configure up to 3 gate ranges for each trace. For details see [Chapter 3.8.5.2, "Gate range definition for APD and CCDF"](#), on page 131.

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 471

3.8.5.2 Gate range definition for APD and CCDF

Access: "Overview" > "Select Measurement" > "APD"/"CCDF" > "APD Config"/"CCDF Config" > "Edit Gate Ranges"

You can configure gate ranges for gated triggering in statistical measurements.

For background information on defining gate ranges see [Chapter 3.8.4, "APD and CCDF basics - gated triggering"](#), on page 127.

The remote commands required to perform these tasks are described in [Chapter 6.7.9.3, "Gate ranges"](#), on page 468.

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

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

Comment	131
Period	131
Range <x> Use	132
Range <x> Start/Stop	132

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 468

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

Remote command:

[SENSe:] SWEEp:EGATe:TRACe<t>:PERiod on page 468

Range <x> Use

Activates tracing of the defined range during a gated measurement.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>[:STATe<gr>] on page 470

Range <x> Start/Stop

Defines the start and stop points of the range within the tracing period. Make sure the value for the stopping time is smaller than the length of the period.

Note: You can define the time values with a greater numerical resolution than is displayed; the values are only rounded for display.

Remote command:

[SENSe:] SWEep:EGATe:TRACe<t>:START<gr> on page 469

[SENSe:] SWEep:EGATe:TRACe<t>:STOP<gr> on page 469

3.8.5.3 Scaling for statistics diagrams

Access: "Overview" > "Amplitude" > "Scale" tab

Or: [AMPT] > "Scale Config"

For statistics displays, scale settings are available for both the y-axis and the x-axis.

The remote commands required to perform these tasks are described in [Chapter 6.7.9.4, "Diagram scale"](#), on page 470.



Figure 3-31: Scale settings for CCDF diagram



In statistical diagrams, the x-axis displays the signal level values (= y-axis in standard display), while the y-axis displays the probability of the values.

X-Axis.....	133
L Ref Level.....	133
L Range.....	133
L Shifting the Display (Offset).....	133
Y-Axis.....	133
L Y-Unit.....	133
L Y-Max/ Y-Min.....	133
Default Settings.....	134
Adjust Settings.....	134

X-Axis

Defines the scaling settings for signal level values.

Ref Level ← X-Axis

Defines the reference level for the signal levels in the currently active unit (dBm, dBμV, etc.).

For the APD function this value corresponds to the right diagram border. For the CCDF function there is no direct representation of this value on the diagram as the x-axis is scaled relatively to the measured mean power.

Remote command:

`CALCulate<n>:STATistics:SCALE:X:RLEVel` on page 471

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 471

Shifting the Display (Offset) ← X-Axis

Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the x-axis is changed accordingly. The setting range is ±200 dB in 0.1 dB steps.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RLEVel:OFFSet` on page 538

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 472

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 472

[CALCulate<n>:STATistics:SCALE:Y:LOWer](#) on page 472

Default Settings

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

X-axis ref level:	0 dBm
X-axis range APD:	100 dB
X-axis range CCDF:	20 dB
Y-axis upper limit:	1.0
Y-axis lower limit:	1E-6

Remote command:

[CALCulate<n>:STATistics:PRESet](#) on page 470

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 471

3.8.6 How to perform an APD or CCDF measurement

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



For remote operation, see [Chapter 6.7.9.7, "Programming example: measuring statistics"](#), on page 474.

To start a basic statistic measurement

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

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

To perform a statistic measurement using gate ranges

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

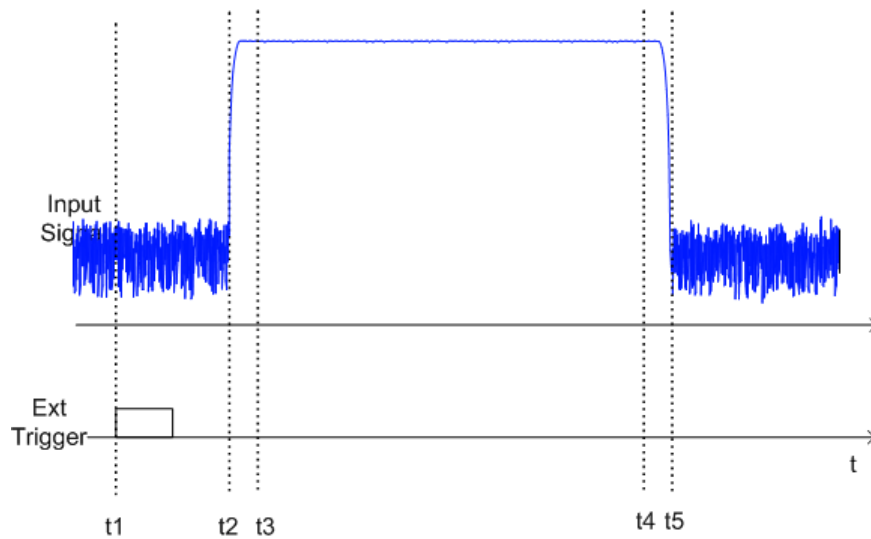
1. Press [MEAS Config], then select "APD Config" or "CCDF Config".
The "APD" or "CCDF" dialog box is displayed.
2. Select "Edit Gate Ranges".
3. Define the time period for which the input signal is to be analyzed, for example the duration of 3 signal pulses.
4. For each active trace, define up to three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

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

3.8.7 Examples

3.8.7.1 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

3.8.7.2 Measurement example – measuring the APD and CCDF of white noise generated by the R&S EPL1000



Setting the analysis bandwidth

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



A programming example demonstrating a statistics measurement in a remote environment is provided in [Chapter 6.7.9.7, "Programming example: measuring statistics"](#), on page 474.

1. Preset the R&S EPL1000.
2. Set the reference level to -60 dBm .

The R&S EPL1000'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 EPL1000 sets the frequency span to 0 Hz and measures the amplitude probability distribution (APD). The number of uncorrelated level measurements used for the measurement is 100000. The mean power and the peak power are displayed in dBm. The crest factor (peak power – mean power) is output as well.

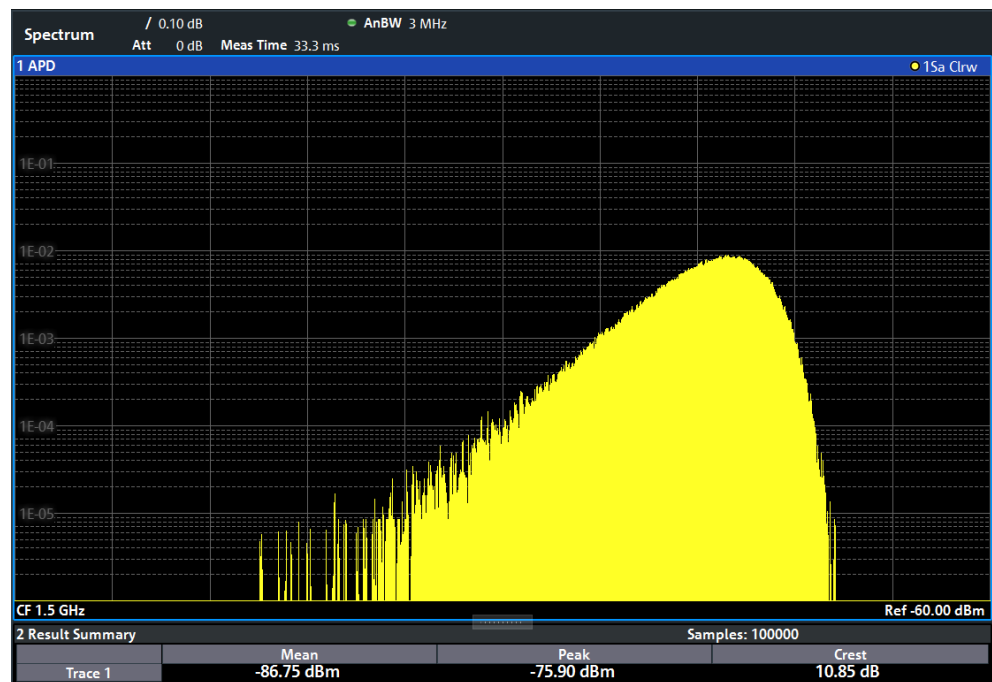


Figure 3-32: Amplitude probability distribution of white noise

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

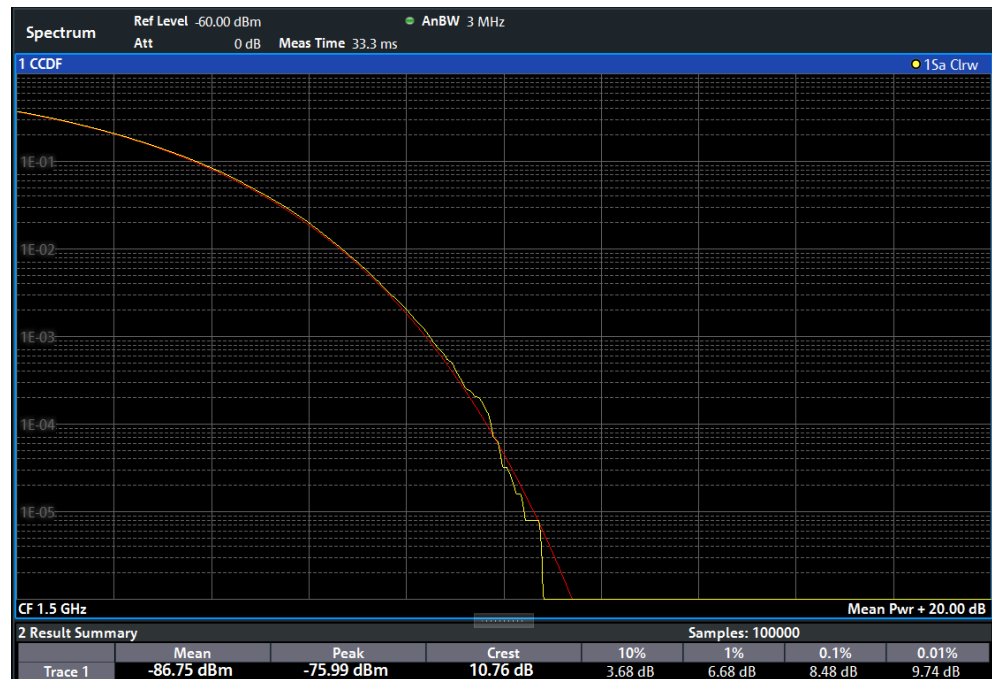


Figure 3-33: CCDF of white noise

The CCDF trace indicates the probability that a level will exceed the mean power. The level above the mean power is plotted along the x-axis of the graph. The origin of the axis corresponds to the mean power level. The probability that a level will be exceeded is plotted along the y-axis.

3.8.8 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 129).
- If the complete signal is to be measured, increase the number of samples so that the resulting measurement time is longer than one period of a burst signal.
- If only parts of the signal are to be examined, define a trigger source and a gate.

3.9 Time domain power measurement

The Time Domain Power measurement determines the power of a signal in the time domain.

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

- [About the measurement](#)..... 139
- [Time domain power results](#)..... 139
- [Time domain power basics - range definition using limit lines](#)..... 140
- [Time domain power configuration](#)..... 140
- [How to measure powers in the time domain](#)..... 142

3.9.1 About the measurement

Using the Time Domain Power measurement function, the R&S EPL1000 determines the power of the signal in zero span by summing up the power at the individual measurement points and dividing the result by the number of measurement points. Thus it is possible to measure the power of TDMA signals during transmission, for example, or during the muting phase. Both the mean power and the RMS power can be measured.

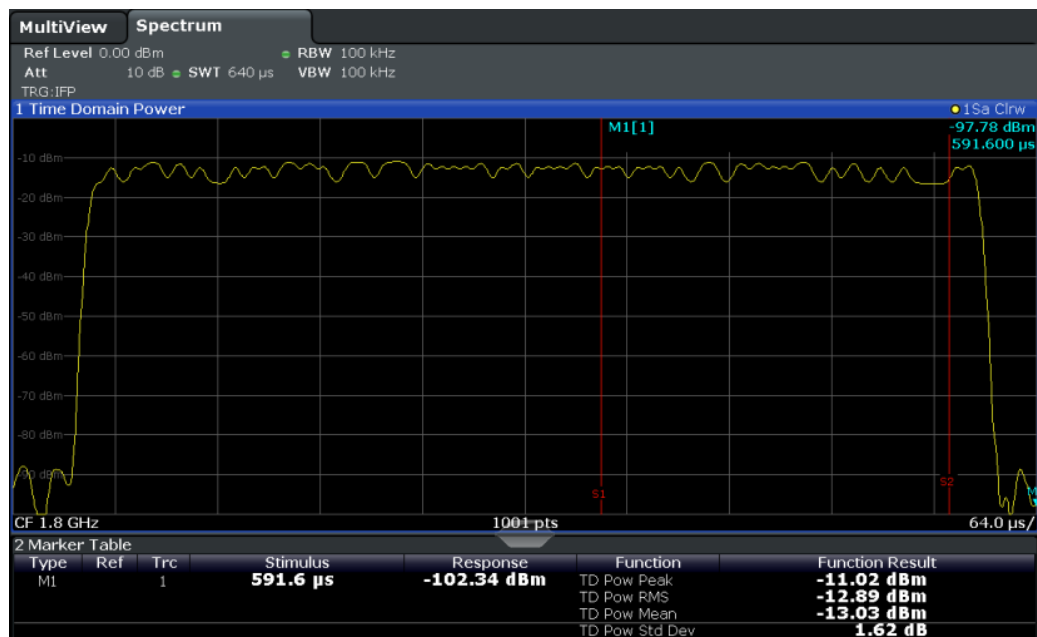
For this measurement, the sample detector is recommended. The sample detector is activated automatically if the detector is in auto mode.

3.9.2 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 6.7.10, "Time domain power"](#), on page 475.

3.9.3 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.

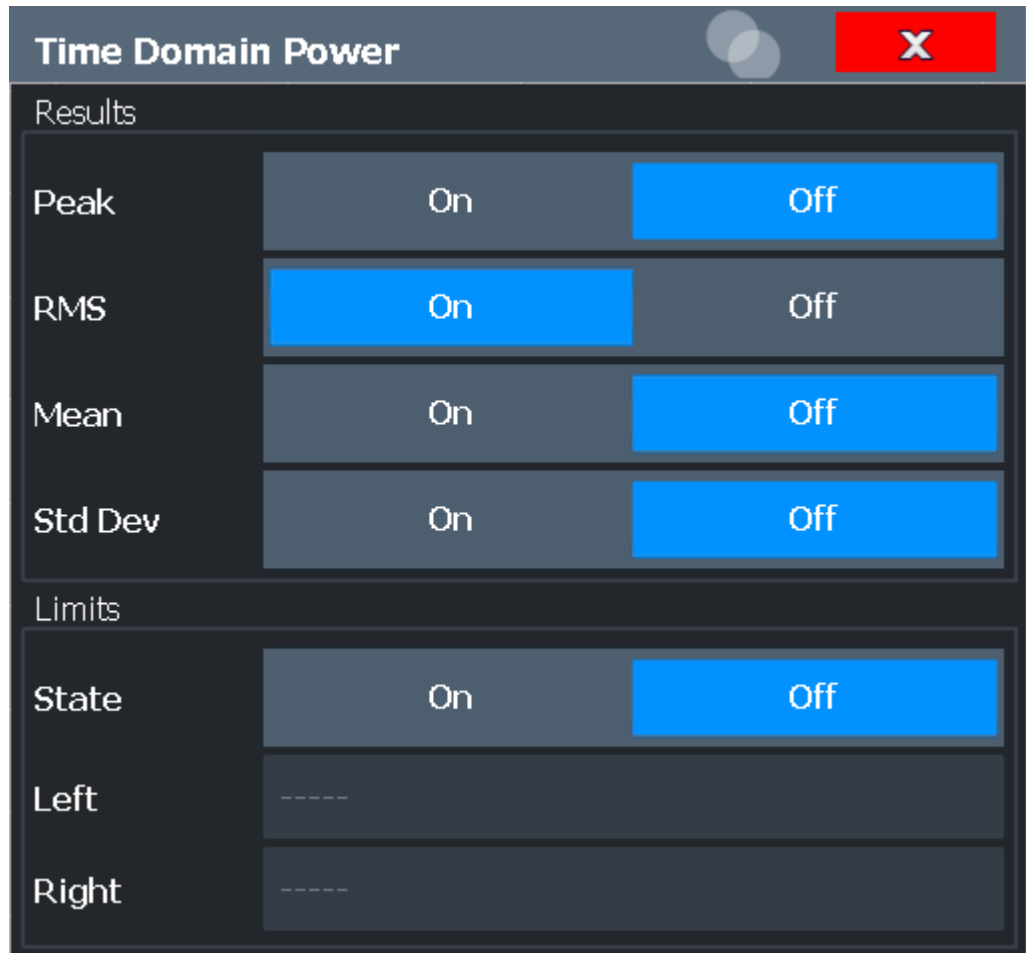
For example, if both the on and off phase of a burst signal are displayed, the measurement range can be limited to the transmission or to the muting phase. The ratio between signal and noise power of a TDMA signal for instance can be measured by using a measurement as a reference value and then varying the measurement range.



In order to get stable measurement results for a limited evaluation range, usually a trigger is required.

3.9.4 Time domain power configuration

Access: "Overview" > "Select Measurement" > "Time Domain Power" > "Time Domain Power Config"



The results can also be queried using the remote commands described in [Chapter 6.7.10.1, "Measurement configuration"](#), on page 476.

Results	141
Limit State	142
Left Limit / Right Limit	142

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 477

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak:RESult?](#) on page 481

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS\[:STATe\]](#) on page 478

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS:RESult?](#) on page 482

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN\[:STATe\]](#) on page 477

[CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN:RESult?](#) on page 480

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 600

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 598

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 599

3.9.5 How to measure powers in the time domain

The step-by-step procedure to measure powers in the time domain is described here in detail.

To measure the power in the time domain

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

5. Start a sweep.

The measured powers are displayed in the marker results.

3.10 Harmonic distortion measurement

The "Harmonic Distortion" measurement measures harmonics and their distortion, including the total harmonic distortion.

- [About the measurement](#)..... 143
- [Harmonic distortion basics](#)..... 143
- [Harmonic distortion results](#)..... 146
- [Harmonic distortion configuration](#)..... 147
- [How to determine the harmonic distortion](#)..... 148

3.10.1 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).



An application note discussing harmonics measurement is available from the Rohde & Schwarz website:

[1EF78: Measurement of Harmonics using Spectrum Analyzers](#)

3.10.2 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 3-34](#), the level of the 2nd harmonic drops by 20 dB if the level of the fundamental wave is reduced by 10 dB.

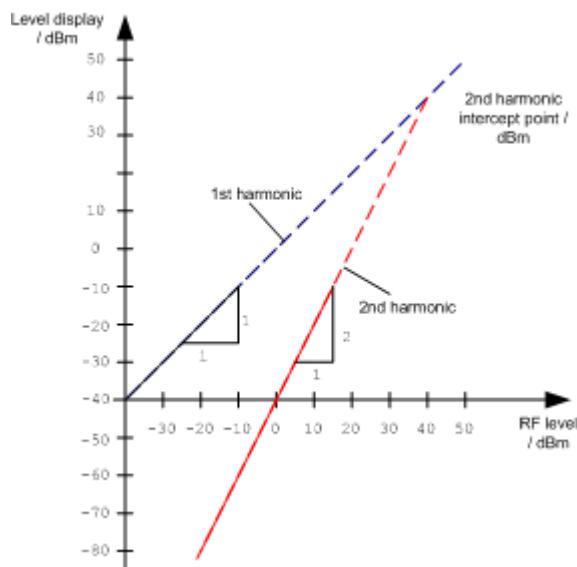


Figure 3-34: Extrapolation of the 1st and 2nd harmonics to the 2nd harmonic intercept at 40 dBm

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:

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

At a resolution bandwidth of 10 Hz (noise level -143 dBm, S.H.I. = 40 dBm), the optimum mixer level is – 51.5 dBm. According to (1) a maximum measurable harmonic distortion of 91.5 dB minus a minimum S/N ratio of 4 dB is obtained.



Detecting the origin of harmonics

If the harmonic emerges from noise sufficiently (approx. >15 dB), it is easy to check (by changing the RF attenuation) whether the harmonics originate from the DUT or are generated internally by the signal analyzer. If a harmonic originates from the DUT, its level remains constant if the RF attenuation is increased by 10 dB. Only the displayed noise is increased by 10 dB due to the additional attenuation. If the harmonic is exclusively generated by the signal analyzer, the level of the harmonic is reduced by 20 dB or is lost in noise. If both – the DUT and the signal analyzer – contribute to the harmonic, the reduction in the harmonic level is correspondingly smaller.

High-sensitivity harmonics measurements

If harmonics have very small levels, the resolution bandwidth required to measure them must be reduced considerably. The sweep time is, therefore, also increased considerably. In this case, the measurement of individual harmonics is carried out with the R&S EPL1000 set to a small span. Only the frequency range around the harmonics will then be measured with a small resolution bandwidth.

Required measurement time

During the harmonics measurement, zero span sweeps are performed at the center frequency and at each harmonic. The duration of each sweep ("Harmonic Sweep

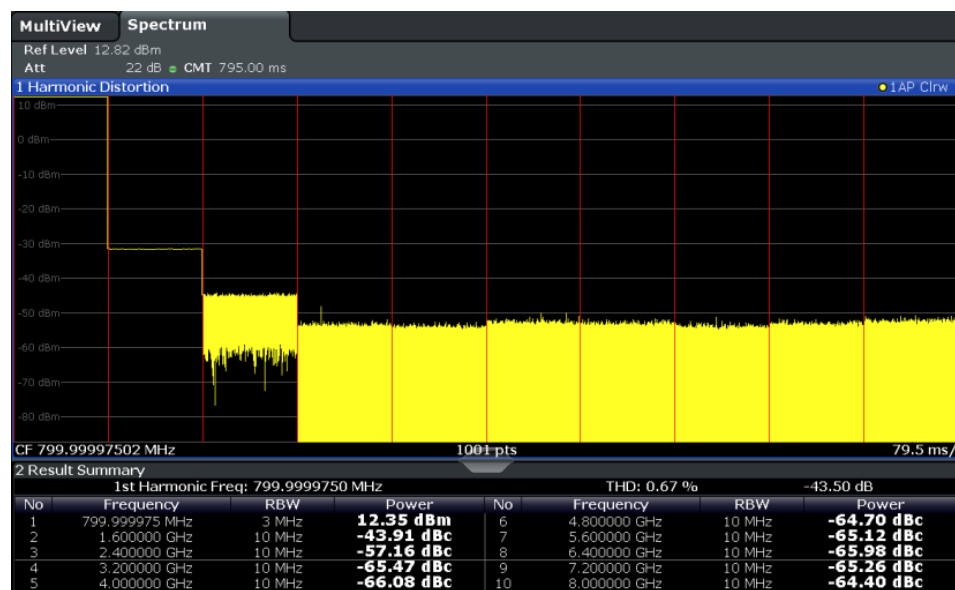
Time", **SWT**) and the "Number of Harmonics" (n) are defined in the "Harmonic Distortion" configuration dialog box. Thus, the required measurement time for the harmonic distortion measurement (*Cumulated Measurement Time*, **CMT**) is:

$$CMT = n * SWT$$

The required measurement time is indicated as "CMT" in the channel bar.

3.10.3 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 531.

THD: `CALCulate<n>;MARKer<m>;FUNCTion:HARMOnics:DISToRtion?`
on page 486

List of harmonics: [CALCulate<n>:MARKer<m>:FUNction:HARMonics:LIST](#)
on page 487

3.10.4 Harmonic distortion configuration

Access: "Overview" > "Select Measurement" > "Harmonic Distortion" > "Harmonic Distortion Config"

The remote commands required to perform these tasks are described in [Chapter 6.7.11.2, "Measurement configuration"](#), on page 485.

Number of Harmonics	147
Harmonic Sweep Time	147
Harmonic RBW Auto	147
Adjust Settings	148

Number of Harmonics

Defines the number of harmonics to be measured. The range is from 1 to 26. Default is 10.

Remote command:

[CALCulate<n>:MARKer<m>:FUNction:HARMonics:NHARmonics](#) on page 485

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 233.

Remote command:

[\[SENSe:\] SWEep:TIME:AUTO](#) on page 550

Harmonic RBW Auto

Enables/disables the automatic adjustment of the resolution bandwidth for Normal (3dB) (Gaussian) 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 485

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 486

3.10.5 How to determine the harmonic distortion



In [Chapter 5.4.6, "Measurement example: measuring harmonics using marker functions"](#), on page 352, measuring harmonics was described using marker functions. This task can be performed much simpler using the Harmonic Distortion measurement, as described in the following procedure.

For remote operation, see [Chapter 6.7.11.5, "Example: measuring the harmonic distortion"](#), on page 487.

1. Select the "Harmonic Distortion" measurement function from the "Select Measurement" dialog box.
2. Define the number of harmonics to be determined using "Number of Harmonics".
3. Perform a sweep.

The trace for the determined harmonics are displayed in the diagram, separated by red display lines. The measured power for each harmonic in relation to the fundamental is indicated in the result table.

4. If the signal changes significantly during or after the harmonics measurement, use the "Adjust Settings" function to adjust the settings automatically and restart the measurement.

3.11 Third order intercept (TOI) measurement

The third order intercept point of the R&S EPL1000 can be determined if a two-tone signal with equal carrier levels is applied to the input.

`CALCulate<n>:MARKer<m>:FUNction:TOI:RESult?` on page 488

- [About the TOI measurement](#)..... 149
- [TOI basics](#)..... 149
- [TOI results](#)..... 153
- [TOI configuration](#)..... 154
- [How to determine the third order intercept](#)..... 155

3.11.1 About the TOI measurement

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

To measure the third order intercept point (TOI), a two-tone signal with equal carrier levels is expected at the R&S EPL1000 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 EPL1000 calculates the third order intercept point from the level difference between the first 2 markers and the markers 3 and 4, and displays it in the marker table.

3.11.2 TOI basics

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

The frequencies of the intermodulation products are above and below the useful signals. [Figure 3-35](#) shows intermodulation products P_{S1} and P_{S2} , generated by the two useful signals P_{U1} and P_{U2} .

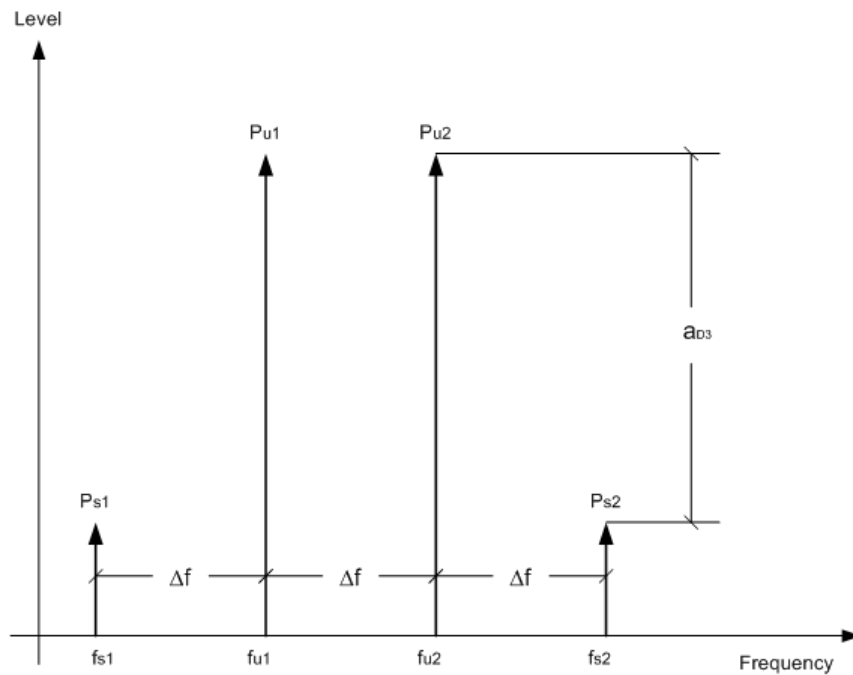


Figure 3-35: Intermodulation products P_{s1} and P_{s2}

The intermodulation product at f_{i2} is generated by mixing the 2nd harmonic of useful signal P_{u2} and useful signal P_{u1} .

The intermodulation product at f_{i1} is generated by mixing the 2nd harmonic of useful signal P_{u1} and useful signal P_{u2} .

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

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

Dependency on level of useful signals

The level of the intermodulation products depends on the level of the useful signals. If the two useful signals are increased by 1 dB, the level of the intermodulation products increases by 3 dB. Thus, the spacing a_{D3} between intermodulation signals and useful signals is reduced by 2 dB, as shown in [Figure 3-36](#).

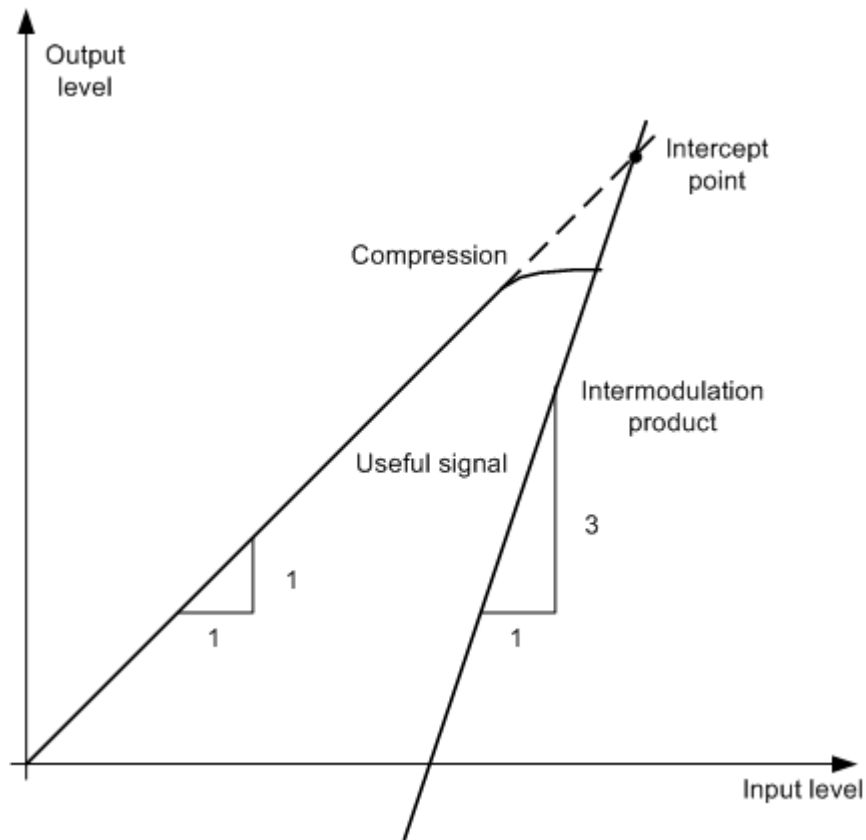


Figure 3-36: Dependency of intermodulation products on level of useful signals

The useful signals at the two-port output increase proportionally with the input level as long as the two-port is in the linear range. A level change of 1 dB at the input causes a level change of 1 dB at the output. Beyond a certain input level, the two-port goes into compression and the output level stops increasing. The intermodulation products of the third order increase three times as quickly as the useful signals. The intercept point is the fictitious level where the two lines intersect. It cannot be measured directly, since the useful level is limited by the maximum two-port output power.

Calculation method

However, the intercept point can be calculated from the known line slopes and the measured spacing a_{D3} between intermodulation signals and useful signals at a given level P_U according to the following formula:

$$IP3 = \frac{a_{D3}}{2} + P_U$$

Example:

Assume that the measured spacing between intermodulation and useful signal is 60 dB at the input level $P_U = -20$ dBm. Then the third order intercept point (TOI) is calculated according to the following formula:

$$IP3 = \frac{60}{2} + (-20dBm) = 10dBm$$

Intermodulation-free dynamic range

The "Intermodulation-free dynamic range" is the level range in which no internal intermodulation products are generated if two-tone signals are measured. It is determined by the third order intercept point, the phase noise and the thermal noise of the signal analyzer. At high signal levels, the range is determined by intermodulation products. At low signal levels, intermodulation products disappear below the noise floor, i.e. the noise floor and the phase noise of the signal analyzer determine the range. The noise floor and the phase noise depend on the resolution bandwidth that has been selected. At the smallest resolution bandwidth, the noise floor and phase noise are at a minimum and so the maximum range is obtained. However, a large increase in sweep time is required for small resolution bandwidths. It is therefore best to select the largest resolution bandwidth possible to obtain the range that is required. Since phase noise decreases as the carrier-offset increases, its influence decreases with increasing frequency offset from the useful signals.

The following diagrams illustrate the intermodulation-free dynamic range as a function of the selected bandwidth and of the level at the input mixer (= signal level – set RF attenuation) at different useful signal offsets.



For typical values for your instrument, see the data sheet.

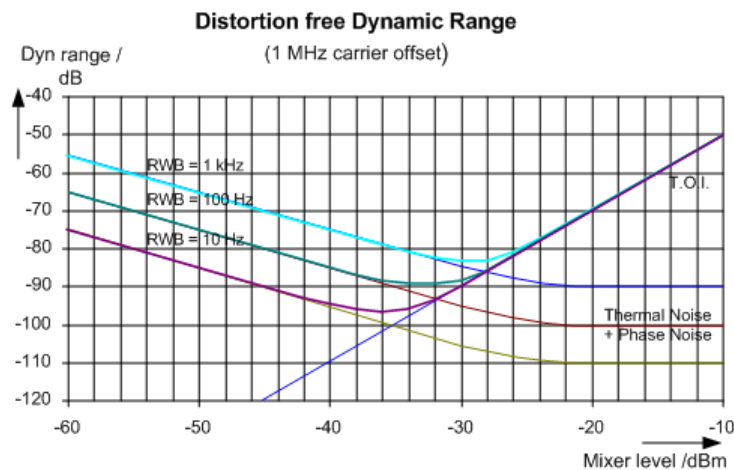


Figure 3-37: Intermodulation-free range as a function of level at the input mixer and the set resolution bandwidth

- Useful signal offset = 1 MHz
- DANL = -145 dBm/Hz
- TOI = 15 dBm

The optimum mixer level, i.e. the level at which the intermodulation distance is at its maximum, depends on the bandwidth. At a resolution bandwidth of 10 Hz, it is approx. -35 dBm. At 1 kHz, it increases to approx. -30 dBm.

Phase noise has a considerable influence on the intermodulation-free range at carrier offsets between 10 kHz and 100 kHz (see [Figure 3-38](#)). At greater bandwidths, the influence of the phase noise is greater than it would be with small bandwidths. The optimum mixer level at the bandwidths under consideration becomes almost independent of bandwidth and is approx. -40 dBm.

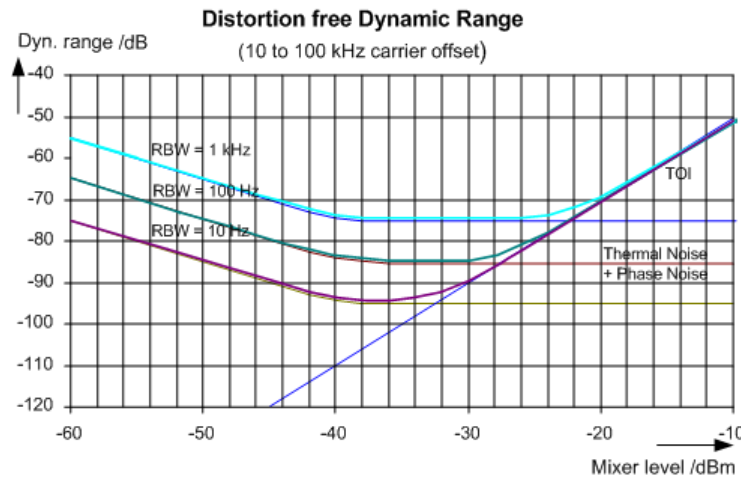


Figure 3-38: Intermodulation-free dynamic range as a function of level at the input mixer and of the selected resolution bandwidth

- Useful signal offset = 10 kHz to 100 kHz
- DANL = -145 dBm/Hz
- TOI = 15 dBm



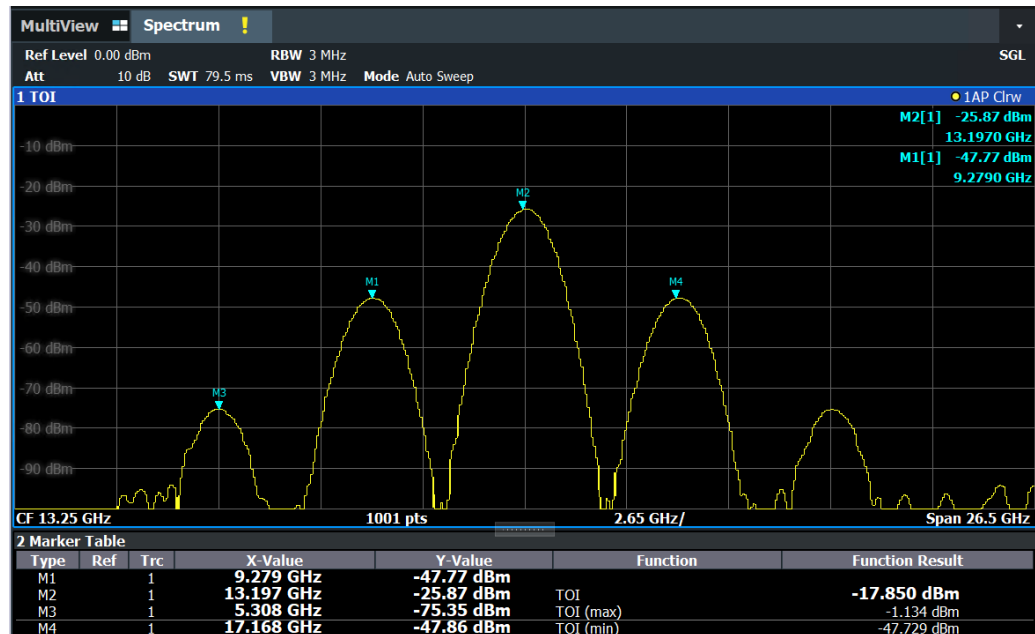
When you measure the intermodulation products of a DUT with a very high dynamic range, the used resolution bandwidth is usually very small. In this case, it is best to measure the levels of the useful signals and those of the intermodulation products separately, using a small span. The measurement time is reduced, in particular if the offset of the useful signals is large. To find signals reliably when the frequency span is small, it is best to synchronize the signal sources and the R&S EPL1000.

3.11.3 TOI results

As a result of the TOI measurement, the following values are displayed in the marker area of the diagram:

Third order intercept (TOI) measurement

Label	Description
TOI	Third-order intercept point for averaged levels (see also Chapter 3.11.3, "TOI results" , on page 153 and Figure 3-35): $P_{U-AVG} + (P_{U-AVG} - P_{S-AVG})/2$
TOI (max)	$P_{U-MAX} + (P_{U-MAX} - P_{S-MIN})/2$
TOI (min)	$P_{U-MIN} + (P_{U-MIN} - P_{S-MAX})/2$
M1	Maximum of first useful signal
M2	Maximum of second useful signal
M3	First intermodulation product
M4	Second intermodulation product

**Remote command**

The TOI can also be queried using the remote commands:

[CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?](#) on page 488.

[CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MAXimum?](#) on page 489

[CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MINimum?](#) on page 489

3.11.4 TOI configuration

Access: "Overview" > "Select Measurement" > "Third Order Intercept" > "TOI Config"

Third Order Intercept	
Marker 1	2.634 GHz
Marker 2	5.281 GHz
Marker 3	2.634 GHz
Marker 4	7.929 GHz
Search Signals	

The remote commands required to perform these tasks are described in [Chapter 6.7.12, "Third order intercept point \(TOI\)"](#), on page 488.

Marker 1/Marker 2/Marker 3/Marker 4	155
Search Signals	155

Marker 1/Marker 2/Marker 3/Marker 4

Indicates the detected characteristic values as determined by the TOI measurement (see [Chapter 3.11.3, "TOI results"](#), on page 153).

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 593

[CALCulate<n>:DELTaMarker<m>:X](#) on page 591

[CALCulate<n>:DELTaMarker<m>:X:RELative?](#) on page 607

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 490

3.11.5 How to determine the third order intercept



The precise TOI for the R&S EPL1000 in relation to the input signals is provided in the data sheet.

For remote operation, see [Chapter 6.7.12.2, "Programming example: measuring the TOI"](#), on page 491.

1. Apply a two-tone signal with equal carrier levels to the R&S EPL1000 input.
2. On the R&S EPL1000, press [MEAS].

3. Select the "Third Order Intercept" measurement function from the "Select Measurement" dialog box.

The calculated TOI is indicated in the marker information. The markers required for calculation are displayed in the marker table.

4. If the signal changes significantly during or after the TOI measurement, use the "Search Signals" function to start a new signal search automatically and restart the calculation of the TOI.

3.12 AM modulation depth measurement

This measurement determines the AM modulation depth of an AM-modulated carrier.

- [About the measurement](#)..... 156
- [AM modulation depth results](#)..... 156
- [AM modulation depth configuration](#)..... 157
- [Optimizing and troubleshooting the measurement](#)..... 158
- [How to determine the AM modulation depth](#)..... 159

3.12.1 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.

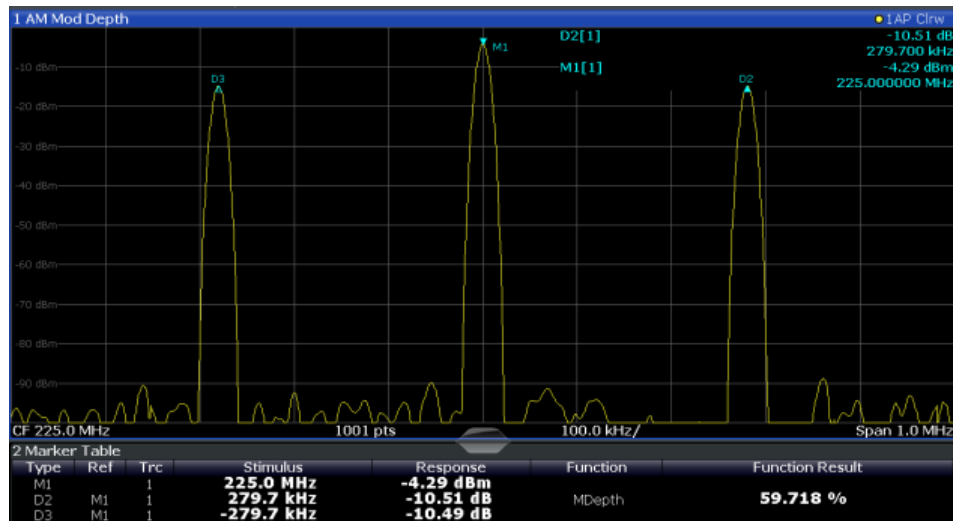
The R&S EPL1000 calculates the power at the marker positions from the measured levels. The AM modulation depth is calculated as the ratio between the power values at the reference marker and at the delta markers. If the powers of the two AM side bands are unequal, the mean value of the two power values is used for AM modulation depth calculation.

3.12.2 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:

AM modulation depth measurement

Label	Description
MDepth	AM modulation depth in percent
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

**Remote command:**

The AM modulation depth can also be queried using the remote command `CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult<t>?` on page 491.

3.12.3 AM modulation depth configuration

Access: "Overview" > "Select Measurement" > "AM Modulation Depth" > "AM Mod Depth Config"

AM Modulation Depth X

Marker 1	2.634 GHz
Marker 2	5.281 GHz
Marker 3	0.0 Hz

Search Signals

The remote commands required to perform these tasks are described in [Chapter 6.7.13, "AM modulation depth"](#), on page 491.

Marker 1/Marker 2/Marker 3	158
Search Signals	158

Marker 1/Marker 2/Marker 3

Indicates the detected characteristic values as determined by the AM Modulation Depth measurement:

Marker	Description
M1	Maximum of the signal (= carrier level)
D2	Offset of next peak to the right of the carrier
D3	Offset of the next peak to the left of the carrier

The marker positions can be edited; the modulation depth is then recalculated according to the new marker values.

To reset all marker positions automatically, use the [Search Signals](#) function.

Note: Moving the marker positions manually. When the position of delta marker 2 is changed, delta marker 3 is moved symmetrically with respect to the reference marker 1.

Delta marker 3, on the other hand, can be moved for fine adjustment independently of marker 2.

Marker 1 can also be moved manually for re-adjustment without affecting the position of the delta markers.

Remote command:

[CALCulate<n>:MARKer<m>:X](#) on page 593

[CALCulate<n>:DELTAmarker<m>:X](#) on page 591

[CALCulate<n>:DELTAmarker<m>:X:RELative?](#) on page 607

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 492

3.12.4 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.

3.12.5 How to determine the AM modulation depth

The following step-by-step instructions demonstrate how to determine the AM modulation depth.



For remote operation, see [Chapter 6.7.13.2, "Example: measuring the AM modulation depth"](#), on page 492.

1. Apply a modulated carrier signal to the R&S EPL1000 input.
2. On the R&S EPL1000, press [MEAS].
3. Select the "AM Modulation Depth" measurement function from the "Select Measurement" dialog box.

The calculated AM Modulation Depth is indicated in the marker information. The markers required for calculation are displayed in the marker table.

4. If the signal changes significantly during or after the AM Modulation Depth measurement, use the "Search Signals" function to start a new peak search automatically and restart the calculation of the AM Modulation Depth.

3.13 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
- [About the EMI measurement](#)..... 160
- [EMI measurement results](#)..... 160
- [EMI measurement basics](#)..... 162
- [EMI measurement configuration](#)..... 168

- [EMI result analysis](#)..... 177
- [How to perform EMI measurements](#)..... 178
- [Measurement example: measuring radio frequency interference](#)..... 180
- [Optimizing and troubleshooting EMI measurements](#)..... 182

3.13.1 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 can lead to very long measurement times.

Splitting the measurement procedure into several stages, however, can eliminate this problem.

The first stage is a peak search, used to get a rough idea about the location of peak levels that can indicate interference over the required frequency range. This stage uses a detector that allows for a fast sweep time, e.g. the peak detector.

During the second stage, or final test, the R&S EPL1000 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 EPL1000 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.

After the final measurement, you can check the signal levels against specified limits.

3.13.2 EMI measurement results

As the result of an EMI measurement, the measured signal levels and active markers are displayed in a Spectrum diagram.

Electromagnetic interference (EMI) measurement

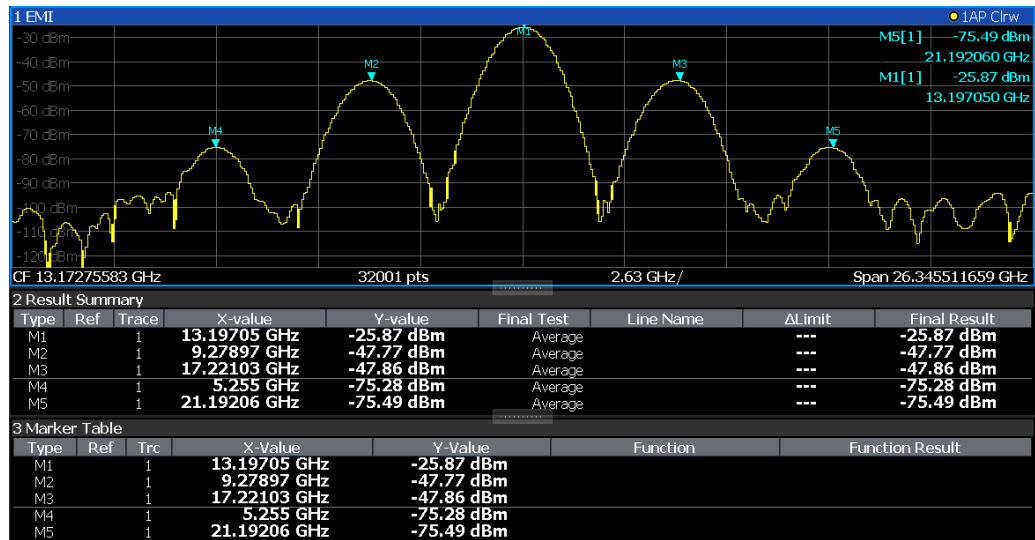


Figure 3-39: EMI measurement results

Initial peak search results - Marker Table

As a result of the initial peak search, the active markers are set to the positive peaks of the measured signal.

If **auto peak search** and **limit lines** are active, the active markers are set to the peak *delta* values between the measured signal and the limit lines.

The active marker levels and positions are displayed in the **Marker Table**.



The marker results are also displayed in the Result Summary; in addition, the Marker Table contains the marker results for those markers for which no final EMI test is performed.

Final test results - Result Summary

The results of the final EMI tests at the active marker frequencies are displayed in the **Result Summary**.

The Result Summary provides the following information:

Label	Description
Type	Marker name
Ref	Reference marker for delta markers
Trace	Assigned trace
X-value	Marker x-value (frequency for final test)
Y-value	Marker y-value (level during initial measurement)
Final Test	Detector used for final EMI test
Line name	Line activated for limit check

Label	Description
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

3.13.3 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](#)..... 162
- [Detectors and dwell time](#)..... 163
- [Frequency resolution - sweep points and scaling](#)..... 164
- [Controlling V-Networks \(LISN\)](#)..... 165
- [Using transducer factors](#)..... 166
- [Initial measurement - peak search](#)..... 166
- [Final measurement at the marker position](#)..... 167
- [Limit checks](#)..... 168

3.13.3.1 Resolution bandwidth and filter types

EMI testing requires resolution filters with a 6 dB bandwidth. The EMI measurement adds the following bandwidths, which comply to commercial and military standards, to those already available with the base unit:

Commercial (CISPR, FFC etc.)

- 200 Hz
- 9 kHz
- 120 kHz
- 1 MHz (not with quasi-peak detector, see "[Quasi-peak detector \(CISPR filter only\)](#)" on page 164)

Military (MIL Std)

- 10 Hz
- 100 Hz
- 1 kHz
- 10 kHz
- 100 kHz
- 1 MHz

If you select a CISPR or MIL filter type, the corresponding RBW that is closest to the currently selected RBW value is used. In this case, the channel setup bar indicates "RBW (CISPR)".

For the quasi-peak, CISPR Average, or RMS Average detector, the bandwidth is fixed depending on the frequency. For more information, see [Chapter 3.13.3.2, "Detectors and dwell time"](#), on page 163.

3.13.3.2 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.

See:

- ["Quasipeak detector"](#) on page 274
- ["CISPR average detector"](#) on page 275
- ["RMS average detector"](#) on page 275

The detector to be used for the initial peak search is configured in the trace settings (see [Chapter 5.3.2.1, "Trace settings"](#), on page 290). The detector for the final test is configured in the EMI marker settings, see [Chapter 3.13.4.1, "EMI marker configuration"](#), on page 169.



Restrictions for the R&S EPL1000 using CISPR detectors

Using the CISPR filter, specific detectors (Quasipeak, CISPR Average, RMS Average) are available for EMI measurements. However, if any of the CISPR detectors are used as trace detectors, the following detectors cannot be used as trace detectors for other traces in the same display:

- Negative peak
- Auto peak
- Sample

If you select a CISPR detector for a trace, any traces using incompatible detectors are automatically set to "Auto detector", which uses the positive peak detector.

If you manually set a trace to use an incompatible detector, any traces currently using a CISPR detector are automatically set to "Auto detector".

CISPR detectors are only available under the following conditions:

- Time domain measurements and frequency measurements in sweep mode (not FFT mode, not power measurements, emission measurements, or statistics measurements)
- Trigger mode "Free Run" or "External" (trigger offset ≥ 0 only for "External")
- Gate mode: "Off"

Dwell time

EMC tests often require a specific *dwell time* for an EMI measurement. The dwell time defines how long the R&S EPL1000 measures the signal at the individual frequencies. Each detector needs a different period of time to fully charge and discharge. For details on defining the dwell time for an EMI measurement, see ["Defining a dwell time for the final measurement"](#) on page 168.

RMS detector

The RMS detector displays the root mean square (RMS) value over the specified dwell time. The integration time is the specified dwell time.

See "[RMS detector](#)" on page 272

Sample detector

The sample detector displays the last value from the samples allocated to a pixel.

The sample detector is used for noise or phase noise marker calculation. However, it is unreliable if the displayed span is much greater than the resolution bandwidth or if the tuning steps of the local oscillator are too large. The sample detector is not recommended for EMI tests.

See "[Sample detector](#)" on page 274

Quasi-peak detector (CISPR filter only)

See "[Quasipeak detector](#)" on page 274

CISPR Average detector (CISPR filter only)

See "[CISPR average detector](#)" on page 275

RMS Average detector (CISPR filter only)

See "[RMS average detector](#)" on page 275

**Required sweep time in FFT mode**

In FFT mode, the sweep time is divided among the required subspans. To ensure the required dwell time at each frequency, the sweep time must be at least:

$$\langle \text{sweep time} \rangle_{\min} = \langle \text{required_dwell_time} \rangle * \langle \text{number_of_FFT_subspans} \rangle$$

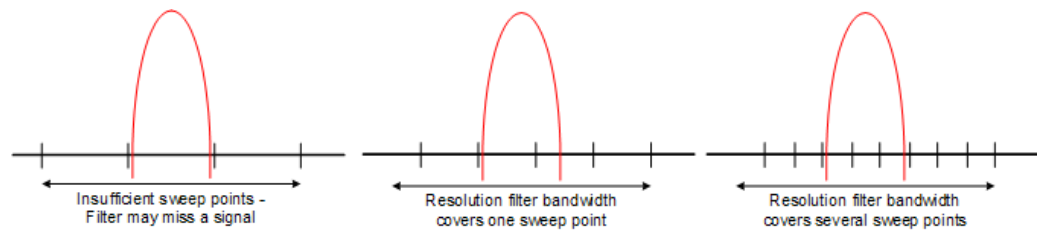
To ensure that the signal within a single subspan is always captured without a gap, the maximum sweep time is restricted.

The number of FFT subspans is indicated in the "Sweep" settings, see "[FFT Subspans](#)" on page 237. It is also returned for the `[SENSe:]SWEep:FFTSubspan?` query.

3.13.3.3 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, be sure to define an adequate number of sweep points, especially when performing the measurement on a logarithmic axis. As on a linear axis, the distance from one sweep point to the next is calculated graphically on a logarithmic axis, and is not based on the frequency itself. Thus, the frequency resolution between two sweep points deteriorates with higher frequencies.

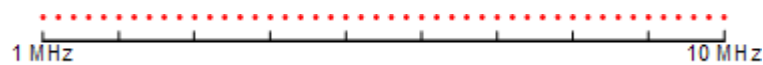


The resolution bandwidth should cover at least one sweep point (more is better). If this condition is not met, signals or interferences can be missed during refined measurement of narrowband interferers. If the distance between two sweep points is larger than $RBW/2$, a warning is displayed in the status bar ("Increase Sweep Points"). If possible for the selected RBW and span, the minimum required number of sweep points to fulfill this condition is indicated. If the number of sweep points exceeds the limit, reduce the span or increase the RBW.

The R&S EPL1000 supports a maximum of 200001 sweep points for EMI measurements.

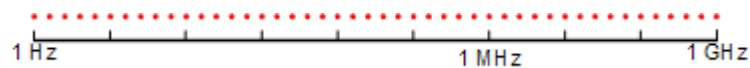
Example:

Linear axis:



With a linear axis, the distance between the sweep points is equal, e.g. 200 kHz.

Logarithmic axis:



With a logarithmic axis, the distance between sweep points is variable. In the spectrum from 10 Hz to 100 Hz, the distance is a few Hz. Between 100 MHz and 1 GHz, the distance is several MHz.

This number is based on typical bands measured with a single resolution bandwidth. There are sufficient sweep points to make sure that a signal is found during the refined measurement, even when covering 30 MHz to 1 GHz with logarithmic scaling and 120 kHz RBW.

3.13.3.4 Controlling V-Networks (LISN)

For measurements on power lines, EMI measurement adds functionality to the R&S EPL1 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 EPL1000. Control cables for the various LISNs are available as accessories. The R&S EPL1000 then controls which phase of the LISN is to be tested and outputs the information to the user port.

The EMI measurement supports several V-networks. For each type of network, you can define the phase you want to test for interferences. The EMI measurement allows you to test one phase at a time.

Table 3-15: Supported networks and phases

Network type	Phases
Two-line V-networks	
ESH3-Z5	N, L1
ENV216 / AMN6500	N, L1
Four-line V-networks	
ESH2-Z5	N, L1, L2, L3
ENV4200	N, L1, L2, L3
ENV432	N, L1, L2, L3

For the ENV216 / AMN6500 network, a 150 kHz highpass filter is available to protect the input of the R&S EPL1000.

3.13.3.5 Using transducer factors

The R&S EPL1000 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 EPL1000 to measure interferences or wanted signals. The transducer converts the measured value such as field strength, current or RFI voltage into a voltage across 50 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.

For more information about transducer factors, see the user manual of the R&S EPL1000.

3.13.3.6 Initial measurement - peak search

The purpose of an initial peak search is to find signals with a high interference level quickly. The peak search is performed with a fast detector like the peak or average detector. The initial peak search is the basis for a possible refined measurement of interferences with the detectors specific to EMI measurements.

The results of the initial peak search are shown in the Marker Table (see [Chapter 3.13.2, "EMI measurement results"](#), on page 160).

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 EPL1000 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 EPL1000 allows you to distribute markers among several traces. If you do so, the marker with the lowest number assigned to a particular trace is positioned on the largest peak of the corresponding trace.

Manual peak search

If automatic peak search is off, you can set the markers to any frequency you need more information about manually. You can change the marker position with the rotary knob or the cursors, or position it to a particular frequency with the numbers.

Setting markers is the same as setting markers in other spectrum measurements. For more information, see [Chapter 5.4.2, "Marker settings"](#), on page 320.

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 EPL1000 searches for peaks on all traces separately, if you have assigned at least one marker to each trace.

A typical selection for EMI measurement is to use the peak and the average detector. After initial measurement, search for peaks on the peak trace and the average trace separately. Thus, you can consider the distribution of narrowband and wideband sources of interference.

Example:

- In the initial measurement, determine the peak on one trace using the average detector by assigning a marker to that trace. For the marker frequency, perform a refined measurement using the CISPR or RMS average detector.
- In the initial measurement, determine the peak on another trace using the peak detector by assigning another marker to that trace. For this marker frequency, perform a refined measurement using the quasi-peak detector.

3.13.3.7 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 EPL1 EMI measurement performs the final measurement automatically as soon as a detector for the final test is defined for an EMI marker and the marker is activated. The final measurement starts immediately after the marker has been set. The advantage of an immediate final measurement is that it eliminates the risk of measurement errors based on frequency drifts of the disturbance signal.

The final measurement at the marker frequency can have a different detector than during the initial peak search. Thus, the final measurement consumes much less time because detectors with a long measurement time are needed only at the critical frequency.

The R&S EPL1 EMI measurement also allows you to use multiple detectors for the final measurement. The advantage of multiple detections is that you only need one test run to see if the results comply with the limits specified in a standard. The detectors for the final EMI tests are defined in the marker configuration, as opposed to the *trace* detector which is used for the initial peak search.

The results of the final measurement are shown in the Result Summary (see [Chapter 3.13.2, "EMI measurement results"](#), on page 160).

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 EPL1000 measures the signal at the frequencies of the marker positions. The dwell time is identical for all EMI final measurements and is thus defined in the EMI measurement configuration. Select a dwell time according to the characteristics of the measured signal. See also [Chapter 3.13.3.2, "Detectors and dwell time"](#), on page 163.

3.13.3.8 Limit checks

General limit line functionality is provided by the R&S EPL1000 base unit. The base unit also provides various predefined limit lines that you can use for various applications.

When using limit lines in combination with EMI measurements, the marker levels from the initial measurement are compared to the limit line values. The result of the limit line check is displayed in the diagram as usual.

In the EMI Result Summary, the limit check is based on the results of the final test. Since the marker can be determined using a different detector than the final test results, the two limit check results can differ. The difference between the limit line and the measured value is colored to indicate the following states:

- **green:** does not exceed limit
- **yellow:** within margin
- **red:** exceeds limit

For more information on using limit lines, see [Chapter 5.5.2.1, "Basics on limit lines"](#), on page 357.

3.13.4 EMI measurement configuration

Access: "Overview" > "Select Measurement" > "EMI" > "EMI Config"

On the R&S EPL1000, EMI measurement configuration consists of the following settings.

In addition, some common settings are also relevant for EMI measurements:

- [Chapter 5.5.2.2, "Limit line settings and functions"](#), on page 361
- [EMI marker configuration](#)..... 169
- [EMI final measurement configuration](#)..... 172
- [LISN control settings](#)..... 176

3.13.4.1 EMI marker configuration

Access: [MKR] > "Marker Config"

The final peak search for the EMI measurement is defined by the marker configuration.

Markers		Marker Settings		Search	Marker Functions				
	Selected	State	X-Value	Type	Ref Marker	Link to Marker	Trace	Final Test Detector	
1-5	Marker 1	On Off	3.75 GHz	Norm Delta	▼	Off ▼	1 ▼	Off ▼	
6-11	Delta 1	On Off	-750.0 MHz	Norm Delta	1	Off ▼	1 ▼	Off ▼	
	Delta 2	On Off	-750.0 MHz	Norm Delta	1	Off ▼	1 ▼	Off ▼	
12-16	Delta 3	On Off	-750.0 MHz	Norm Delta	1	Off ▼	1 ▼	Off ▼	
	Delta 4	On Off	-750.0 MHz	Norm Delta	1	Off ▼	1 ▼	Off ▼	
	Delta 5	On Off	-750.0 MHz	Norm Delta	1	Off ▼	1 ▼	Off ▼	
All Markers Off									

Selected Marker	169
Marker State	169
Marker Position X-value	170
Marker Type	170
Reference Marker	170
Linking to Another Marker	170
Assigning the Marker to a Trace	171
Final Test Detector	171
Select Marker	172

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 592

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 590

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 593

[CALCulate<n>:DELTAmarker<m>:X](#) on page 591

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 592

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 590

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 325), the reference point ("FXD") can also be selected instead of another marker.

Remote command:

[CALCulate<n>:DELTAmarker<m>:MREference](#) on page 590

Linking to Another Marker

Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:

[CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>](#) on page 592

[CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>](#) on page 589

[CALCulate<n>:DELTamarker<m>:LINK](#) on page 588

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 593

Final Test Detector

Defines the detector to be used for the final EMI test at the marker frequency.

For details, see [Chapter 3.13.3.2, "Detectors and dwell time"](#), on page 163.

Note: The trace detector configured in the trace settings is used for the initial peak search only, see [Chapter 5.3.2.1, "Trace settings"](#), on page 290.

"Off"	No final test is performed.
"PositivePeak"	Determines the maximum signal level that was detected during the specified dwell time.
"Average"	Determines the average signal level of the samples that were collected during the specified dwell time.
"Quasi-Peak"	Determines the maximum signal level weighted to CISPR 16-1-1 that was detected during the dwell time. The "Quasi-Peak" detector is only available for the CISPR filter, and not for an RBW of 1 MHz.
"CISPR Average"	Determines a weighted average signal level according to CISPR 16-1-1. 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). Lowpass filters of the second order determine the average value (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 503

[CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:DETECTOR](#) on page 503

Select Marker

The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.



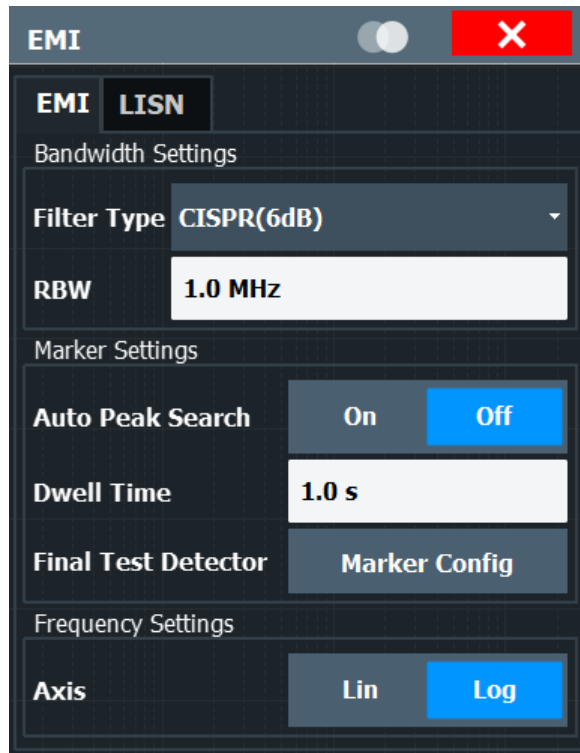
Remote command:

[CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 592

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 590

3.13.4.2 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 171.

Filter Type	173
RBW	174
Automatic Peak Search	174
Dwell Time	174
Final Test Detector	174
Frequency Axis Scaling	175
Res BW CISPR	175
Res BW MIL	176

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

For more information, see [Chapter 4.5.1.6, "Which data may pass: filter types"](#), on page 229.

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 543

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 a list of supported filters, see the data sheet.

For more information see [Chapter 4.5.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 226.

Note: Restrictions.

- For EMI measurements using the quasipeak detector, the 1 MHz RBW filter is not available (see [Chapter 3.13.3.1, "Resolution bandwidth and filter types"](#), on page 162).

Remote command:

`[SENSe:]BANDwidth[:RESolution]` on page 543

`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 542

Automatic Peak Search

If activated, a peak search is performed automatically for all active markers after each sweep.

If Auto peak search *and* limit lines are active, the active markers are set to the peak *delta* values between the measured signal and the limit lines.

Note: The general search functions [Auto Max Peak Search / Auto Min Peak Search](#) are not available for EMI measurements.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:PEAKsearch:AUTO`
on page 634

Dwell Time

Sets the dwell time for the EMI marker measurement.

For more information see [Chapter 3.13.3.2, "Detectors and dwell time"](#), on page 163.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DWELL` on page 504

Final Test Detector

Defines the detector to be used for the final EMI test at the marker frequency.

For details, see [Chapter 3.13.3.2, "Detectors and dwell time"](#), on page 163.

Note: The trace detector configured in the trace settings is used for the initial peak search only, see [Chapter 5.3.2.1, "Trace settings"](#), on page 290.

"Off" No final test is performed.

"PositivePeak"	Determines the maximum signal level that was detected during the specified dwell time.
"Average"	Determines the average signal level of the samples that were collected during the specified dwell time.
"Quasi-Peak"	Determines the maximum signal level weighted to CISPR 16-1-1 that was detected during the dwell time. The "Quasi-Peak" detector is only available for the CISPR filter, and not for an RBW of 1 MHz.
"CISPR Average"	Determines a weighted average signal level according to CISPR 16-1-1. 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). Lowpass filters of the second order determine the average value (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 503

[CALCulate<n>:DELTAmarker<m>:FUNCTION:FMEasurement:DETECTOR](#) on page 503

Frequency Axis Scaling

Switches between linear and logarithmic scaling for the frequency axis.

Logarithmic scaling is only available for $f_{\text{stop}} \geq 1.4 * f_{\text{start}}$.

By default, the frequency axis has linear scaling. Logarithmic scaling of the frequency axis, however, is common for measurements over large frequency ranges as it enhances the resolution of the lower frequencies. On the other hand, high frequencies get more crowded and become harder to distinguish.

For more information see [Chapter 4.3.1.3, "Coping with large frequency ranges - logarithmic scaling"](#), on page 209.

Remote command:

[DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:X:SPACing](#) on page 571

Res BW CISPR

Automatically sets the measurement bandwidth for commercial EMC standards according to CISPR.

For more information, see [Chapter 3.13.3.1, "Resolution bandwidth and filter types"](#), on page 162.

Remote command:

Filter type:

[\[SENSe:\]BANDwidth\[:RESolution\]:TYPE](#) on page 543

Filter bandwidth:

[SENSe:]BANDwidth[:RESolution] on page 543

Res BW MIL

Automatically sets the measurement bandwidth for military EMC standards.

For more information, see [Chapter 3.13.3.1, "Resolution bandwidth and filter types"](#), on page 162.

Remote command:

Filter type:

[SENSe:]BANDwidth[:RESolution]:TYPE on page 543

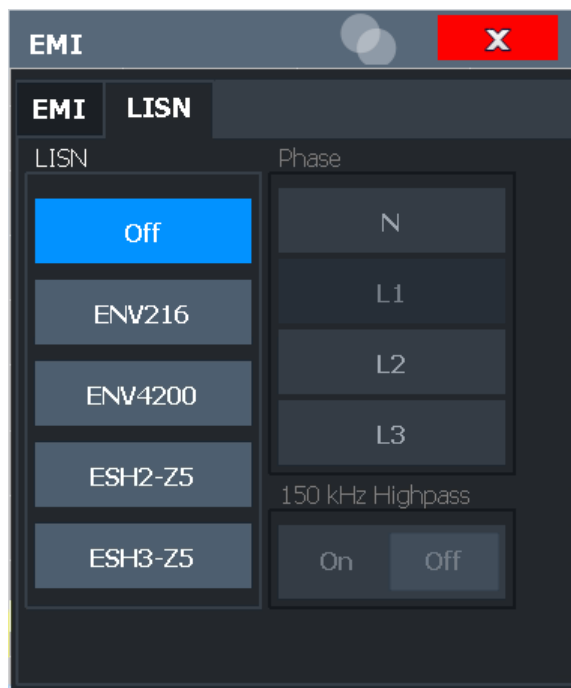
Filter bandwidth:

[SENSe:]BANDwidth[:RESolution] on page 543

3.13.4.3 LISN control settings

Access: [MEAS CONFIG] > "LISN Config"

For measurements with power lines, the following settings are available for the R&S EPL1000 to control which phase of the LISN is to be tested (e.g. for EMI measurements).



For more information, see [Chapter 3.13.3.4, "Controlling V-Networks \(LISN\)"](#), on page 165.

LISN Type	177
Phase	177
150 kHz Highpass	177

LISN Type

Selects the network type and activates output to the network via the user port of the R&S EPL1000. The network type determines the supported phases (see [Table 3-15](#)).

"Off" disables LISN control and output.

Remote command:

`INPut:LISN[:TYPE]` on page 506

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 505

150 kHz Highpass

Enables or disables the use of an additional 150 kHz highpass filter to protect the R&S EPL1000 LISN from excessive input.

The filter is available for the ENV 216 network only.

Remote command:

`INPut:LISN:FILTer:HPASs[:STATe]` on page 505

3.13.5 EMI result analysis

The EMI measurement provides functionality to analyze the results.

Marker demodulation

The R&S EPL1000 is able to demodulate AM and FM signals for acoustic tests and monitoring purposes.

When the demodulator function is active, the EMI measurement demodulates the signal continuously (regardless of the "Continuous Demodulation" setting in the marker function configuration). The demodulation begins as soon as a marker is activated. During the initial measurement, demodulation is performed for the entire measurement span; during the final measurement only the detected peak marker positions are demodulated (for the defined dwell time). You can listen to the results during the measurement using headphones or the internal speaker.

In FFT mode, demodulation is only performed during the final measurement. You do not hear any results during the initial measurement.

For more information, see [Chapter 5.4.4.7, "Demodulating marker values and providing audio output \(marker demodulation\)"](#), on page 345.

Limit lines

General limit line functionality is provided by the R&S EPL1000 base unit. The base unit also provides various predefined limit lines that you can use for various applications.

Limit line configuration is described in [Chapter 5.5.2.2, "Limit line settings and functions"](#), on page 361.

Test reports

The R&S EPL1000 features a test report generator. A test report is a document that summarizes the results and configuration of measurements.

Test reports are based on a general template, and are completed with user-defined, measurement-specific contents. You can create multiple templates for different applications.

3.13.6 How to perform EMI measurements

The following step-by-step instructions demonstrate how to perform an EMI measurement with the R&S EPL1000.



For remote operation, see [Chapter 6.7.17, "Programming example: EMI measurement"](#), on page 510.

1. Select [MODE] on the front panel and select the "Spectrum" application.
2. Define the frequency range of the EMI measurement.
 - a) Select [FREQ] and then the "Frequency Config".
 - b) Define the start and stop frequency.
3. Configure the traces for the initial EMI measurement.
 - a) Select [TRACE].
 - b) Select the "Trace Config" to configure as many traces as required.
4. Select [MEAS] on the front panel and select the "EMI" measurement.
The EMI main menu is displayed.
5. Select the "EMI Config".
6. Define the resolution bandwidth and filter type to be used for the measurement.
By default, the R&S EPL1000 uses a filter with a 3-dB bandwidth. EMI measurements usually require a filter with a 6 dB bandwidth.
7. Define the dwell time for which each marker position is measured during the final measurement.
8. To obtain an overview of peak values in the input signal during the initial measurement, activate the "Auto Peak Search".

As soon as a sweep is started, the R&S EPL1000 looks for the strongest peaks in the frequency range you are measuring and positions one of the active markers on those peaks. The number of active markers determines the number of detected peaks; no additional markers are activated.

9. Define the type of scaling for the frequency axis according to the definition of the limit lines in the standard.
10. Optionally, select the "LISN Config" to configure a LISN control.
11. Configure the EMI measurement markers.
 - a) Select "Marker Config".
 - b) Activate the number of markers or delta markers you want to analyze.
 - c) For each active marker, select a detector to be used for the "Final Test", that is: the subsequent EMI measurement at the marker position.
 - d) If you already know which frequencies cause irregular values, set the markers to those positions. (Otherwise perform an initial peak search to obtain an overview, see [step 8](#)).
12. Optionally, select the "Marker Demod Config" to configure continuous marker demodulation.

Demodulation begins immediately with the next measurement. During the initial measurement, demodulation is performed for the entire measurement span; during the final measurement only the detected peak marker positions are demodulated (for the defined dwell time).

In FFT mode, demodulation is only performed during the final measurement. You do not hear any results during the initial measurement.
13. Increase the number of sweep points for the EMI measurement.
 - a) Select [SWEEP] on the front panel.
 - b) Select the "Sweep Config" .
 - c) Set the number of "Sweep Points" so that the distance between two sweep points is smaller than RBW/2.
14. Optionally, select or configure limit lines to check the marker results against.
 - a) Select [Lines] and then the "Lines Config" , then select the "Lines Config" tab.
 - b) In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".

All limit lines that comply with the following conditions are displayed in the overview:

 - Stored in the `limits` subfolder of the main installation folder of the instrument
 - File extension `.LIN`
 - Compatible to the current EMI measurement settings
 - c) Select the "Check Traces" setting for a limit line in the overview.
 - d) Select the trace numbers to be included in the limit check. You can assign the same limit line to several traces.
15. The default unit dBm is not suitable for EMI measurements. Define a suitable unit for the measured values, or select a transducer.

To change the unit:
Select [AMPT] > "Amplitude Config" > "Unit".

To select a transducer:

- a) Select [SETUP].
 - b) Select "Transducer".
 - c) In the "Transducer" dialog box, set the "View Filter" to "Show Compatible" to determine the available transducers for the current EMI measurement setup.
 - d) In the overview, select the "Active" setting for a transducer line.
16. Select [RUN SINGLE] to start a new EMI measurement.

If activated, a peak search is performed. For each active marker, a final measurement is performed using the specified detector for the specified dwell time. If activated, the signal is demodulated at the active marker positions.

The specified traces to be checked are compared with the active limit lines. The status of the limit check for the final measurement is indicated in the Result Summary.

3.13.7 Measurement example: measuring radio frequency interference

A common measurement task that you can do with the EMI measurement is to detect radio frequency interference (RFI) or electromagnetic interferences (EMI).

The measurement shows signal levels over a particular frequency range. A typical frequency range for EMI measurements is 150 kHz to 1 GHz. Usually, the captured signal characteristics are unknown. Thus, the best way to start the measurement is to preset the R&S EPL1000 and perform a peak search to obtain a general overview.

If you perform measurements according to a particular EMI standard, a preset also eliminates the risk of wrong settings inherited from previous measurements. Note that EMI measurements are possible in the Spectrum application only.



A programming example demonstrating an EMI measurement in a remote environment is provided in [Chapter 6.7.17, "Programming example: EMI measurement"](#), on page 510.

Preparing the measurement

1. Select [PRESET] .
The R&S EPL1000 restores the default settings.
2. Define the frequency range of the measurement.
 - a) Select [FREQ] .
 - b) Select "Start Frequency".
 - c) Enter a frequency of *150 kHz*.
 - d) Select "Stop Frequency".
 - e) Enter a frequency of *1 GHz*.

The R&S EPL1000 scales the horizontal axis accordingly.
3. Select [MEAS] on the front panel and select the "EMI" measurement.
The EMI main menu is displayed.

4. Select the "EMI Config" .
5. Define the resolution bandwidth and filter type for the measurement.
By default, the R&S EPL1000 uses a filter with a 3-dB bandwidth. EMI measurements usually require a filter with a 6-dB bandwidth.
6. Define the dwell time for which each marker position is measured during the final measurement.
7. To obtain an overview of exceptional values in the input signal during the initial measurement, activate the "Auto Peak Search".
8. Select the measurement bandwidth.
 - a) Select the "Res BW CISPR" .
A CISPR (6 dB) filter is configured.
 - b) Set the bandwidth to *1 MHz*.

The R&S EPL1000 shows the currently selected resolution bandwidth in the diagram header.
9. Configure the traces for the initial EMI measurement.
 - a) Select [TRACE] .
 - b) Select "Trace Config" to configure two traces.
 - c) Define the detectors to use for the initial measurement. Select the peak detector for trace 1 and the average detector for trace 2.
The peak detector ensures that the detected peak levels in the frequency range covered by one pixel are displayed.

The R&S EPL1000 now displays two traces. Trace 1 shows the peak values, trace 2 shows the average values.
10. Increase the number of sweep points for the EMI measurement.
 - a) Select [SWEEP] on the front panel.
 - b) Select the "Sweep Config" .
 - c) Set the number of "Sweep Points" to *200000*.
11. Select [AMPT] , then select the "Amplitude Config" and, in the "Amplitude" dialog box, select *V* as the "Unit".

Performing the measurement

1. Configure the EMI measurement markers. In this example, we use 6 markers.
 - a) Select the "Marker Config" .
 - b) Activate six normal markers.
 - c) Set markers 1 to 3 on trace 1. Set markers 4 to 6 on trace 2.
 - d) For each of these markers, select the "CISPR AV" detector to be used for the "Final Test", i.e. the subsequent EMI measurement at the marker positions.
2. Select a limit line to check the marker results against.
 - a) Select [Lines] and then the "Lines Config" , then select the "Lines Config" tab.

- b) In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".

All limit lines that comply with the following conditions are displayed in the overview:

- Stored in the `limits` subfolder of the main installation folder of the instrument
 - File extension `.LIN`
 - Compatible to the current EMI measurement settings
- c) In the overview, click the "Check Traces" setting for the `EN55011A` limit line.
- d) Select trace 1 to be included in the limit check. (Trace 2, which is defined as the average, is always lower than trace 1, which contains peak values.)

3. Select [RUN SINGLE] to start a new EMI measurement.

If activated, a peak search is performed. For each active marker, a final measurement is performed using the specified detector for the specified dwell time.

If activated, the signal is demodulated. During the initial measurement, demodulation is performed for the entire measurement span; during the final measurement only the detected peak marker positions are demodulated (for the defined dwell time).

The specified traces to be checked are compared with the active limit line. The status of the limit check for the final measurement is indicated in the Result Summary.

Evaluating the measurement

Check the Result Summary to detect exceeded limit values.

Zoom into the diagram at the conspicuous frequency for more details.

If necessary, decrease the span to the area in which irregular values occurred and repeat the measurement.

3.13.8 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 interferers. See [Chapter 3.13.3.3, "Frequency resolution - sweep points and scaling"](#), on page 164.

If the distance between two sweep points is larger than $RBW/2$, a warning is displayed in the status bar ("Increase Sweep Points" or "RBW").

Dwell time

Consider the following when defining the dwell time:

- **Unknown signals:** select a dwell time of at least 1 second to ensure that pulses down to a frequency of 5 Hz are weighted correctly
- **Pulsed signals or signals that fluctuate slowly:** the dwell time must cover at least the time until the first signal peak is measured; can require long dwell time
- **Unmodulated signals or signals with a high modulation frequency:** the dwell time must cover at least the time until the first signal peak is measured; usually shorter than for pulsed signals

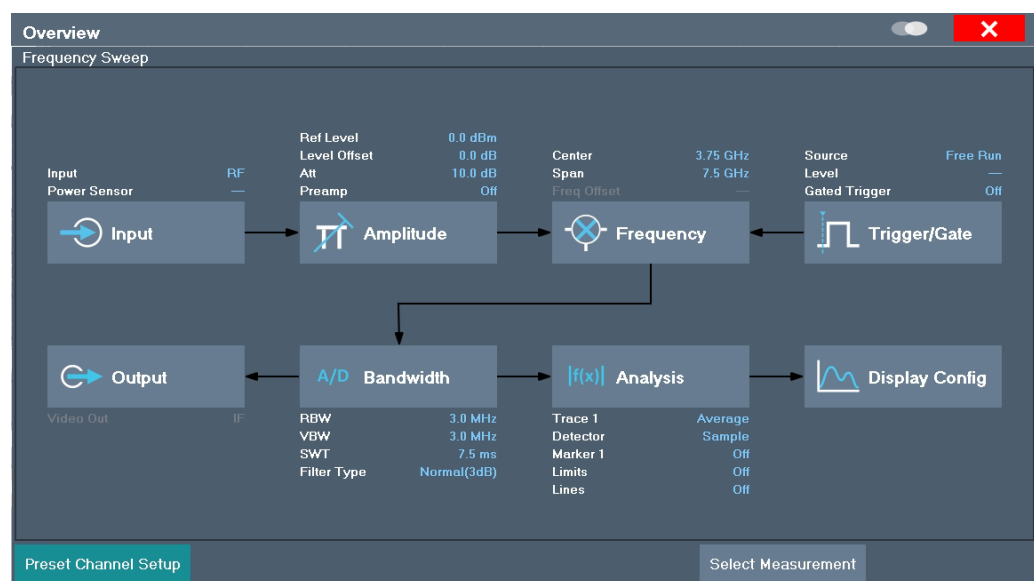
4 Configuration

4.1 Configuration overview



Access: all menus

Each channel setup provides an overview of the most important currently defined settings and access to the most important configuration dialog boxes for the particular measurement. This overview is available via the "Overview" icon, which is displayed in all menus.



Using this overview, you can easily configure an entire channel setup from input over processing to output and analysis by stepping through the dialog boxes as indicated.

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

1. "Select Measurement"
See [Chapter 3, "Measurements and results"](#), on page 11
2. Input
[Chapter 4.2, "Data input and output"](#), on page 185
3. Amplitude
[Chapter 4.4, "Amplitude and vertical axis configuration"](#), on page 215
4. Frequency
See [Chapter 4.3, "Frequency and span configuration"](#), on page 208
5. (Optionally:) Trigger/Gate
See [Chapter 4.6, "Trigger and gate configuration"](#), on page 239

6. Bandwidth
See [Chapter 4.5.2, "Bandwidth, filter and sweep settings"](#), on page 231
(For SEM measurements: SEM Setup, see [Chapter 3.6.5, "SEM configuration"](#), on page 84)
(For Spurious measurements: Spurious Setup, see [Chapter 3.7.4, "Spurious emissions measurement configuration"](#), on page 115)
7. (Optionally:) Outputs
See [Chapter 4.2.3, "Configuring outputs \(IF / video / demodulation\)"](#), on page 188
8. Analysis
See [Chapter 5, "Common analysis and display functions"](#), on page 255
9. Display
See [Chapter 5.1, "Result display configuration"](#), on page 255

To configure settings

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

Preset Channel setup

Select "Preset Channel" in the lower left-hand corner of the "Overview" to restore all measurement settings *in the current channel setup* to their default values.

Note: Do not confuse the "Preset Channel" button with the [Preset] key, which restores the entire instrument to its default values and thus closes *all channel setups* on the R&S EPL1000 (except for the default channel setup)!

Remote command:

`SYSTem:PRESet:CHANnel[:EXEC]` on page 391

4.2 Data input and output

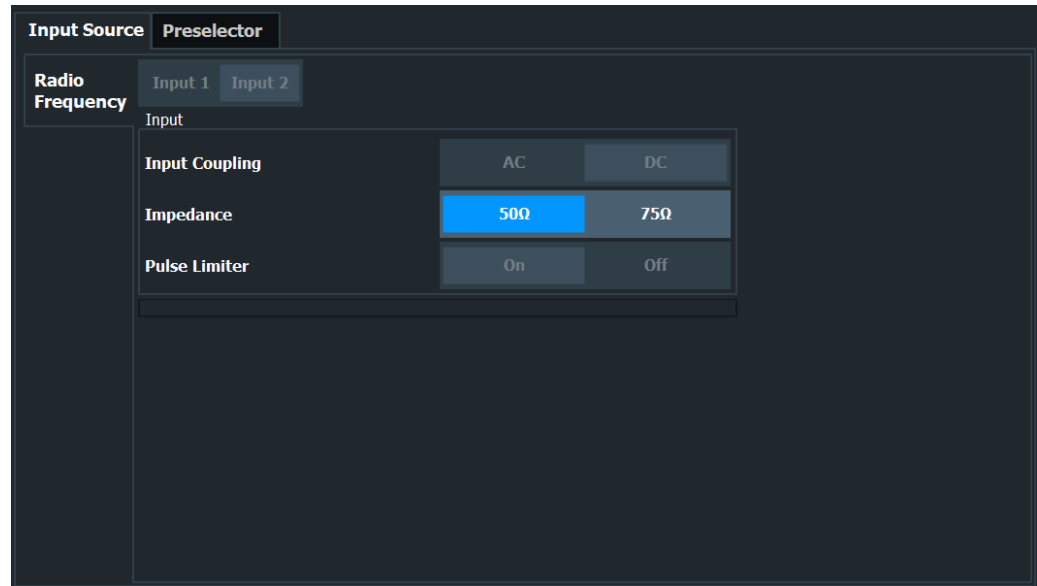
The R&S EPL1000 can analyze signals from different input sources and provide various types of output (such as video or trigger signals).

- [Configuring the input](#)..... 185
- [Configuring the preselector](#)..... 187
- [Configuring outputs \(IF / video / demodulation\)](#)..... 188
- [Configuring LISNs](#)..... 191
- [Configuring additional outputs](#)..... 191
- [Internal generator](#)..... 192

4.2.1 Configuring the input

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

The default input source for the R&S EPL1000 is "Radio Frequency", i.e. the signal at the [RF Input] connector on the front panel of the R&S EPL1000. In the Receiver application, this is the only available input source.



Input Coupling.....	186
Impedance.....	186
Pulse Limiter.....	187

Input Coupling

The RF input is coupled by direct current (DC).

Make sure to protect the instrument from damaging DC input voltages. For details, refer to the data sheet.

Remote command:

n/a

Impedance

For some measurements, the reference impedance for the measured levels of the R&S EPL1000 can be set to 50 Ω or 75 Ω.

For GSM and Avionics measurements, the impedance is always 50 Ω and cannot be changed.

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

This value also affects the unit conversion.

Remote command:

[INPut<ip>:IMPedance](#) on page 517

Pulse Limiter

The pulse limiter is a protection mechanism against high level pulses or signals (which can damage the input mixer).

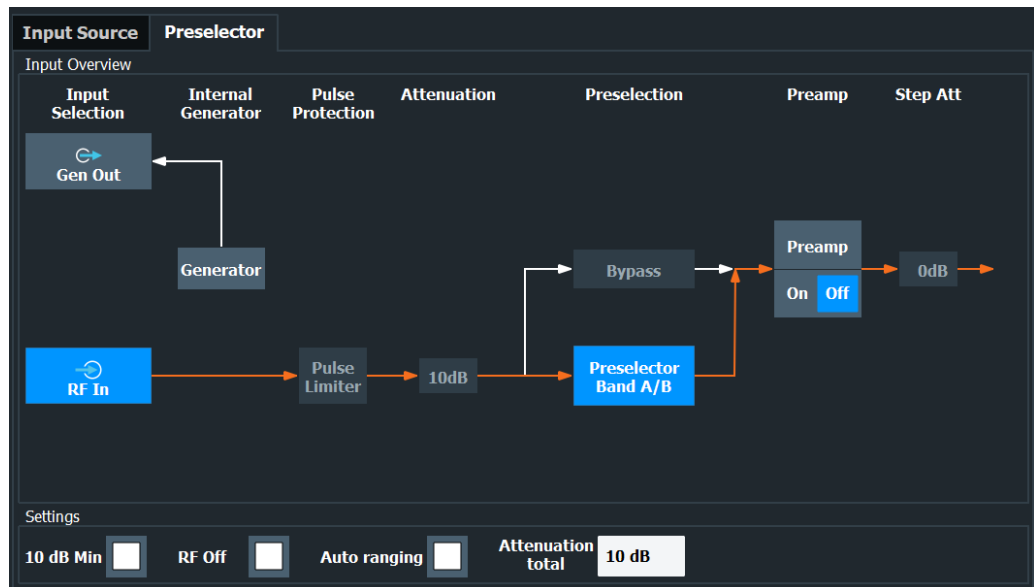
The pulse limiter is always on. However, it works only if the attenuation is at least 10 dB. The pulse limiter has no effect for attenuation smaller than 10 dB.

Remote command:
n/a

4.2.2 Configuring the preselector

Access: "Overview" > "Input" > "Preselector"

Preselector settings allow you to configure the signal path up to the input mixer, especially the preselector characteristics.



The orange arrow in the dialog box represents the current signal path. Grey arrows represent other possible signal paths.

Functions of the "Preselector" dialog box described elsewhere:

- [Generator state](#)
The generator block in the diagram turns blue to indicate that the generator is on.
- ["Pulse Limiter"](#) on page 187
- ["Attenuation"](#) on page 223
The preselector dialog indicates how the total attenuation is distributed over the individual attenuators (attenuator and step attenuator).
- ["Preamplifier"](#) on page 223
- ["10 dB Minimum Attenuation"](#) on page 222

[Generator](#)..... 188
[RF Off](#)..... 188
[Preselection filter](#)..... 188

Generator

Turns the internal generator on and off.

For details, see [Chapter 4.2.6, "Internal generator"](#), on page 192.

Remote command:

`OUTPut [:STATe]` on page 526

RF Off

Turns off the RF input. The R&S EPL1000 no longer processes signals if you turn off the RF input. You can also no longer configure the signal path.

Preselection filter

Selects the filter of the preselector.

In the receiver application, the preselection filter is always "Preselector Band A/B". The filter characteristics correspond to CISPR band A (9 kHz to 15 MHz) and CISPR band b (15 MHz to 30 MHz).

In other applications, you can bypass the filter.

An orange arrow in the diagram represents the path you have selected.

Remote command:

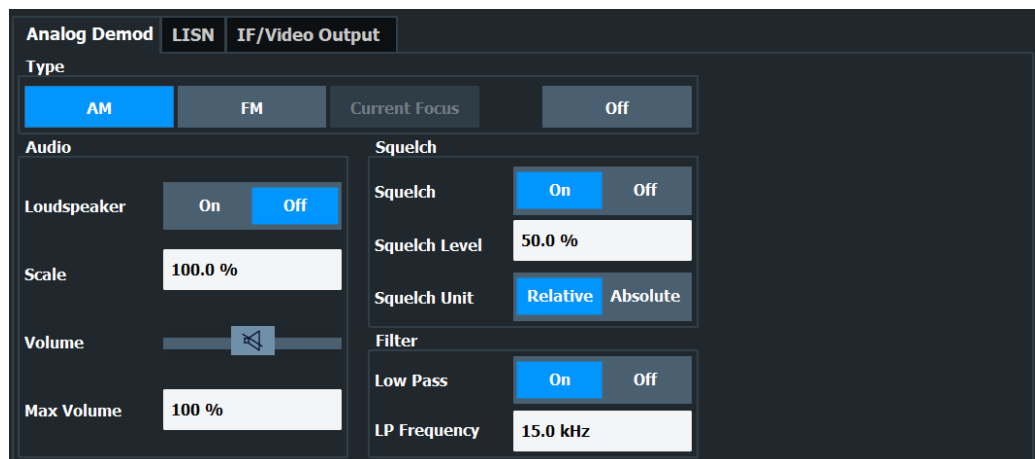
`INPut<ip>:PRESelection:BYPass` on page 518

4.2.3 Configuring outputs (IF / video / demodulation)

Access: "Overview" > "Output" > "Output Config"

The R&S EPL1000 provides several outputs. The R&S EPL1000 allows you to configure the output as required.

For details on the connectors refer to the R&S EPL1000 getting started manual, chapter "Instrument Tour".



The remote commands required to configure the outputs are described in [Chapter 6.8.1.4, "Output configuration \(analog demodulation\)"](#), on page 518.

Selecting the output type.....	189
L Configuring the output of the IF signal.....	189
L Configuring the output of the Video signal.....	189
L Configuring the output of an AM signal.....	189
L Configuring the output of an FM signal.....	190
Controlling and configuring the output.....	190
L IF Output Frequency.....	190
L Low Pass.....	190
L Loudspeaker.....	190
L Squelch.....	190
L Scale.....	191
Controlling the volume.....	191

Selecting the output type

Selects the type of analog signal you want to output.

In the spectrum application, selecting output types is only possible for zero span measurements.

"IF Output"	Outputs the IF signal (see "Configuring the output of the IF signal" on page 189 for available settings). Access: "Output" > "IF / Video Output"
"Video"	Outputs the video signal (see "Configuring the output of the Video signal" on page 189 for available settings). Access: "Output" > "IF / Video Output"
"AM"	Outputs the AM demodulated signal (see "Configuring the output of an AM signal" on page 189 for available settings). Access: "Output" > "Analog Demod"
"FM"	Outputs the FM demodulated signal (see "Configuring the output of an FM signal" on page 190 for available settings). Access: "Output" > "Analog Demod"
"Current Focus"	Outputs the data of the currently selected measurement window (highlighted with a blue frame). Available in the Analog Modulation Analysis application.
"Off"	Turns off the output. Note that you can only turn off audio output (AM / FM). One of either IF or video output is always on.

Remote command:

`OUTPut<ou>: IF[:SOURce]` on page 520

Configuring the output of the IF signal ← Selecting the output type

For the output of the IF signal, you can adjust the following parameters.

- ["IF Output Frequency"](#) on page 190

Configuring the output of the Video signal ← Selecting the output type

Additional settings for video signal output are not supported.

Configuring the output of an AM signal ← Selecting the output type

For the output of AM demodulated signals, you can adjust the following parameters.

- ["Scale"](#) on page 191
- ["Low Pass"](#) on page 190
- ["Loudspeaker"](#) on page 190

Configuring the output of an FM signal ← Selecting the output type

For the output of FM demodulated signals, you can adjust the following parameters.

- ["Scale"](#) on page 191
- ["Low Pass"](#) on page 190
- ["Loudspeaker"](#) on page 190

Controlling and configuring the output

Depending on the selected [output type](#), you can configure one or more of the following output characteristics.

IF Output Frequency ← Controlling and configuring the output

Defines the output frequency of the IF signal.

The IF signal has an fixed output frequency of 25 MHz.

Remote command:
not supported

Low Pass ← Controlling and configuring the output

Turns a low pass filter to control the frequencies that are output on and off.

When you turn on the filter, you can define its **cutoff frequency**. The available cutoff frequencies depend on the type of output and the individual settings of the selected [output type](#).

Remote command:

[OUTPut<ou>:IF:LPASs\[:STATe\]](#) on page 519

[OUTPut<ou>:IF:LPASs:FREQuency:MANual](#) on page 519

Loudspeaker ← Controlling and configuring the output

Turns the loudspeaker on and off.

When you turn on this feature, you can listen to the signal with speakers or headphones connected to the headphone jack on the rear panel. To control the volume of the output, use either the volume control knob on the front panel or the [volume slider](#).

Squelch ← Controlling and configuring the output

You can suppress noise during audio output over the headphone jack for demodulated AM or FM signals with the "Squelch" feature.

When you turn on this feature, you can define a relative "Squelch Level" in %, below which the signal is not demodulated (and thus not audible). The squelch level is indicated by a red line in the diagram.

Alternatively, you can define the squelch level as an absolute value ("Squelch Unit"). The unit depends on the unit you have currently selected for the measurement.

Remote command:

[\[SENSe:\]DEMod:SQUelch\[:STATe\]](#) on page 522

[\[SENSe:\]DEMod:SQUelch:LEVEl](#) on page 521

Absolute squelch level: [\[SENSe:\]DEMod:SQUelch:LEVEl:ABSolute](#) on page 522

Scale ← Controlling and configuring the output

Defines the scale for the data you are transferring.

The unit depends on the signal type you are transferring.

- AM signals: a value in %.
- FM signals: a value in Hz

Remote command:


`OUTPut<ou>:IF:SCALe[:VALue]` on page 520

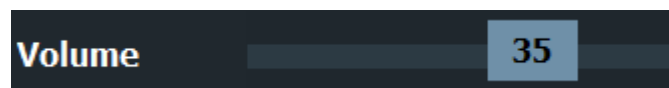
Controlling the volume

CAUTION! Risk of hearing damage. To protect your hearing, make sure that the volume setting is not too high before putting on the headphones.

When you output an audio signal and listen to it with headphones, for example, you can control the volume of the output.

Use the **volume control slider** to define the volume. The volume is a percentage from 0 % to 100 % with 100 % being the loudest.

Tip: You can open the volume control easily with the loudspeaker icon the the status bar (.



In addition to simply changing the volume, you can also define a **maximum volume level**. The maximum volume level limits the audio output to a certain level.

The slider will not go further than this level.

Remote command:

Volume: `SYSTem:SPEaker:VOLume` on page 523

Maximum volume: `SYSTem:SPEaker:MAXVolume` on page 523

Mute: `SYSTem:SPEaker:MUTE` on page 523

4.2.4 Configuring LISNs

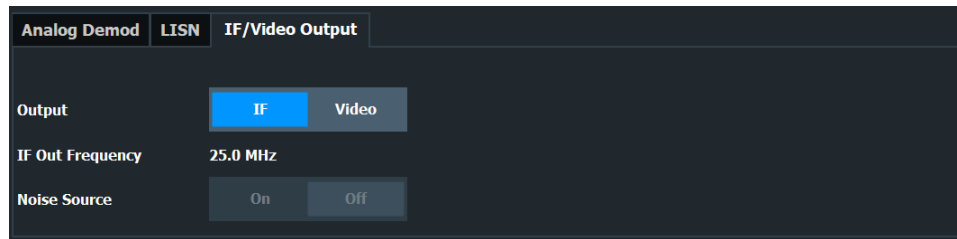
For more information see the user manual of the R&S EPL1000.

4.2.5 Configuring additional outputs

Access: "Overview" > "Output" > "IF/Video Output"

The R&S EPL1000 provides additional outputs that you can use for various tasks.

Note that the "Noise Source" output is not available in the receiver application.



The remote commands required to configure the outputs are described in [Chapter 6.8.1.5, "Additional output"](#), on page 523.

Functions in the "IF/Video Output" dialog box described elsewhere:

- [Output type IF and video](#)

[Noise Source Control](#)..... 192

Noise Source Control

Enables or disables the 28 V voltage supply for an external noise source connected to the "Noise source control / Power sensor") connector. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S EPL1000 itself, for example when measuring the noise level of an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the R&S EPL1000 and measure the total noise power. From this value, you can determine the noise power of the R&S EPL1000. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

Remote command:

[DIAGnostic:SERvice:NSource](#) on page 524

4.2.6 Internal generator

Access: "GEN State"

Access: "GEN Config"

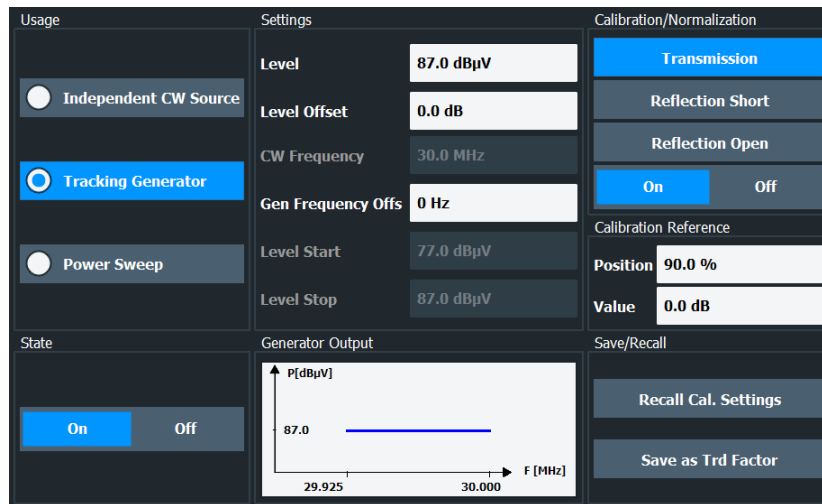
Or: [Freq] > "Generator Config"

The internal generator provides a signal at the generator output on the front panel of the R&S EPL1000.



Note that the full set of generator settings is only available in the spectrum application. The other applications only provide the following subset of settings.

- Generator state
- Output level
- Level offset
- Frequency



The remote commands required to configure the internal generator are described in [Chapter 6.8.1.6, "Generator configuration"](#), on page 524.

- [Basics on the internal generator](#)..... 193
- [Configuring the generator](#)..... 200
- [How to work with the tracking generator](#)..... 206

4.2.6.1 Basics on the internal generator

The internal generator emits a signal at a specified frequency. The generated signal is sent to the GEN Output 50 Ω connector. You can connect your DUT to the output connector, thus allowing the analyzer to control the input signal for the device directly.

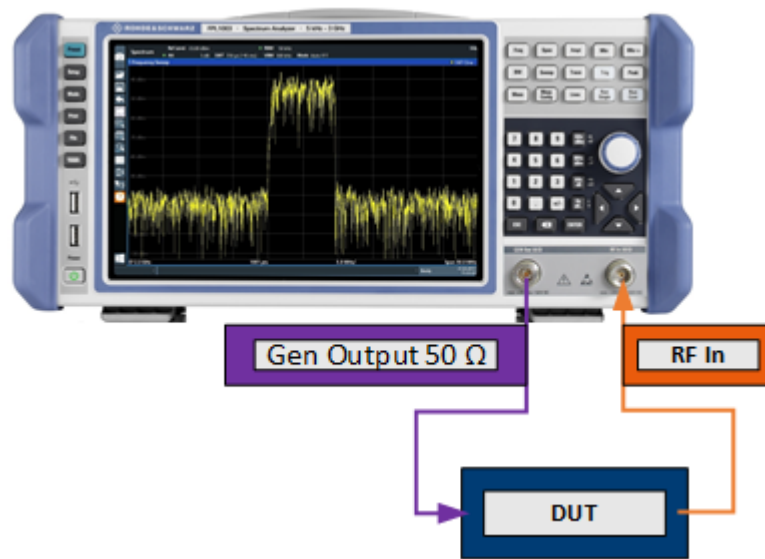
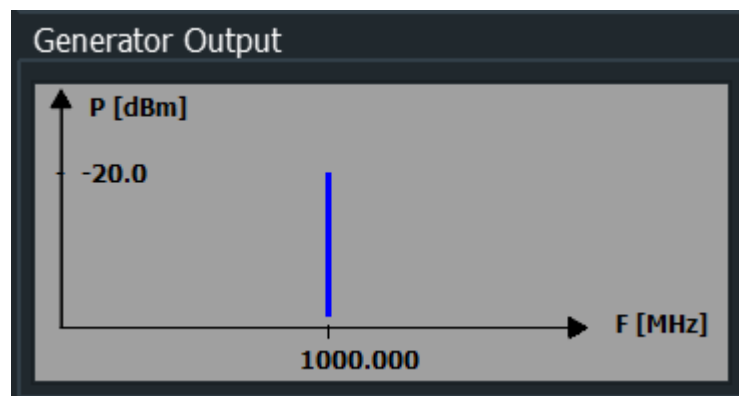


Figure 4-1: Test setup using the internal generator

You can enable or disable and configure the generator individually for each application. Different usages are provided for various measurement scenarios.

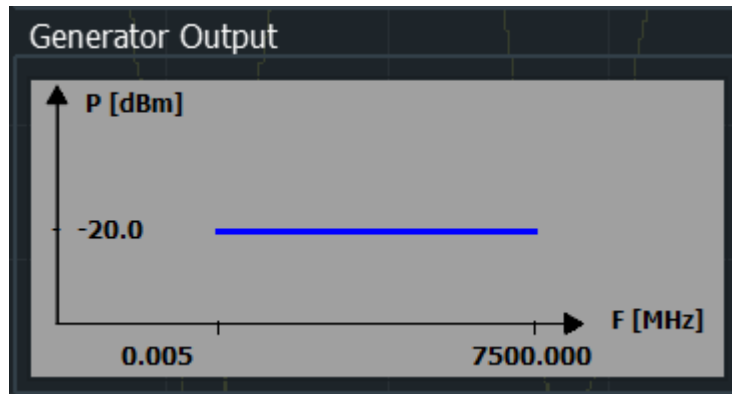
Independent CW source

The internal generator can be used as an independent CW source for a DUT in all applications on the R&S EPL1000. In this case, the frequency of the internal generator is independent of the analyzer input.



Tracking generator

The frequency of the internal generator can be coupled to the input frequency of the analyzer, so that the input signal for the DUT tracks (or follows) the input signal of the analyzer. This function is referred to as a tracking generator.



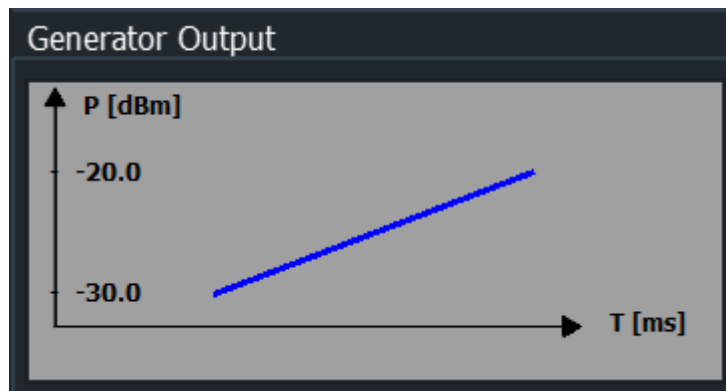
Frequency coupling is useful for test scenarios for which a signal generator is required, but an additional instrument is too expensive or takes up too much space.

When using the internal generator as a tracking generator, the R&S EPL1000 also allows you to set a frequency offset for frequency-converting measurements.

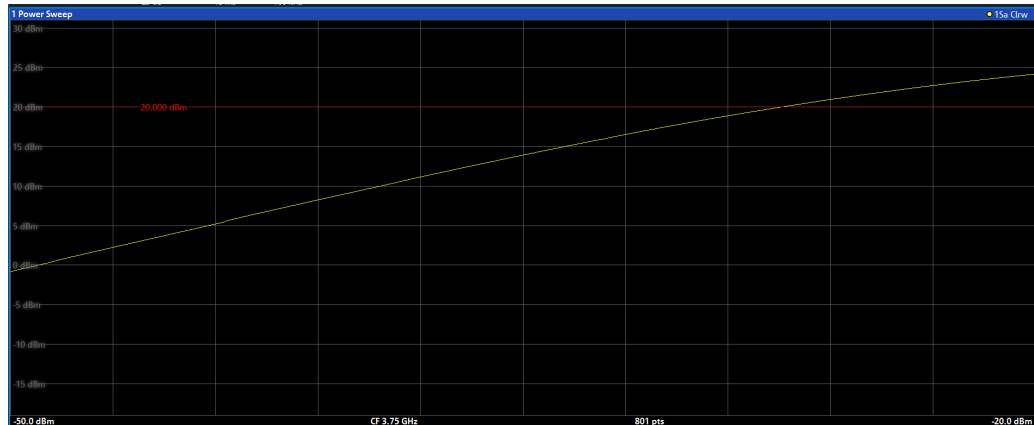
Using the internal generator as a tracking generator is only available in the Spectrum application for frequency sweeps. If you switch to another application, a currently active tracking generator is disabled.

Power sweep

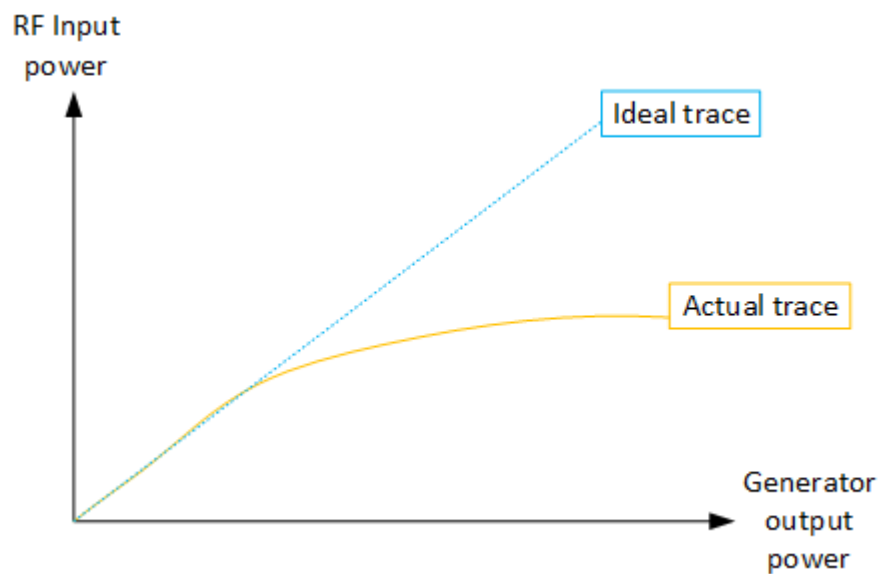
For a power sweep measurement, the internal generator signal remains at a fixed frequency, but increases its power level within a specified range over time. The default frequency of the internal generator is coupled to the (center) frequency of the analyzer and can be set from 5 kHz to the maximum frequency of the R&S EPL1000. However, you can define an offset for the internal generator frequency.



As a result, the measured power levels at the RF input are displayed versus the provided power levels of the internal generator output.



Thus, you can use the internal generator signal as a reference input signal for your power-converting DUT. Then you can compare the DUT input to its output at the RF input of the analyzer. Ideally, the result is a linear trace, that is: the output is directly proportional to the input power. Any distortion to the linear trace indicates the effects of the DUT. This result is useful, for example, to determine the compression point for amplifiers.



For details on determining compression points, see [Chapter 3.2, "Power sweep measurements"](#), on page 32.

Calibration mechanism

A common measurement setup includes a signal generator, a device under test (DUT), and a signal and spectrum analyzer. Therefore, it is useful to measure the attenuation or gain caused by the cables and connectors from the signal generator and the signal analyzer in advance. The known level offsets can then be removed from the measurement results to obtain accurate information on the DUT.

Calculating the difference between the currently measured power and a reference trace is referred to as *calibration*. Thus, the measurement results from the internal 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 enabling the use of the internal generator as a tracking generator. The analyzer sends a predefined list of frequencies to the internal generator. The frequency list for the calibration sweep contains 201 values by default, divided in equidistant frequencies between the analyzer's start and stop frequency. The internal generator then sends a signal with the specified level at each frequency in the predefined list. The analyzer measures the signal and determines the level offsets to the expected values.

Saving calibration results

A reference dataset for the calibration results is stored internally as a table of value pairs (frequency/level), one for each sweep point. The measured offsets can then be used as calibration factors for subsequent measurement results. The calibration data can also be stored permanently with the instrument settings using the "Save" function in the toolbar.

The calibration can be performed using either transmission or reflection measurements. The selected type of measurement used to determine the reference trace is included in the reference dataset.

Normalization

Once the measurement setup has been calibrated and the reference trace is available, subsequent measurement results can be corrected according to the calibration factors, if necessary. Correction is done by subtracting the reference trace from the measurement results. The resulting level values are provided in dB. This process is referred to as *normalization*. Normalization is automatically enabled after calibration, but it can be enabled or disabled as required. If normalization is enabled, "NOR" is displayed in the channel bar, next to the indication that a tracking generator is being used ("Trk.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

If any of the calibration measurement settings are changed, the stored reference trace is no longer identical to the new measurement results. However, if the measurement settings do not deviate too much, the measurement results can still be normalized *approximately* using the stored reference trace. Approximate normalization is indicated by the "APX" label in the channel bar (instead of "NOR").

Approximate normalization occurs 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 internal generator
- Detector (max. peak, min. peak, sample, etc.)
- Frequency deviation at a maximum of 201 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.

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 (90% 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 199).

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 "Trk.Gen" in the channel bar), you can restore the calibration settings, which are stored with the reference dataset on the R&S EPL1000.

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 EPL1000 applications that do not support the use of the tracking generator. The normalized trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix `.tdf` under

`C:\ProgramData\Rohde-Schwarz\ZNL-FPL\trd`. The frequency points are allocated in equidistant steps between the start and stop frequency.

Defining transducer factors are useful, for example, to determine the effects of a particular device component and then remove these effects from a subsequent measurement which includes this component.

For an example, see "[How to remove the effects of a particular component from measurement results using calibration](#)" on page 207.



Note that the *normalized* measurement data is stored, not the original *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor is 0 dB for the entire span (by definition of the normalized trace).

Reference trace, reference line and reference level

Reference trace

The calibration results are stored internally on the R&S EPL1000 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 "Internal 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 (90% of the window height). If you shift the reference line, the normalized trace is shifted, as well.

Shifting the reference line (and normalized trace)

You can shift the reference line - and thus the normalized trace - in the result display by changing the [Reference Position](#) or the [Reference Value](#).

If the DUT inserts a gain or an attenuation in the measurement, this effect can be reflected in the result display on the R&S EPL1000. To reflect a power offset in the measurement trace, change the [Reference Value](#).

Displayed information and errors

Channel bar

If internal generator control is active, some additional information is displayed in the channel bar.

Label	Description
"CWSource:" <source power>	Internal generator in operation as independent CW source with specified level
"Trk.Gen:" <source power>	Internal generator active; signal sent with <source power> level
"NOR"	Normalization on; No difference between reference setting and measurement
"APX" (approximation)	Normalization on; Deviation from the reference setting occurs

Error and status messages

The following status and error messages can occur during internal generator control.

Message	Description
"Generator Frequency Limits Exceeded!"	The allowed frequency ranges for the generator were exceeded (see data sheet)
"Generator Level Overrange" / "Generator Level Underrange"	The power level exceeds the range specified in the data sheet
"Generator Maximum Level Exceeded"	The power level exceeds the maximum available output level of the internal generator

NOTICE

Overloading

At a reference level of -13 dBm and at an internal generator output level of the same value, the R&S EPL1000 operates without overrange reserve. That means the R&S EPL1000 is in danger of being overloaded if a signal is applied whose amplitude is higher than the reference line. In this case, an overload message is displayed in the status line.

Overloading can be avoided as follows:

- Reducing the output level of the internal generator ("[Level](#)" on page 201)
- Increasing the reference level

4.2.6.2 Configuring the generator

You can select one of several types of signal provided by the internal generator:

- "[Independent CW source settings](#)" on page 200: constant frequency and power level
- "[Tracking generator settings](#)" on page 201: constant power level, frequency follows analyzer frequency (only available for frequency sweeps in the Spectrum application)
- "[Power sweep](#)" on page 195: constant frequency, linearly increasing power level (only available in the Spectrum application)

SCPI commands

[SOURce<si>:FREQuency:COUPling\[:STATe\]](#) on page 527

[SOURce<si>:POWer:MODE](#) on page 528

- [Independent CW source settings](#).....200
- [Tracking generator settings](#).....201
- [Power sweep settings](#).....204

Independent CW source settings

Access: "GEN Config" > "Independent CW Source"

The preview in the dialog box visualizes the configured signal from the internal generator.

State.....	201
Level.....	201
Level Offset.....	201
CW Frequency.....	201

State

Enables or disables the internal generator. The generator signal is output at the GEN Output 50 Ω connector on the front panel.

Remote command:

`OUTPut [:STATe]` on page 526

Level

Defines the output power of the internal generator.

The default output power is -20 dBm. The range is from -60 dBm to +10 dBm.

Remote command:

`SOURce<si>:POWer[:LEVel][:IMMediate][:AMPLitude]` on page 527

Level Offset

Defines an offset to the output power of the internal generator.

Used to adapt the level display, for example to cable loss.

Remote command:

`SOURce<si>:POWer[:LEVel][:IMMediate]:OFFSet` on page 527

CW Frequency

Defines the frequency of the independent CW source. The step size depends on the measurement mode.

If the internal generator is used as a tracking generator, the frequency is coupled to the frequency of the analyzer. Thus, this setting is not available.

Remote command:

`SOURce<si>:INTernal:FREQuency` on page 527

Tracking generator settings

Access: "GEN Config" > "Tracking Generator"

The tracking generator signal is only available for frequency sweeps in the spectrum application.

The preview in the dialog box visualizes the configured signal from the internal tracking generator.

State.....	202
Level.....	202
Level Offset.....	202
CW Frequency.....	202
Frequency Offset.....	202
Calibrate Transmission.....	202

Calibrate Reflection Short.....	203
Calibrate Reflection Open.....	203
Normalization state.....	203
Reference Position.....	203
Reference Value.....	204
Recall Cal. Settings.....	204
Save as Trd Factor.....	204

State

Enables or disables the internal generator. The generator signal is output at the GEN Output 50 Ω connector on the front panel.

Remote command:

`OUTPut [:STATe]` on page 526

Level

Defines the output power of the internal generator.

The default output power is -20 dBm. The range is from -60 dBm to +10 dBm.

Remote command:

`SOURce<si>:POWer[:LEVel] [:IMMediate] [:AMPLitude]` on page 527

Level Offset

Defines an offset to the output power of the internal generator.

Used to adapt the level display, for example to cable loss.

Remote command:

`SOURce<si>:POWer[:LEVel] [:IMMediate]:OFFSet` on page 527

CW Frequency

Defines the frequency of the independent CW source. The step size depends on the measurement mode.

If the internal generator is used as a tracking generator, the frequency is coupled to the frequency of the analyzer. Thus, this setting is not available.

Remote command:

`SOURce<si>:INTernal:FREQuency` on page 527

Frequency Offset

Shifts the frequency of the internal generator by the defined offset.

The default frequency of the internal generator is coupled to the (center) frequency of the analyzer and can be set from 5 kHz to the maximum frequency of the R&S EPL1000.

Remote command:

`SOURce<si>:INTernal:FREQuency:OFFSet` on page 528

Calibrate Transmission

Starts a transmission type measurement to determine a reference trace. This trace is used to calculate the difference for the normalized values.

Remote command:

[\[SENSe:\]CORRection:MEtHod](#) on page 525

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 525

Selects the reflection method.

[\[SENSe:\]CORRection:COLLect\[:ACQuire\]](#) on page 525

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 525

Selects the reflection method.

[\[SENSe:\]CORRection:COLLect\[:ACQuire\]](#) on page 525

Starts the sweep for open-circuit calibration.

Normalization state

Switches the normalization of measurement results on or off. This function is only available if the memory contains a reference trace, that is, after a calibration has been performed.

Remote command:

[\[SENSe:\]CORRection\[:STATe\]](#) on page 524

Reference Position

Defines the position of the reference line in percent of the total y-axis range.

The top of the diagram is 100%, the bottom is 0%. By default, the 0 dB line is displayed at 90% of the diagram height.

This setting is only available if normalization is on (see "[Normalization state](#)" on page 203).

The reference line defined by the reference value and reference position is similar to the reference level defined in the "Amplitude" settings. However, this reference line only affects the y-axis scaling in the diagram, it has no effect on the expected input power level or the hardware settings.

The normalized trace (0 dB directly after calibration) is displayed on this reference line, indicated by a red line in the diagram. If you shift the reference line, the normalized trace is shifted, as well.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition`
on page 541

Reference Value

Defines an offset for the position of the reference line.

This setting can be used to shift the reference line and thus the normalized trace, similar to the reference level defined in the "Amplitude" settings shifts the reference level *in the display*.

Shifting the normalized trace is useful, for example, to reflect an attenuation or gain caused by the measured DUT. If you then zoom into the diagram around the normalized trace, the measured trace still remains fully visible.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue`
on page 526

Recall Cal. Settings

Restores the settings that were used during source calibration. This can be useful if instrument settings were changed after calibration (e.g. center frequency, frequency deviation, reference level, etc.).

Remote command:

`[SENSe:]CORRection:RECall` on page 526

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:\ProgramData\Rohde-Schwarz\ZNL-FPL\trd`. The frequency points are allocated in equidistant steps between start and stop frequency.

The generated transducer factor can be further adapted using the "Transducer" function in the [Setup] menu.

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

For more information on transducers, see the R&S EPL1000 User Manual.

Note: Note that the *normalized* measurement data is used, not the *reference* trace! Thus, if you store the normalized trace directly after calibration, without changing any settings, the transducer factor is 0 dB for the entire span (by definition of the normalized trace).

Remote command:

`[SENSe:]CORRection:TRANsducer:GENerate` on page 526

Power sweep settings

Access: "GEN Config" > "Power Sweep"

The power sweep is only available in the spectrum application.

The preview in the dialog box visualizes the configured signal from the internal tracking generator.

State.....	205
Level Offset.....	205
PS Frequency.....	205
Frequency Offset.....	205
Level Start / Level Stop.....	205
Calibrate Transmission.....	206
Normalization state.....	206

State

Enables or disables the internal generator. The generator signal is output at the GEN Output 50 Ω connector on the front panel.

Remote command:

`OUTPut [:STATe]` on page 526

Level Offset

Defines an offset to the output power of the internal generator.

Used to adapt the level display, for example to cable loss.

Remote command:

`SOURce<si>:POWER[:LEVel] [:IMMediate]:OFFSet` on page 527

PS Frequency

Defines the frequency of the internal generator signal for a power sweep measurement. This frequency corresponds to the center frequency of the RF measurement.

Remote command:

`[SENSe:]FREQuency:CENTer` on page 531

Frequency Offset

Shifts the frequency of the internal generator by the defined offset.

The default frequency of the internal generator is coupled to the (center) frequency of the analyzer and can be set from 5 kHz to the maximum frequency of the R&S EPL1000.

Remote command:

`SOURce<si>:INTernal:FREQuency:OFFSet` on page 528

Level Start / Level Stop

Defines the start and stop levels of the output power of the internal generator. The power increases linearly within this range. Only ascending values are allowed, that is: the level start value must be lower than the level stop value.

The range is from -60 dBm to +10 dBm.

If a [Level Offset](#) is defined, the "Level Start" / "Level Stop" values are indicated with the offset applied.

Remote command:

`SOURce<si>:POWER:START` on page 529

`SOURce<si>:POWER:STOP` on page 529

Calibrate Transmission

Starts a transmission type measurement to determine a reference trace. This trace is used to calculate the difference for the normalized values.

Remote command:

[\[SENSe:\]CORRection:METhod](#) on page 525

Normalization state

Switches the normalization of measurement results on or off. This function is only available if the memory contains a reference trace, that is, after a calibration has been performed.

Remote command:

[\[SENSe:\]CORRection\[:STATe\]](#) on page 524

4.2.6.3 How to work with the tracking generator

The following step-by-step instructions demonstrate how to work with the optional tracking generator.



For remote operation, see [Chapter 6.8.1.7, "Programming example for a tracking generator"](#), on page 529.

- [How to calibrate a measurement setup using a tracking generator](#).....206
- [How to remove the effects of a particular component from measurement results using calibration](#)..... 207
- [How to compensate for additional gain or attenuation after calibration](#)..... 207

How to calibrate a measurement setup using a tracking generator

1. If the measurement setup does not require the full span of the R&S EPL1000, change the "Frequency Start" and "Frequency Stop" values ([FREQ] > "Frequency Config").
2. Select the "GEN Config" tool on the toolbar.
3. Select the "Usage": "Tracking Generator".
4. Set the "State" to "On".
5. Define the generator output level as the "Level".
6. Optionally, to define a constant level offset for the tracking generator, define a "Level Offset".
7. Select the "Source Calibration" type: "Transmission" to perform a calibration sweep and store a reference trace for the measurement setup.
Normalization is automatically set to "On".



8. Optionally, shift the reference line further down in the result display by decreasing the "Reference": "Position".

The measurement setup is now calibrated. Subsequent measurement results are normalized, so that any unwanted effects from the cables and connectors are removed.

How to remove the effects of a particular component from measurement results using calibration

1. Set up the measurement, including the component, and perform a calibration as described in ["How to calibrate a measurement setup using a tracking generator"](#) on page 206.
2. After calibration, select "Save as Trd Factor" to store the normalized reference trace as a transducer factor.
3. Select [Setup] > "Transducer".
4. Select the stored transducer in the list of available transducers and select the "Active" setting for it.
5. 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 EPL1000. 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 a tracking generator"](#) on page 206.)

1. Insert the additional component in the calibrated measurement setup and perform a new measurement.
2. Select the "GEN Config" tool on the toolbar.
3. With active normalization, set the "Calibration Reference": "Value" to the same value as the gain or attenuation the inserted component causes.
4. Optionally, shift the reference line further down in the result display by decreasing the "Calibration Reference": "Position".

The normalized reference trace moves to the position of the measured trace.



5. Optionally, zoom into the measured trace by changing the y-axis scaling (or the range: "AMPT > Scale Config > Range").

The measured trace is still fully visible, and the absolute values are still valid.

4.3 Frequency and span configuration

The frequency and span settings define the scope of the signal and spectrum to be analyzed with the R&S EPL1000.

- [Impact of the frequency and span settings](#)..... 208
- [Frequency and span settings](#)..... 210
- [Keeping the center frequency stable - signal tracking](#)..... 213
- [How to define the frequency range](#)..... 214
- [How to move the center frequency through the frequency range](#)..... 215

4.3.1 Impact of the frequency and span settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- [Defining the scope of the measurement - frequency range](#)..... 208
- [Stepping through the frequency range - center frequency stepsize](#)..... 208
- [Coping with large frequency ranges - logarithmic scaling](#)..... 209

4.3.1.1 Defining the scope of the measurement - frequency range

The frequency range defines the scope of the signal and spectrum to be analyzed. It can either be defined as a span around a center frequency, or as a range from a start to a stop frequency. Furthermore, the full span comprising the entire possible frequency range can be selected, or a zero span. The full span option allows you to perform an overview measurement over the entire span. Using the "Last Span" function you can easily switch back to the detailed measurement of a specific frequency range.

For sinusoidal signals, the center frequency can be defined automatically by the R&S EPL1000 as the highest frequency level in the frequency span (see "[Adjusting the Center Frequency Automatically \(Auto Frequency\)](#)" on page 253).

4.3.1.2 Stepping through the frequency range - center frequency stepsize

Using the arrow keys you can move the center frequency in discrete steps through the available frequency range. The step size by which the center frequency is increased or decreased is defined by the "Center Frequency Stepsize".



The "Center Frequency Stepsize" also defines the step size by which the value is increased or decreased when you use the rotary knob to change the center frequency; however, the **rotary knob** moves in steps of only **1/10 of the "Center Frequency Stepsize"** to allow for a more precise setting.

By default, the step size is set in relation to the selected span or resolution bandwidth (for zero span measurements). In some cases, however, it may be useful to set the step size to other values.



For example, to analyze signal harmonics, you can define the step size to be equal to the center frequency. In this case, each stroke of the arrow key selects the center frequency of another harmonic. Similarly, you can define the step size to be equal to the current marker frequency.

4.3.1.3 Coping with large frequency ranges - logarithmic scaling

In a linear display, the frequencies are distributed linearly across the x-axis. That means the entire frequency range is divided by the number of sweep points, and the distance between sweep points is equal. Linear scaling is useful to determine precise frequencies within a small range.



Figure 4-2: Linear x-axis scaling: the distance between the sweep points is equal, e.g. 200 kHz

However, if high and low frequencies appear in the same display, it is difficult to determine individual frequencies precisely or to distinguish frequencies that are close together.

In a logarithmic display, lower frequencies are distributed among a much larger area of the display, while high frequencies are condensed to a smaller area. Now it is much easier to distinguish several lower frequencies, as they are spread over a wider area. Logarithmic scaling is useful for overview measurements when a large frequency range must be displayed in one diagram.

However, with logarithmic scaling, the frequency resolution between two sweep points deteriorates with higher frequencies.

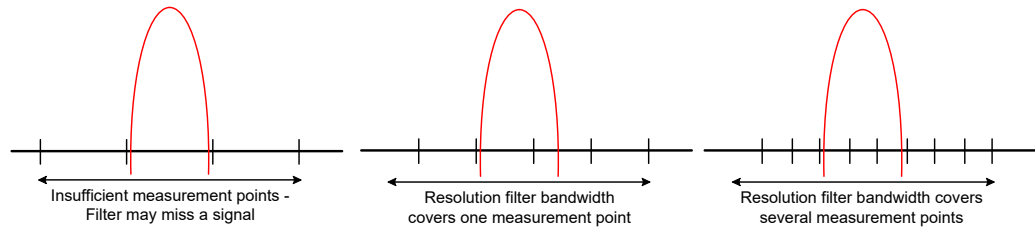


Figure 4-3: Logarithmic x-axis scaling: the distance between sweep points is variable

In the spectrum from 10 Hz to 100 Hz, the distance is a few Hz. Between 100 MHz and 1 GHz, the distance is several MHz.

Thus, for logarithmic x-axis scaling, the number of sweep points must be sufficiently high in order to distinguish high frequencies precisely. The resolution bandwidth should

cover at least one sweep point (that means: the distance between two sweep points should not exceed the RBW). If this condition is not met, signals or interferers could be missed, especially narrowband interferers.



4.3.2 Frequency and span settings

Access: "Overview" > "Frequency"

For more information see [Chapter 4.3.4, "How to define the frequency range"](#), on page 214.

Frequency
⊞

Frequency
Auto Settings
Signal Tracking

Frequency/Span

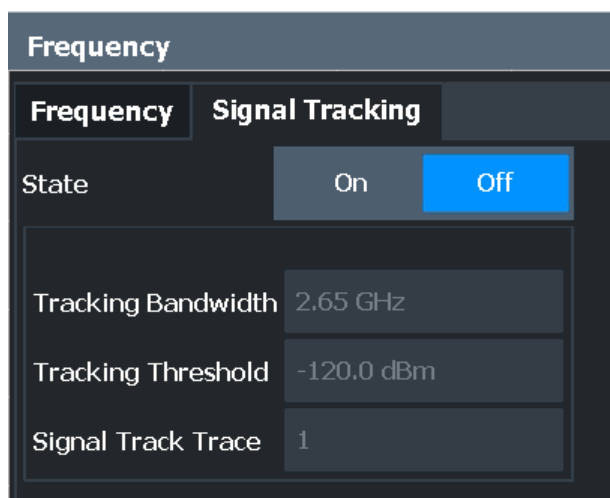
Center	3.75 GHz	Full Span
Span	7.5 GHz	Zero Span
Start	0.0 Hz	Last Span
Stop	7.5 GHz	

Center Frequency Stepsize

Stepsize	0.1 * Span	X-Factor	10.0 %
----------	------------	----------	--------

Frequency Offset

Value	0.0 Hz
-------	--------



"Auto Settings" are described in [Chapter 4.7, "Adjusting settings automatically"](#), on page 252.

Signal Tracking is described in [Chapter 4.3.3, "Keeping the center frequency stable - signal tracking"](#), on page 213.

Center Frequency	211
Span	211
Start / Stop	212
Full Span	212
Zero Span	212
Last Span	212
Center Frequency Stepsize	212
Frequency Offset	213

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 531

Span

Defines the frequency span. The center frequency is kept constant. The following range is allowed:

$$\text{span} = 0: 0 \text{ Hz}$$

$$\text{span} > 0:$$

$$\text{span}_{\min} \leq f_{\text{span}} \leq f_{\text{max}}$$

f_{max} and span_{\min} are specified in the data sheet.

For more information, see [Chapter 4.3.1.1, "Defining the scope of the measurement - frequency range"](#), on page 208.

Remote command:

[\[SENSe:\] FREQuency: SPAN](#) on page 533

Start / Stop

Defines the start and stop frequencies.

The following range of values is allowed:

$$f_{\min} \leq f_{\text{start}} \leq f_{\max} - \text{span}_{\min}$$

$$f_{\min} + \text{span}_{\min} \leq f_{\text{stop}} \leq f_{\max}$$

f_{\min} , f_{\max} and span_{\min} are specified in the data sheet.

Remote command:

[\[SENSe:\] FREQuency: START](#) on page 533

[\[SENSe:\] FREQuency: STOP](#) on page 534

Full Span

Sets the span to the full frequency range of the R&S EPL1000 specified in the data sheet. This setting is useful for overview measurements.

Remote command:

[\[SENSe:\] FREQuency: SPAN: FULL](#) on page 533

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").

Remote command:

`FREQ: SPAN 0Hz`, see [\[SENSe:\] FREQuency: SPAN](#) on page 533

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 533

Center Frequency Stepsize

Defines the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob the center frequency changes in much smaller steps (1/10 the size as for the arrow keys).

The step size can be coupled to the span or the resolution bandwidth, or it can be manually set to a fixed value.

"0.1 * Span" / Sets the step size for the center frequency to 10 % of the span /
"0.1 * RBW" RBW.
 This is the default setting.

"0.5 * Span" / Sets the step size for the center frequency to 50 % of the span /
"0.5 * RBW" RBW.

"x * Span" / "x * RBW"	Sets the step size for the center frequency to a manually defined factor of the span / RBW. The "X-Factor" defines the percentage of the span / RBW. Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.
"= Center"	Sets the step size to the value of the center frequency and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.
"= Marker"	This setting is only available if a marker is active. Sets the step size to the value of the current marker and removes the coupling of the step size to span or resolution bandwidth. The used value is indicated in the "Value" field.
"Manual"	Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:

[\[SENSe:\] FREQuency:CENTer:STEP:LINK](#) on page 532

[\[SENSe:\] FREQuency:CENTer:STEP:LINK:FACTOR](#) on page 532

[\[SENSe:\] FREQuency:CENTer:STEP](#) on page 531

Frequency Offset

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

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

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

The allowed values range from -1 THz to 1 THz. The default setting is 0 Hz.

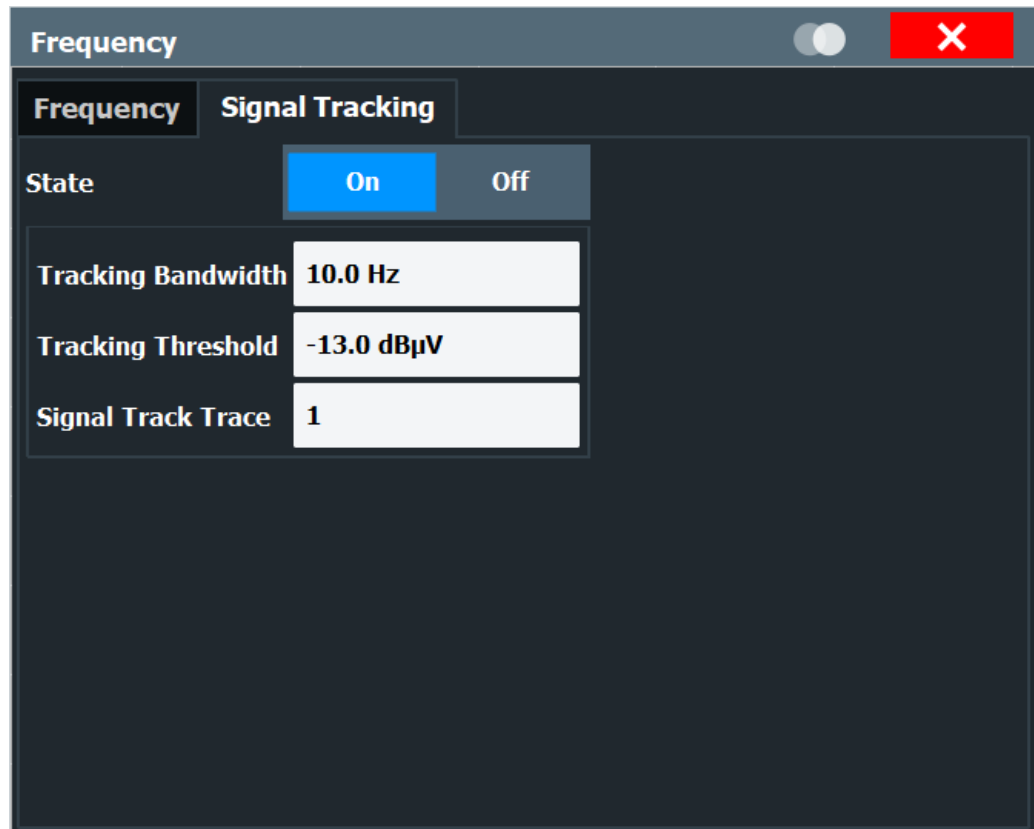
Remote command:

[\[SENSe:\] FREQuency:OFFSet](#) on page 533

4.3.3 Keeping the center frequency stable - signal tracking

Note: in the Receiver application, signal tracking is available for the IF analysis.

If the signal drifts on the display but you want to keep the center frequency on the signal peak, the center frequency can be adjusted automatically using **signal tracking**. In this case, the signal trace is surveyed in a specified bandwidth around the expected center frequency. After each sweep, the center frequency is set to the maximum signal found within the searched bandwidth. If no maximum signal above a defined threshold value is found in the searched bandwidth, the center frequency remains unchanged. The search bandwidth and the threshold value are shown in the diagram by red lines which are labeled as "TRK".



Signal Tracking

Access: "Overview" > "Frequency" > "Signal Tracking" tab

Defines the settings for signal tracking. These settings are only available for spans > 0.

For more details see [Chapter 4.3.3, "Keeping the center frequency stable - signal tracking"](#), on page 213.

If activated, after each sweep, the center frequency is set to the maximum level of the specified "Signal Track Trace" found within the searched "Tracking Bandwidth".

If the signal level does not pass the "Tracking Threshold", the center frequency is not changed.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:STRack\[:STATE\]](#) on page 534

[CALCulate<n>:MARKer<m>:FUNCTION:STRack:BANDwidth](#) on page 535

[CALCulate<n>:MARKer<m>:FUNCTION:STRack:THReshold](#) on page 535

[CALCulate<n>:MARKer<m>:FUNCTION:STRack:TRACe](#) on page 536

4.3.4 How to define the frequency range

The following step-by-step instructions demonstrate how to configure the frequency and span settings. For details on individual functions and settings see [Chapter 4.3.2, "Frequency and span settings"](#), on page 210.

The remote commands required to perform these tasks are described in [Chapter 6.8.2, "Frequency configuration"](#), on page 530.

To configure the frequency and span

Frequency and span settings can be configured via the "Frequency" dialog box. Signal tracking is configured in the "Signal Tracking" tab of this dialog box.

1. To display the "Frequency" dialog box, do one of the following:
 - Select "Frequency" from the "Overview".
 - Select [FREQ] and then "Frequency Config".
 - Select [SPAN] and then "Frequency Config".
2. Define the frequency range using one of the following methods:
 - Define the "Center Frequency" and "Span".
 - Define the "Start Frequency" and "Stop Frequency".
 - To perform a measurement in the time domain, define the "Center Frequency" and select "Zero Span".
 - To perform a measurement over the entire available frequency range, select "Full Span".
 - To return to the previously set frequency range, select "Last Span".

4.3.5 How to move the center frequency through the frequency range

In some cases it may be useful to move the center frequency through a larger frequency range, for example from one harmonic to another.

1. In the "Frequency" dialog box, define the "Center Frequency Stepsize". This is the size by which the center frequency is to be increased or decreased in each step. Enter a manual or relative value, or set the step size to the current center frequency or marker value. To move from one harmonic to the next, use the center frequency or marker value.
2. Select the "Center Frequency" dialog field.
3. Use the arrow keys to move the center frequency in discrete steps through the available frequency range.

4.4 Amplitude and vertical axis configuration

In the Spectrum application, measurement results usually consist of the measured signal levels (amplitudes) displayed on the vertical (y-)axis for the determined frequency spectrum or for the measurement time (horizontal, x-axis). The settings for the vertical axis, regarding amplitude and scaling, are described here.

- [Impact of the vertical axis settings](#)..... 216
- [Amplitude settings](#).....220
- [Scaling the y-axis](#).....223
- [How to optimize the amplitude display](#).....225

4.4.1 Impact of the vertical axis settings

Some background knowledge on the impact of the described settings is provided here for a better understanding of the required configuration.

- [Increasing measurement sensitivity \(or avoiding an input mixer overload\)](#)..... 216
- [Reference level](#).....219
- [Scaling](#)..... 220

4.4.1.1 Increasing measurement sensitivity (or avoiding an input mixer overload)

Measurements often confront you with unknown or unintentional signals with unknown signal levels (and often with pulse characteristics). Such signals can either have very weak signal levels, in which case you might miss them during the measurement. Or they can have very strong signal levels, in which case they can damage the input mixer.

Protecting the input mixer

Always consider how to protect the input mixer from damage when setting up a measurement.

- ▶ **NOTICE!** EMC measurements often measure unknown signals that contain pulses with possibly strong signal levels. Strong signal levels can damage the input mixer. Read the following topics carefully before you apply a signal to learn more about protecting the input mixer and avoid an overload.

Note that pulses have different level characteristics. Refer to the data sheet for more information on the allowed maximum pulse energy.

The signal level at the input mixer is calculated as follows.

$$\text{Mixer Level} = \text{Input Level} - \text{attenuation} + \text{gain}$$



The R&S EPL1000 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](#).....217
- [Using the preamplifier](#).....218
- [Using the preselector](#).....218

Using the RF attenuator

The first tool provided by the R&S EPL1000 to control measurement sensitivity is the RF attenuator.

The RF attenuator is available in all hardware configurations of the R&S EPL1000.

Attenuation has the following effects on the measurement:

- High attenuation protects the input mixer: the main purpose of the attenuator is to protect the input mixer.
- High attenuation makes sure that the measurement results are reliable (signals that are stronger than allowed can distort the results)
- High attenuation helps you to avoid intermodulation
- High attenuation increases inherent noise (i.e. the noise floor) and thus decreases measurement sensitivity: if you increase attenuation by 10 dB, the sensitivity is reduced by 10 dB (in other words: the displayed noise increases by 10 dB)

Depending on the required test setup, you must find a compromise between a high sensitivity, low intermodulation and input mixer protection. We recommend to let the R&S EPL1000 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 EPL1000 does not allow you to select attenuation levels of less than 10 dB unless you explicitly turn on this feature ("[10 dB Minimum Attenuation](#)").

Protecting the input mixer

1. **NOTICE!** EMC measurements often measure unknown signals that contain pulses with possibly strong signal levels. Strong signal levels can damage the input mixer.
Select an appropriate attenuation when you measure unknown signals or RFI voltage in combination with an artificial network (LISN). Do not apply a 0 dB attenuation for such measurements.
During phase switching, such test setups generate very strong pulses which can damage the input mixer.
2. Make sure that the signal level at the RF input does not exceed the allowed limits when you allow attenuation of less than 10 dB in combination with auto ranging
Exceeding the limits can damage the input mixer.

Using the preamplifier

The second tool that allows you to control measurement sensitivity is the preamplifier.

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 EPL1000 and thus increases its sensitivity. Thus, it is recommended to use the preamplifier for measurements that require maximum sensitivity.
- The preamplifier reduces the dynamic range. To perform a measurement using the maximum dynamic range, turn off the preamplifier.
- The preamplifier is located after the preselection filters, reducing the risk of overloading the input mixer by strong out-of-band signals.

The gain of the preamplifier is automatically considered in the level display. The disadvantage of a lower large-signal immunity (intermodulation) is reduced by the "preselector".

Using the preselector

The "preselector" is another tool to control measurement sensitivity.

Preselection has the following effects on the measurement:

- Preselection rejects most of the spectral energy which helps to protect the input mixer and thus makes sure that the measurement results are valid and reliable.
- Preselection filters out signals that you do not want to be displayed (selectivity) and thus allows you to analyze only the frequency range you are interested in.

The preselector of the R&S EPL1000 consists of several filters which are automatically applied during measurements. The filter that is used depends on the frequency that is currently measured. You can see the list of filters and the progress in the "Preselector" result display. The currently applied filter is indicated by a green LED, filters that are outside the scan range are ignored.

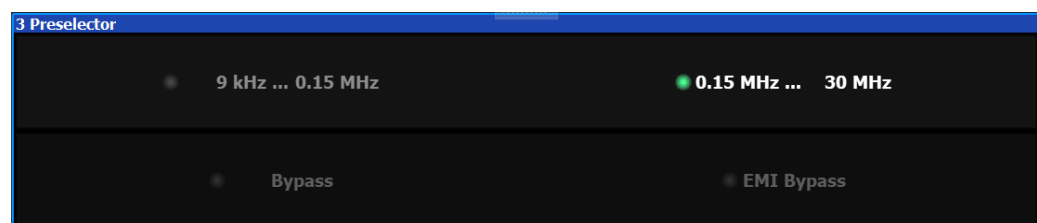


Figure 4-4: Preselector result display. The green LED indicates the currently applied filter.



Using the preselector

Switching the filters is a mechanical process. Avoid excessive filters switches, because the hardware can wear out.

Note that results in a frequency band are only displayed if there is at least one valid measurement point in the corresponding range. If a particular measurement point is captured by more than one filter, the R&S EPL1000 displays the combined results.

4.4.1.2 Reference level

The reference level value is the maximum value the AD converter can handle without distortion of the measured value. Signal levels above this value will not be measured correctly, which is indicated by the "IF Overload" status display.

Internally, the reference level is also used to determine the optimum hardware settings for the R&S EPL1000. 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 EPL1000 (see "Reference Level" on page 221).

In general, the R&S EPL1000 measures the signal voltage at the RF input. The level display is calibrated in RMS values of an unmodulated sine wave signal. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance, conversion to other units is possible.

Reference level offset

If the signal is attenuated or amplified before it is fed into the R&S EPL1000, 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 EPL1000 increases the displayed power values.

If an external gain is applied, define a negative offset so the R&S EPL1000 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 EPL1000 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 dBm (displayed ref level) - 3 dB (offset) = 2 dBm)

- 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 dBm (displayed ref level) - 3 dB (offset) = -2 dBm.

4.4.1.3 Scaling

In a linear display, the measurement values are distributed linearly throughout the grid. That means the entire range of measured values is divided by the number of rows in the grid (10) and each row corresponds to 1/10 of the total range. Linear scaling is useful to determine precise levels for a small range of values. However, if large and small values appear in the same display, it is difficult to determine individual values precisely or to distinguish values that are close together.

In a logarithmic display, smaller values are distributed among a much larger area of the display, while large values are condensed to a smaller area. Now it is much easier to distinguish several lower values, as they are spread over a wider area. Logarithmic scaling is useful when large ranges of values must be combined in one display. Logarithmic scaling is best applied to measurement values in logarithmic units (dB, dBm etc.).

In addition to linear or logarithmic scaling, the vertical axis can be set to display either absolute or relative values. Absolute values show the measured levels, while relative values show the difference between the measured level and the defined reference level. Relative values are indicated in percent for linear scaling, and in dB for logarithmic scaling.

4.4.2 Amplitude settings

Access: "Overview" > "Amplitude" > "Amplitude"

Amplitude settings determine how the R&S EPL1000 must process or display the expected input power levels.

The dialog box also contain settings to scale the diagrams, which are described in [Chapter 4.4.3, "Scaling the y-axis"](#), on page 223.

Reference Level		Attenuation	
Value	107.0 dBµV	Mode	Auto Manual
Offset	0.0 dB	10 dB Min	On Off
Unit	dBµV	Value	13.0 dB
Auto Level			
Input Settings			
Impedance	50Ω 75Ω	Preamplifier	Off Preamp

The remote commands required to define these settings are described in [Chapter 6.8.4, "Y-axis scaling"](#), on page 540.

Functions in the "Amplitude" dialog box described elsewhere:

- "Impedance" on page 186

Reference Level.....	221
L Shifting the Display (Offset).....	221
L Unit.....	221
L Setting the Reference Level Automatically (Auto Level).....	222
10 dB Minimum Attenuation.....	222
Attenuation.....	223
Preamplifier.....	223

Reference Level

Defines the expected maximum reference level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IF Overload" status display.

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

Since the hardware of the R&S EPL1000 is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level. Thus you ensure an optimal measurement (no compression, good signal-to-noise ratio).

For details, see [Chapter 4.4.1.2, "Reference level"](#), on page 219.

Remote command:

```
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel
```

on page 537

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 EPL1000 so the application shows correct power results. All displayed power level results are shifted by this value.

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

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the R&S EPL1000 must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

For details, see ["Reference level offset"](#) on page 219.

Remote command:

```
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet
```

on page 538

Unit ← Reference Level

The R&S EPL1000 measures the signal voltage at the RF input.

The following units are available and directly convertible:

- dBm
- dBmV

- dB μ V
- dBm/Hz (power density)
- dBm/MHz (power density)
- dB μ A
- dBpW
- Volt
- Ampere
- Watt
- dBmV/MHz (normalized to 1 MHz)
- dB μ V/MHz (normalized to 1 MHz)
- dB μ V/mMHz (normalized to 1 MHz)
(only available for active transducers with dB μ V/m values)
- dB μ A/MHz (normalized to 1 MHz)
- dB μ A/mMHz (normalized to 1 MHz)
(only available for active transducers with dB μ A/m values)
- dBpW/MHz (normalized to 1 MHz)

Remote command:

`INPut<ip>:IMPedance` on page 517

`CALCulate<n>:UNIT:POWer` on page 537

Setting the Reference Level Automatically (Auto Level) ← Reference Level

Automatically determines a reference level which ensures that no overload occurs at the R&S EPL1000 for the current input data. At the same time, the internal attenuators are adjusted. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S EPL1000.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meas Time Manual)" on page 253).

Remote command:

`[SENSe:]ADJust:LEVel` on page 560

10 dB Minimum Attenuation

Turns the availability of attenuation levels of less than 10 dB on and off.

When you turn on this feature, the attenuation is always at least 10 dB. This minimum attenuation protects the input mixer and avoids accidental setting of 0 dB, especially if you measure EUTs with high RFI voltage.

When you turn it off, you can also select attenuation levels of less than 10 dB.

The setting applies to a manual selection of the attenuation as well as the automatic selection of the attenuation.

Remote command:

`INPut<ip>:ATTenuation:PROTection[:STATe]` on page 539

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](#).

The auto ranging feature in the receiver remains active even if you change the attenuation and preamplifier properties in other measurement channels and then return to the receiver application.

The R&S EPL1000 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<ip>:ATTenuation[:VALue]` on page 538

Attenuation mode: `INPut<ip>:ATTenuation:AUTO` on page 539

Preamplifier

Configures the preamplifier.

The preamplifier amplifies the signal by 20 dB.

[More information.](#)

Remote command:

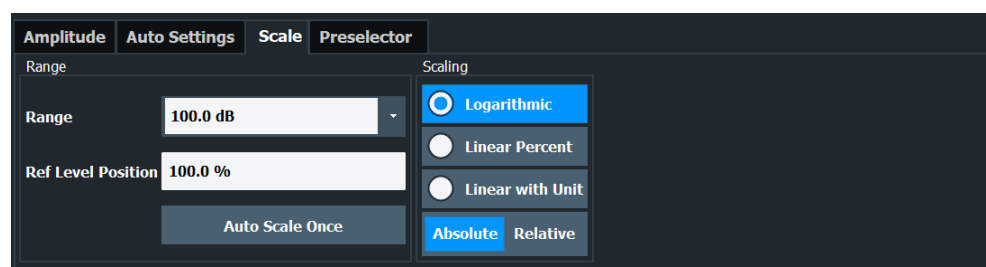
State (global): `INPut<ip>:GAIN:STATE` on page 539

`INPut<ip>:GAIN:STATE` on page 539

4.4.3 Scaling the y-axis

Access: "Overview" > "Amplitude" > "Scale"

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



The remote commands required to define these settings are described in [Chapter 6.8.4, "Y-axis scaling"](#), on page 540.

Range	224
Ref Level Position	224
Auto Scale Once	224
Scaling	224

Range

Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]` on page 540

Ref Level Position

Defines the reference level position, i.e. the position of the maximum AD converter value on the level axis in %.

0 % corresponds to the lower and 100 % to the upper limit of the diagram.

Values from -120 % to +280 % are available.

Larger values are useful for small scales, such as a power range of 10 dB or 20 dB, and low signal levels, for example 60 dB below the reference level. In this case, large reference level position values allow you to see the trace again.

For spectrograms, this value defines the position of the reference level value within the span covered by the color map. In this case, the value is given in %, where 0 % corresponds to the maximum (right end) and 100 % to the minimum (left end) of the color map.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 541

Auto Scale Once

Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 540

Scaling

Defines the scaling method for the y-axis.

For more information, see [Chapter 4.4.1.3, "Scaling"](#), on page 220.

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

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 542

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE`

on page 541

4.4.4 How to optimize the amplitude display

This section gives you some advice on how to optimize the display of the measured signal amplitudes depending on the required evaluation.

1. Perform a measurement with the default settings to get an impression of the values to be expected.
2. Select "Overview" > "Amplitude" > "Auto Settings" > "Auto Level" to optimize the reference level.
3. Select "Overview" > "Amplitude" > "Scale" > "Auto Scale Once" to optimize the scaling.
4. **To determine a precise level at a specific point in the signal:**
 - Reduce the "Range" of the y-axis to a small area around the required level. If necessary, change the "Ref Level Position" so the required range remains visible.
 - Select "Linear with Unit" scaling.

Now you can set a marker at the point in question and read the result.

5. **To detect a spurious signal close to the noise floor:**
 - Set the "RF Attenuation" to "Manual" mode and reduce the "Value" to lower the noise floor.
 - Select "Relative" - "Logarithmic" scaling.

Now you can determine if any spurious levels of a certain size are visible.

4.5 Bandwidth, filter and sweep configuration

The basic bandwidth, filter and sweep settings that apply to most measurements are described here. These parameters define how the data is measured: how much data is collected internally and which filters are used.

- [Impact of the bandwidth, filter and sweep settings](#)..... 225
- [Bandwidth, filter and sweep settings](#).....231

4.5.1 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:

$$T_{\text{MIN}} = K \cdot \text{Span} / \text{RBW}^2$$

where K = Filter constant

By default, a Gaussian filter is used. The resolution bandwidth, the video bandwidth and the "Sweep Time" are set automatically according to the set span, and default coupling is used. Thus, the following settings are applied:

$$\text{RBW} = \text{Span} / 100$$

$$\text{VBW} = \text{RBW}$$

$$\text{"Sweep Time"} = T_{\text{min}} \text{ for set Span, RBW, VBW}$$

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](#)..... 226
- [Smoothing the trace using the video bandwidth](#)..... 227
- [Coupling VBW and RBW](#)..... 227
- [Coupling span and RBW](#)..... 228
- [How data is measured: the sweep type](#)..... 228
- [Which data may pass: filter types](#)..... 229
- [How long the data is measured: Sweep Time](#) 230
- [How much data is measured: sweep points and sweep count](#)..... 230
- [How often data is measured: sweep mode](#)..... 231

4.5.1.1 Separating signals by selecting an appropriate resolution bandwidth

The resolution bandwidth defines the 3 dB bandwidth of the resolution filter to be used. An RF sinusoidal signal is displayed according to the passband characteristic of the resolution filter (RBW), i.e. the signal display reflects the shape of the filter.

A basic feature of a signal analyzer is being able to separate the spectral components of a mixture of signals. The resolution at which the individual components can be separated is determined by the resolution bandwidth. Selecting a resolution bandwidth that is too large may make it impossible to distinguish between spectral components, i.e. they are displayed as a single component. Smaller resolution bandwidths, however, increase the required "Sweep Time" .

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

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77 dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

If there are large level differences between signals, the resolution is determined by selectivity as well as by the resolution bandwidth that has been selected. The measure of selectivity used for signal analyzers is the ratio of the 60 dB bandwidth to the 3 dB bandwidth (= shape factor).

For the R&S EPL1000, the shape factor for bandwidths is < 5 , i.e. the 60 dB bandwidth of the 30 kHz filter is < 150 kHz.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are very far away (e.g. from a different signal) are considered in the measurement and distort the results. The noise increases.

If the RBW is too small, parts of the signal are lost. As the displayed signal always reflects the shape of the filter, select a bandwidth large enough so the displayed signal reflects the entire shape of the filter.

4.5.1.2 Smoothing the trace using the video bandwidth

The video filters are responsible for smoothing the displayed trace. Using video bandwidths that are small compared to the resolution bandwidth, only the signal average is displayed and noise peaks and pulsed signals are repressed. If pulsed signals are to be measured, it is advisable to use a video bandwidth that is large compared to the resolution bandwidth ($VBW = 10 \times RBW$) for the amplitudes of pulses to be measured correctly.

The level of a sine wave signal is not influenced by the video bandwidth. A sine wave signal can therefore be freed from noise by using a video bandwidth that is small compared with the resolution bandwidth, and thus be measured more accurately.



RMS/Average detector and VBW

If an RMS detector is used, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS or average detector no longer occurs. However, the VBW is still considered when calculating the "Sweep Time". This leads to a longer "Sweep Time" for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if the RMS detector is used, the "Sweep Time" should be increased to get more stable traces.

If an average detector is used, the video bandwidth in the hardware is only bypassed if the video filter is set to "Auto" mode. Use this mode to avoid duplicate trace averaging with small VBWs.

4.5.1.3 Coupling VBW and RBW

The video bandwidth can be coupled to the resolution bandwidth automatically. In this case, if the resolution bandwidth is changed, the video bandwidth is automatically adjusted.

Coupling is recommended if a minimum "Sweep Time" is required for a selected resolution bandwidth. Narrow video bandwidths require longer "Sweep Time" s due to the longer settling time. Wide bandwidths reduce the signal/noise ratio.

Table 4-1: Overview of RBW/VBW ratios and recommendations for use

Ratio RBW/VBW	Recommendation for use
1/1	Recommended for sinusoidal signals 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

4.5.1.4 Coupling span and RBW

The resolution bandwidth can be coupled to the span setting, either by a manually defined factor or automatically. If the span is changed, the resolution bandwidth is automatically adjusted. The automatic coupling adapts the resolution bandwidth to the currently set frequency span/100.

With a span/RBW ratio of 100 and a screen resolution of 1000 pixels, each frequency in the spectrum is displayed by 10 pixels. A span/RBW ratio of 1000 provides the highest resolution.

4.5.1.5 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. The R&S EPL1000 automatically selects the appropriate sweep type. For RBWs lower than 100 kHz and for gated measurements, an FFT is performed, otherwise a sweep is performed. When using CISPR detectors, sweeps can also be performed for lower RBWs.

For EMI measurements, the R&S EPL1000 automatically selects sweep mode for auto sweep type. You can also select sweep mode manually.

Optimization

In FFT mode, FFT analysis is performed to determine a spectrum of frequencies. Several analysis steps are required to cover the entire span. The subspan which is cov-

ered by one FFT analysis depends on the RBW. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

Narrow subspans provide a higher dynamic range, and also allow you to perform measurements near a carrier with a reduced reference level. With a wide subspan, the carrier and the useful signal are likely to be measured at the same time, in which case the powers of both signals are summarized, so the reference level must be high enough to consider this factor. With a narrow subspan, this is less likely to happen, so the reference level can be reduced.

For an optimal dynamic range, the narrowest possible subspan (depending on the RBW) is used. Furthermore, the autorange function for the internal IF gain calculation is activated to obtain the best control range of the A/D converter.

On the other hand, the narrower the subspan, the more steps are required to cover the entire span, thus increasing analysis and calculation time. To **optimize the sweep rate**, the widest possible subspan (depending on the RBW) is used.



For an optimal sweep rate, it is recommended that you set the "Sweep Time" to "Auto", as well.

For general purpose measurements, an "Auto" mode is available, which provides a **compromise between a large dynamic range and a fast sweep**. In this case, a medium-sized subspan is used.



FFT mode and EMI measurements

For EMI measurements, the subspan optimization mode "Dynamic" is not supported. "Auto" mode always uses "Speed" optimization.

4.5.1.6 Which data may pass: filter types

While the filter is irrelevant when measuring individual narrowband signals (as long as the signal remains within the RBW), the measurement result for broadband signals is very dependant on the selected filter type and its shape. If the filter is too narrow, the signal is distorted by the filter. If the filter is too wide, multiple signals can no longer be distinguished. Generally, the smaller the filter width and the steeper its edges, the longer the settling time and thus the longer the "Sweep Time" must be.

All resolution bandwidths are realized with digital filters. Normal (3dB) Gaussian filters are set by default. Some communication standards require different filters.

For a list of available filter types, see the data sheet.

Normal (3 dB) Gaussian filters

Gaussian filters provide a good compromise between steep edges and a short settling time. This filter is suitable for most measurement tasks and is used by default.

The available Gaussian (3 dB) filters are listed in the R&S EPL1000 data sheet.

6 dB Gaussian filters

6 dB Gaussian filters are required for Receiver tests and measurements. The R&S EPL1000 provides bandwidths that comply to commercial and military standards. For details refer to the data sheet.

Channel filters

Channel filters are fairly steep but require a long settling time; they are useful for pulse measurements in the time domain.

4.5.1.7 How long the data is measured: Sweep Time

Each filter has a settling time that must be awaited in order to obtain correct results. Since the resolution bandwidth and video bandwidth define the filter, the smaller of the two determines the minimum "Sweep Time" required for the measurement. Allowed values depend on the ratio of span to RBW and RBW to VBW.

If the selected "Sweep Time" is too short for the selected bandwidth and span, level measurement errors will occur. In this case, the R&S EPL1000 displays the error message "Sweep time too low" and marks the indicated "Sweep Time" with a red bullet. Furthermore, a status bit indicates an error.

The "Sweep Time" can be coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW) automatically. If the span, resolution bandwidth or video bandwidth is changed, the "Sweep Time" is automatically adjusted.



Note that the "Sweep Time" only indicates how long data is captured; the time required to process the captured data may be considerably longer, in particular for FFT mode. For FFT mode, an estimated duration is indicated behind the "Sweep Time" in the channel bar (for RF measurements only).

4.5.1.8 How much data is measured: sweep points and sweep count

By default, 1001 data points are determined in a single sweep. During the next sweep, 1001 new data points are collected, and so on. The number of **sweep points** defines how much of the entire span is covered by a single data point. By increasing the number of sweep points you can increase the reliability of the individual data points and thus the accuracy of the analyzed results. However, these data points are all stored on the instrument, occupying a large amount of memory, and each sweep point increases the overall measurement time.

The number of sweeps to be performed in single sweep mode is defined by the "Sweep Count". Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed. The sweep count is applied to all the traces in a diagram.

If the trace configurations "Average", "Max Hold" or "Min Hold" are set, the "Sweep/Average Count" also determines the number of averaging or maximum search procedures (see [Chapter 5.3.1.2, "Analyzing several traces - trace mode"](#), on page 276).

4.5.1.9 How often data is measured: sweep mode

How often the spectrum is swept depends on the sweep mode. Either a certain number of sweeps can be defined ("Sweep Count") which are performed in "Single Sweep" mode, or the sweep is repeated continuously ("Continuous Sweep" mode).

By default, the data is collected for the specified number of sweeps and the corresponding trace is displayed. When the next sweep is started, the previous trace is deleted.

However, the data from a single sweep run can also be retained and displayed together with the new data ("Continue Single Sweep" mode). This is particularly of interest when using the trace configurations "Average" or "Max Hold" to take previously recorded measurements into account for averaging/maximum search (see [Chapter 5.3.1.2, "Analyzing several traces - trace mode"](#), on page 276).

4.5.2 Bandwidth, filter and sweep settings

Access: "Overview" > "Bandwidth"

The remote commands required to define these settings are described in [Chapter 6.8.5, "Bandwidth configuration"](#), on page 542.

How to perform a basic sweep measurement is described in [Chapter 3.1.2, "How to perform a basic sweep measurement"](#), on page 13.

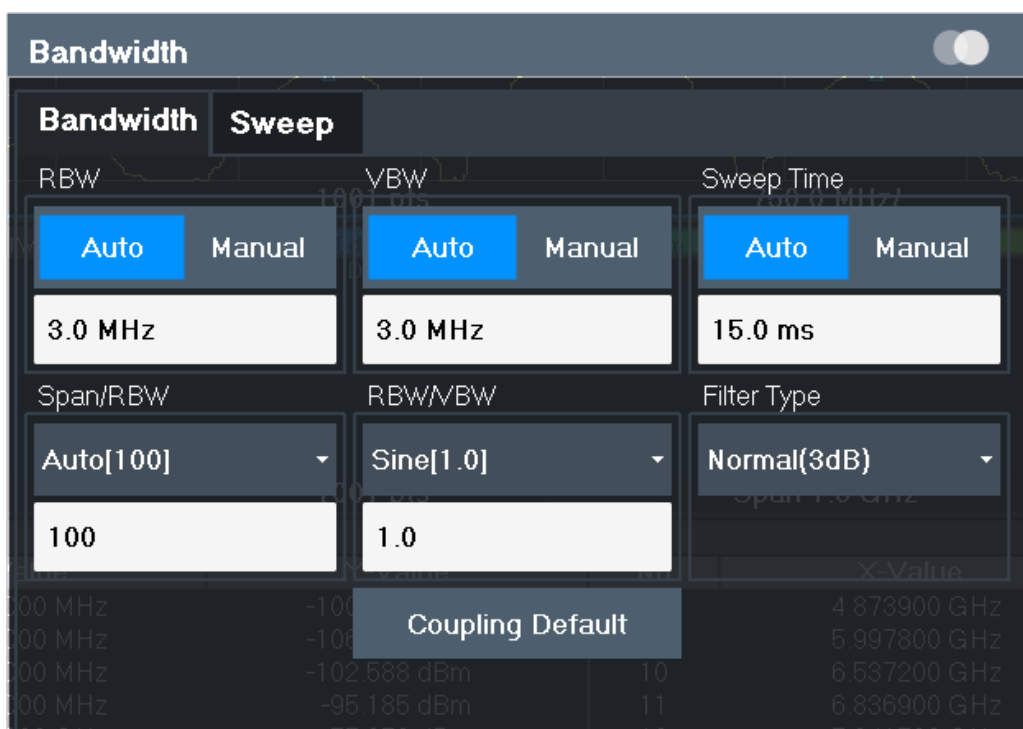


Figure 4-5: Bandwidth dialog box for RF measurements

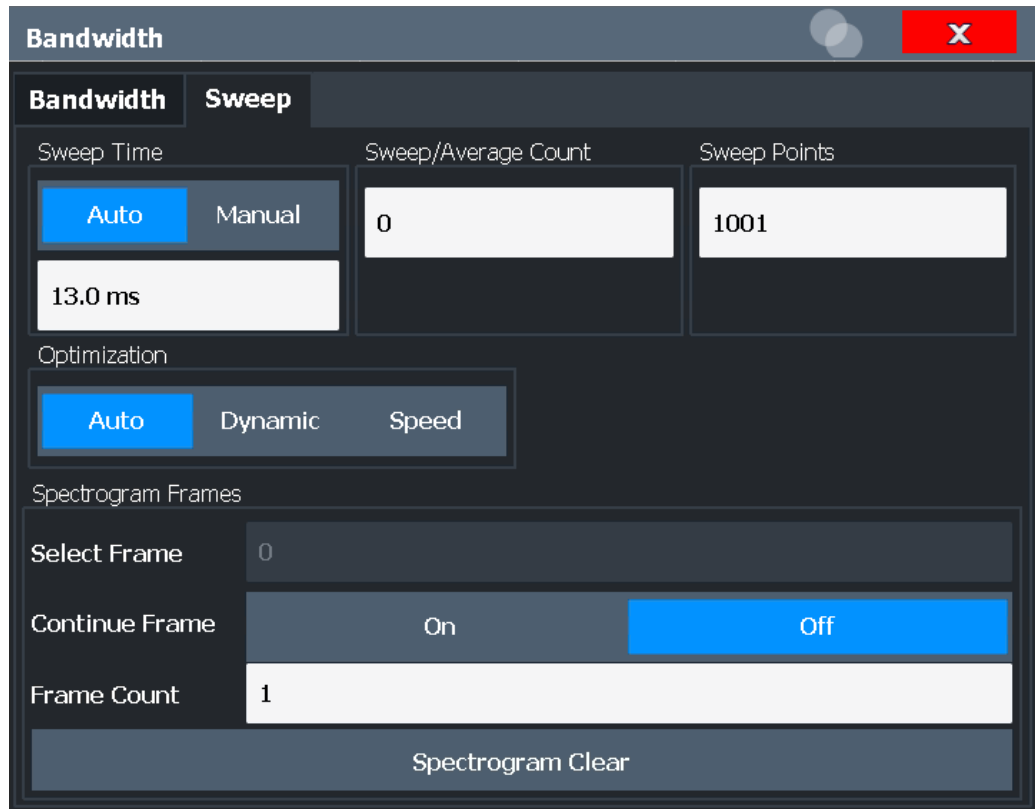


Figure 4-6: Sweep dialog box for spectrogram display

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VBW.....	233
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RBW/VBW.....	234
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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 a list of supported filters, see the data sheet.

For more information see [Chapter 4.5.1.1, "Separating signals by selecting an appropriate resolution bandwidth"](#), on page 226.

Note: Restrictions.

- For EMI measurements using the quasipeak detector, the 1 MHz RBW filter is not available (see [Chapter 3.13.3.1, "Resolution bandwidth and filter types"](#), on page 162).

Remote command:

[\[SENSe:\]BANDwidth\[:RESolution\]](#) on page 543

[\[SENSe:\]BANDwidth\[:RESolution\]:AUTO](#) on page 542

VBW

Defines the video bandwidth automatically or manually.

For more information see [Chapter 4.5.1.2, "Smoothing the trace using the video bandwidth"](#), on page 227.

"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 544

[\[SENSe:\]BANDwidth:VIDeo](#) on page 544

[\[SENSe:\]BANDwidth:VIDeo:TYPE](#) on page 545

Sweep Time

Defines the duration of a single sweep, during which the defined number of sweep points are measured. The "Sweep Time" can be defined automatically or manually.

The allowed "Sweep Time" depends on the device model; refer to the data sheet.

For more information see [Chapter 4.5.1.7, "How long the data is measured: Sweep Time"](#), on page 230.

Note: The "Sweep Time" only indicates how long data is captured; the time required to process the captured data may be considerably longer, in particular for FFT mode. For FFT mode, an estimated duration is indicated behind the "Sweep Time" in the channel bar (for RF measurements only).

- "Auto" The "Sweep Time" is coupled to the span (not zero span), video bandwidth (VBW) and resolution bandwidth (RBW). If the span, resolution bandwidth or video bandwidth is changed, the "Sweep Time" is automatically adjusted.
- "Manual" For manual mode, define the "Sweep Time" . Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible "Sweep Time" .

Remote command:

[\[SENSe:\] SWEEp:TIME:AUTO](#) on page 550

[\[SENSe:\] SWEEp:TIME](#) on page 549

[\[SENSe:\] SWEEp:DURation?](#) on page 548

Span/RBW

Sets the coupling ratio if **RBW** is set to auto mode.

For more information see [Chapter 4.5.1.4, "Coupling span and RBW"](#), on page 228.

- "Auto[100]" "Resolution Bandwidth" = "Span/100"
This coupling ratio is the default setting of the R&S EPL1000.
- "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 543

RBW/VBW

Sets the coupling ratio between the resolution bandwidth and the video bandwidth.

This setting is only effective if **VBW** is set to auto mode.

For more information see [Chapter 4.5.1.3, "Coupling VBW and RBW"](#), on page 227.

- "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[0.1]" "Video Bandwidth" = 10 x "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 544

[\[SENSe:\] BANDwidth:VIDeo:RATio](#) on page 544

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

For more information, see [Chapter 4.5.1.6, "Which data may pass: filter types"](#), on page 229.

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 543

Default Coupling

Sets all coupled functions to the default state ("Auto"). In addition, the ratio "RBW/VBW" is set to "Sine[1/1]" and the ratio "Span/RBW" to 100.

For more information see [Chapter 4.5.1.3, "Coupling VBW and RBW"](#), on page 227.

Remote command:

`[SENSe:]BANDwidth[:RESolution]:AUTO` on page 542

`[SENSe:]BANDwidth:VIDeo:AUTO` on page 544

`[SENSe:]SWEep:TIME:AUTO` on page 550

Sweep/Average Count

Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed.

The sweep count is applied to all the traces in all diagrams.

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

In continuous sweep mode, if "Sweep Count" = 0 (default), averaging is performed over 10 sweeps. For "Sweep Count" = 1, no averaging, maxhold or minhold operations are performed.

For more information, see [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230.

For spectrogram displays, the sweep count determines how many sweeps are combined in one frame in the spectrogram; that is: how many sweeps the R&S EPL1000 performs to plot one trace in the spectrogram result display. For more details, see ["Time frames"](#) on page 283.

Remote command:

`[SENSe:]SWEep:COUNT` on page 547

Sweep Points

Defines the number of measured values to be collected during one sweep.

For details see [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230.

All values from 101 to 100001 can be set. The default value is 1001 sweep points.

For EMI measurements, 200001 sweep points are available.

Remote command:

[SENSe:] SWEEp[:WINDow<n>]: POINTs on page 549

Optimization

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *subspan*. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

Table 4-2: Optimization parameters in FFT mode

Optimization mode	Description
"Dynamic"	Optimizes the dynamic range by using the narrowest possible subspan (depending on the RBW).
"Speed"	Optimizes the sweep rate by using the widest possible subspan (depending on the RBW). It is recommended that you set the Sweep Time to "Auto" to optimize the sweep rate.
"Auto"	Uses a medium-sized subspan to obtain a compromise between a large dynamic range and a fast sweep rate.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 4-3: Optimization parameters in zero span mode

Optimization mode	Description
Dynamic	The narrowest filter possible (depending on the RBW) is used.
Speed	The widest filter possible (depending on the RBW) is used.
Auto	A medium-sized prefilter is used.

Note: EMI measurements

For EMI measurements, "Dynamic" mode is not supported. "Auto" mode always uses "Speed" optimization.

Remote command:

[SENSe:] SWEEp:OPTimize on page 548

Sweep Type

The R&S EPL1000 automatically sets the optimal sweep type for the current measurement (sweep or FFT). The sweep type cannot be defined manually, except for EMI measurements. For measurements other than EMI, the sweep type is set to "Auto" automatically. See also [Chapter 4.5.1.5, "How data is measured: the sweep type"](#), on page 228.

Remote command:

[SENSe:] SWEEp:TYPE on page 550

FFT Subspans

Indicates the number of FFT subspans required to cover the entire measurement range (read-only).

Only available in EMI measurements in FFT sweep mode.

Remote command:

[\[SENSe:\] SWEEp: FFTSubspan?](#) on page 548

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, "Single Sweep" only controls the sweep mode for the currently selected channel setup. However, the sweep mode only takes effect the next time the Sequencer activates that channel setup, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel setup in single sweep mode only once.

Furthermore, [RUN SINGLE] controls the Sequencer, not individual sweeps. [RUN SINGLE] starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed channel setup is updated.

For details on the Sequencer, see the R&S EPL1000 User Manual.

Remote command:

Measurement mode: [INITiate<n>:CONTinuous](#) on page 393

Run measurement: [INITiate<n>\[:IMMediate\]](#) on page 392

[CALCulate<n>:SPECTrogram:CONTinuous](#) on page 579

Continuous Sweep / Run Cont

After triggering, starts the measurement and repeats it continuously until stopped.

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, "Continuous Sweep" only controls the sweep mode for the currently selected channel setup. However, the sweep mode only takes effect the next time the Sequencer activates that channel setup, and only for a channel-defined sequence. In this case, a channel setup in continuous sweep mode is swept repeatedly.

Furthermore, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see the R&S EPL1000 User Manual.

Remote command:

Measurement mode: [INITiate<n>:CONTinuous](#) on page 393

Run measurement: [INITiate<n>\[:IMMediate\]](#) on page 392

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 392

Spectrogram Frames

These settings are only available if spectrogram display is active.

For more information see [Chapter 5.3.3.4, "How to display and configure a spectrogram"](#), on page 308.

Select Frame ← Spectrogram Frames

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details, see ["Time frames"](#) on page 283.

Remote command:

[CALCulate<n>:SPECTrogram:FRAMe:SELEct](#) on page 580

Continue Frame ← Spectrogram Frames

Determines whether the results of the previous sweeps are included in the analysis of the next sweeps for trace modes "Max Hold", "Min Hold", and "Average".

This function is available in single sweep mode only.

- **On**
When the average or peak values are determined for the new sweep, the results of the previous sweeps in the spectrogram are also considered.
- **Off**
The average or peak values are determined from the results of the newly swept frames only.

Remote command:

[CALCulate<n>:SPECTrogram:CONTInuous](#) on page 579

Frame Count ← Spectrogram Frames

Determines how many frames are plotted during a single sweep (as opposed to a continuous sweep). The maximum number of possible frames depends on the history depth (see ["History Depth"](#) on page 303).

Remote command:

[CALCulate<n>:SPECTrogram:FRAMe:COUNt](#) on page 580

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 579

4.6 Trigger and gate configuration

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your signals.

Gating allows you to restrict measurement analysis to the important part or parts of the signal, for example bursts.

- [Triggering](#).....239
- [Gating](#).....247

4.6.1 Triggering

4.6.1.1 Trigger basics

In a basic measurement with default settings, the sweep is started immediately. However, sometimes you want the measurement to start only when a specific condition is fulfilled, for example a signal level is exceeded, or in certain time intervals. For these cases, you can define a trigger for the measurement. In FFT sweep mode, the trigger defines when the data acquisition starts for the FFT conversion.

An "Offset" can be defined to delay the measurement after the trigger event, or to include data before the actual trigger event in time domain measurements (pre-trigger offset).

For complex tasks, advanced trigger settings are available:

- Hysteresis to avoid unwanted trigger events caused by noise
- Holdoff to define exactly which trigger event causes the trigger in a jittering signal
- [Trigger source](#).....239
- [Trigger offset](#).....240
- [Trigger hysteresis](#).....240
- [Trigger drop-out time](#).....241
- [Trigger holdoff](#).....241

Trigger source

The trigger source defines which source must fulfill the condition that triggers the measurement. Basically, the source can be:

- Time: the measurement is repeated in a regular interval

- Power: an input signal is checked for a defined power level
The trigger signal can be any of the following:
 - The input signal at one of various stages in the signal analysis process - before or after the input mixer, after the video filter etc.
 - A signal from an external device via one of the TRIGGER INPUT / OUTPUT connectors on the instrument

For details on the available trigger sources, see ["Trigger Source"](#) on page 243.

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 EPL1000 captures data continuously in the time domain, even before the trigger occurs.

See ["Trigger Offset"](#) on page 245.

Trigger hysteresis

Setting a hysteresis for the trigger helps avoid unwanted trigger events caused by noise, for example. The hysteresis is a threshold to the trigger level that the signal must fall below on a rising slope or rise above on a falling slope before another trigger event occurs.

Example:

In the following example, the signal does not drop below the hysteresis (threshold) before it reaches the trigger level again. Thus, the second possible trigger event on the rising edge is ignored. On the falling edge, however, two trigger events occur. The signal exceeds the hysteresis before it falls to the trigger level the second time.

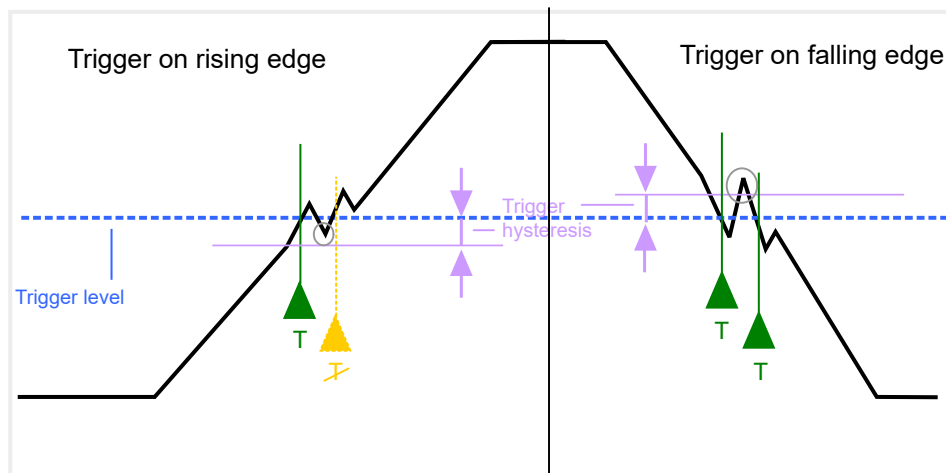


Figure 4-7: Effects of the trigger hysteresis

See ["Hysteresis"](#) on page 246

Trigger drop-out time

If a modulated signal is instable and produces occasional "drop-outs" during a burst, you can define a minimum duration that the input signal must stay below the trigger level before triggering again. This is called the "drop-out" time. Defining a dropout time helps you stabilize triggering when the analyzer is triggering on undesired events.

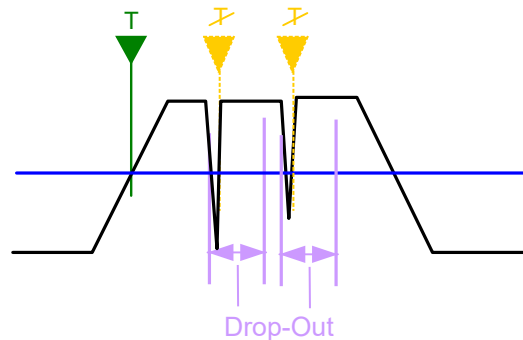


Figure 4-8: Effect of the trigger drop-out time

See "[Drop-Out Time](#)" on page 245.



Drop-out times for falling edge triggers

If a trigger is set to a falling edge ("Slope" = "Falling", see "[Slope](#)" on page 246) the measurement is to start when the power level falls below a certain level. This is useful, for example, to trigger at the end of a burst, similar to triggering on the rising edge for the beginning of a burst.

If a drop-out time is defined, the power level must remain below the trigger level at least for the duration of the drop-out time (as defined above). However, if a drop-out time is defined that is longer than the pulse width, this condition cannot be met before the final pulse. Thus, a trigger event does not occur until the pulsed signal is over.

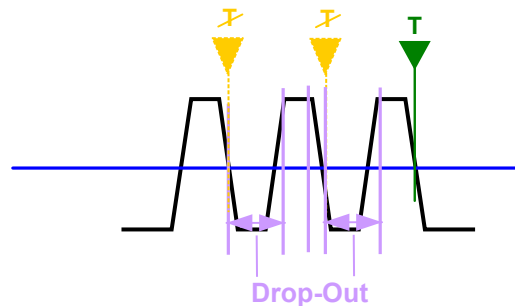


Figure 4-9: Trigger drop-out time for falling edge trigger

For gated measurements, a combination of a falling edge trigger and a drop-out time is generally not allowed.

Trigger holdoff

The trigger holdoff defines a waiting period before the next trigger after the current one will be recognized.

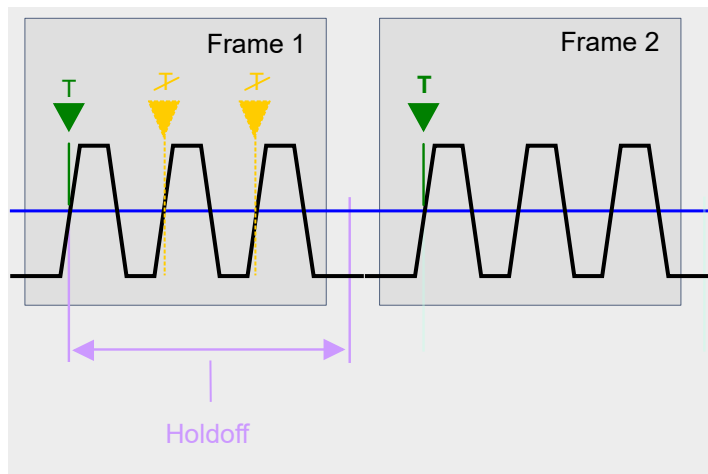


Figure 4-10: Effect of the trigger holdoff

See "Trigger Holdoff" on page 246.

4.6.1.2 Trigger settings

Access: "Overview" > "Trigger/Gate"

For step-by-step instructions on configuring triggered measurements, see [Chapter 4.6.1.4, "How to configure a triggered measurement"](#), on page 247.

Preview.....	243
L Frequency.....	243
L RBW.....	243
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Trigger Level.....	245
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Trigger Offset.....	245
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Trigger Holdoff.....	246
Slope.....	246

Preview

The preview mode allows you to try out trigger and gate settings before actually applying them to the current measurement.

The preview diagram displays a zero span measurement at the center frequency with the defined RBW and sweep time. This is useful when analyzing bursts, for example, to determine the required gate settings.

The trigger and gate settings are applied to the measurement when the dialog box is closed.

Note: The zero span settings refer only to the preview diagram. The main diagram remains unchanged.

If preview mode is switched off, any changes to the settings in this dialog box are applied to the measurement diagram directly. In this case, the zero span settings for the preview diagram are not displayed.

For information on the zero span settings, see:

- "Center Frequency" on page 211
- "RBW" on page 174
- "Sweep Time" on page 233

Frequency ← Preview

Defines the center frequency for the preview diagram.

Remote command:

[SENSe:] FREQuency:CENTer on page 531

RBW ← Preview

Defines the resolution bandwidth for the preview diagram. 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 543

Sweep Time ← Preview

Defines the sweep time for the preview diagram. Allowed values depend on the ratio of span to RBW and RBW to VBW. For details refer to the data sheet. Numeric input is always rounded to the nearest possible sweep time.

Trigger Source

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

For gated measurements, this setting also selects the gating source.

For more information, see "[Trigger source](#)" on page 239.

Remote command:

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 553

[\[SENSe:\]SWEep:EGATe:SOURce](#) on page 556

Free Run ← Trigger Source

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

In the Spectrum application, this is the default setting.

Remote command:

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 553

External Trigger 1 ← Trigger Source

Data acquisition starts when the TTL signal fed into the trigger input connector of the R&S EPL1000 meets or exceeds the specified trigger level.

(See "[Trigger Level](#)" on page 245).

Remote command:

`TRIG:SOUR EXT`

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 553

`SWE:EGAT:SOUR EXT` for gated triggering, see [\[SENSe:\]SWEep:EGATe:SOURce](#) on page 556

Video ← Trigger Source

Defines triggering by the video signal, i.e. the filtered and detected version of the input signal (the envelope of the IF signal), as displayed on the screen.

Define a trigger level from 0 % to 100 % of the diagram height. The absolute trigger level is indicated by a horizontal trigger line in the diagram, which you can also move graphically to change the trigger level.

A fixed hysteresis of 10 % of the specified trigger value (in V) is applied to the video trigger level automatically and cannot be changed.

Video mode is only available in the time domain, and not for I/Q-based data.

Remote command:

[TRIGger<tp>\[:SEQuence\]:SOURce](#) on page 553

IF Power ← Trigger Source

The R&S EPL1000 starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument data sheet.

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

This trigger source is only available for RF input.

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

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

Remote command:

[TRIGger<tp>\[:SEquence\]:SOURce](#) on page 553

[SWE:EGAT:SOUR IFP](#) for gated triggering, see [\[SENSe:\]SWEep:EGATe:SOURce](#) on page 556

Trigger Level

Defines the trigger level for the specified trigger source.

For gated measurements, this setting also defines the gate level.

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

For time triggers, the repetition interval is defined. See "[Repetition Interval](#)" on page 245.

Remote command:

[TRIGger\[:SEquence\]:LEVel:IFPower](#) on page 552

Repetition Interval

Defines the repetition interval for a time trigger.

The shortest interval is 2 ms.

Set the repetition interval to the exact pulse period, burst length, frame length or other repetitive signal characteristic. If the required interval cannot be set with the available granularity, configure a multiple of the interval that can be set. Thus, the trigger remains synchronized to the signal.

Remote command:

[TRIGger\[:SEquence\]:TIME:RINTerval](#) on page 554

Drop-Out Time

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

For more information on the drop-out time, see "[Trigger drop-out time](#)" on page 241.

Remote command:

[TRIGger\[:SEquence\]:DTIME](#) on page 551

Trigger Offset

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

For more information, see "[Trigger offset](#)" on page 240.

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: $\text{Pretrigger}_{\text{max}} = \text{sweep time}_{\text{max}}$

For the "Time" trigger source, this function is not available.

Remote command:

`TRIGger<tp>[:SEquence]:HOLDoff[:TIME]` on page 551

Hysteresis

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

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

For more information, see "[Trigger hysteresis](#)" on page 240.

Remote command:

`TRIGger[:SEquence]:IFPower:HYSteresis` on page 552

Trigger Holdoff

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

For more information, see "[Trigger holdoff](#)" on page 241.

Remote command:

`TRIGger[:SEquence]:IFPower:HOLDoff` on page 552

Slope

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

For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

Remote command:

`TRIGger<tp>[:SEquence]:SLOPe` on page 553

`[SENSe:]SWEep:EGATe:POLarity` on page 556

4.6.1.3 How to determine the required trigger/gate parameters

1. In the "Trigger And Gate" dialog box, switch on "Show Preview".
A zero span measurement for the currently defined center frequency is displayed.
2. Set the "Frequency", "RBW" and "Sweep Time" such that the relevant part of the signal is displayed, for example a complete burst.
3. Determine the parameters you want to use to define the trigger and gate conditions from the preview diagram, for example:
 - the length of a burst or slot
 - the upper or lower power level of a pulse
 - the maximum noise level
 - the power level or time at which a certain incident occurs
4. Try out different trigger and gate settings as described in [How to configure a triggered measurement](#) and [How to configure a gated measurement](#), then select

"Update Main Diagram" to see the effect of the current settings on the main measurement in the background.

5. If the results are as expected, close the dialog box to keep the changes permanently. Otherwise, correct the settings as necessary.

4.6.1.4 How to configure a triggered measurement

To define a time trigger:

1. In the "Trigger And Gate" dialog box, define the "Trigger Source" = "Time".
2. Define the "Repetition Interval": the time after which a new measurement is started.

To define an external trigger:

1. Connect an external device that will provide the trigger signal to one of the TRIGGER INPUT / OUTPUT connectors on the R&S EPL1000.
For details see the R&S EPL1000 "Getting Started" manual.
2. In the "Trigger And Gate" dialog box, define the "Trigger Source" = "External".
3. Configure the external trigger as described for the other power triggers.

To define a power trigger:

1. In the "Trigger And Gate" dialog box, define the "Trigger Source" = "IF Power".
2. Define the "Trigger Level": the power level at which the measurement will start.
3. Define whether the signal must cross the trigger level on a falling or on a rising edge ("Slope") to trigger the measurement.
4. To start the measurement with a time delay, define a "Trigger Offset".
5. To reject triggers due to noise or jittering in the signal, define a "Hysteresis" that is larger than the expected noise or jittering. After the previous trigger, the signal must exceed this threshold before the next level crossing triggers a new measurement.
6. To skip multiple triggers in a burst, define a "Holdoff" time that must pass between two triggers. The holdoff time should be slightly larger than the burst.

4.6.2 Gating

- [Gated measurements](#).....248
- [Gate settings](#).....250
- [How to configure a gated measurement](#).....251

4.6.2.1 Gated measurements

Like a gate provides an opening in a fence, a gated measurement lets data from the input signal pass in defined areas only. The *gate* controls exactly when data is included in the measurement results and when not. The gate is opened by the trigger source, which is also the gate source.

Gates can be used in two different modes:

- **Level:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the gate source drops below the "Gate Level".
Using a pulsed gate signal in level mode, the following behavior can be achieved: When the gate source signal is active, the input signal data is collected; when the gate signal is inactive, the input signal is ignored.
- **Edge:** The gate opens and the measurement starts when a defined level in the gate source is exceeded and stops when the defined "Gate Length" is reached.

Additionally, a delay time can be defined so that the first few measurement points after the gate opening are ignored.

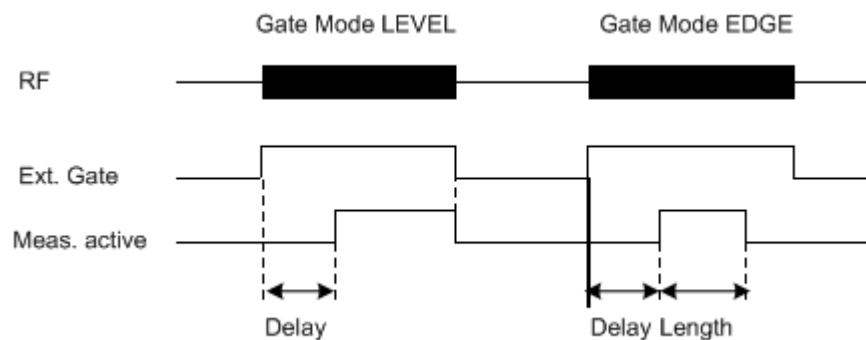


Figure 4-11: Effects of Gate mode, Gate delay and Gate length

Example:

By using a gate in sweep mode and stopping the measurement while the gate signal is inactive, the spectrum for pulsed RF carriers can be displayed without the superposition of frequency components generated during switching. Similarly, the spectrum can also be analyzed for an inactive carrier. The sweep can be controlled by an external gate or by the internal power trigger.

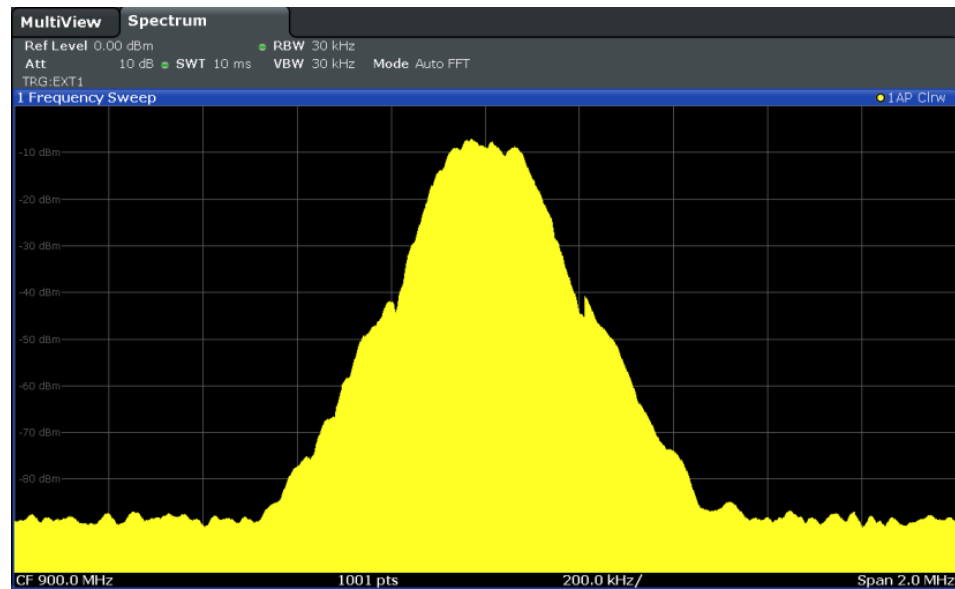


Figure 4-12: GSM signal with GATE OFF

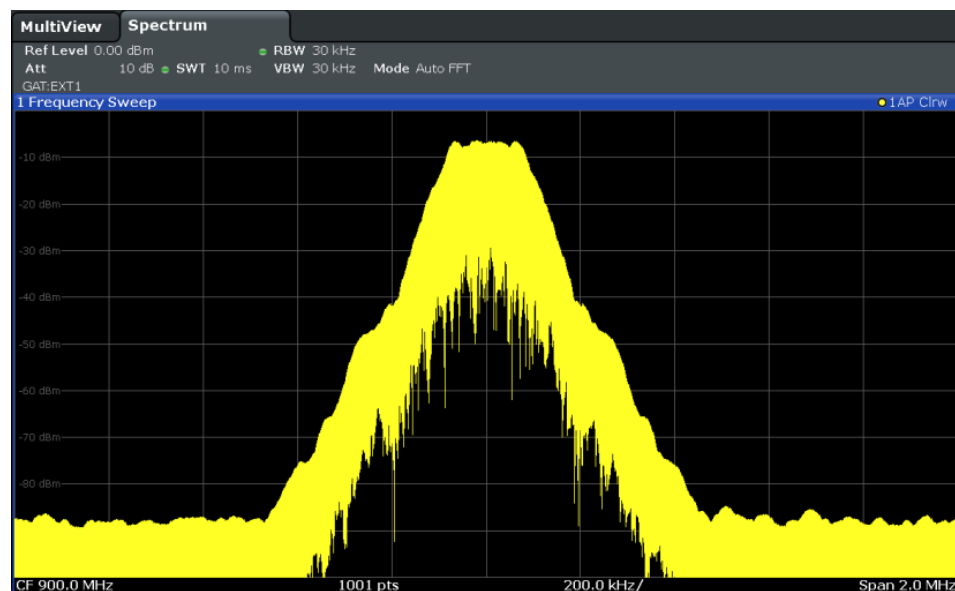


Figure 4-13: GSM signal with GATE ON

To indicate that a gate is used for the sweep, "GAT" and the gate source is displayed in the channel bar.

4.6.2.2 Gate settings

Access: "Overview" > "Trigger" > "Trigger / Gate Config." > "Gate Settings"

Gate settings define one or more extracts of the signal to be measured.

Gated Trigger	<input checked="" type="radio"/> On	<input type="radio"/> Off
Gate Mode	<input type="radio"/> Level	<input checked="" type="radio"/> Edge
Gate Delay	0 s	
Gate Length	400.0 μ s	



Gating is not available for measurements on I/Q-based data.

Gated Trigger.....	250
Gate Mode.....	250
Gate Delay.....	251
Gate Length.....	251

Gated Trigger

Switches gated triggering on or off.

Note: Gating is not available for time domain scans and measurements on I/Q based data.

Remote command:

[SENSe:] SWEep:EGATE on page 554

Gate Mode

Sets the gate mode.

For more information, see [Chapter 4.6.2.1, "Gated measurements"](#), on page 248

- "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 EPL1000 ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

Remote command:

[SENSe:] SWEep:EGATE:TYPE on page 556

Gate Delay

Defines the delay time between the gate signal and the continuation of the measurement.

In the Spectrum application, the delay position on the time axis in relation to the sweep is indicated by a line labeled "GD".

For more information, see [Chapter 4.6.2.1, "Gated measurements"](#), on page 248

Remote command:

`[SENSe:] SWEep:EGATe:HOLDoff` on page 555

Gate Length

Defines how long the gate is open when it is triggered.

The gate length can only be set in the edge-triggered gate mode. In the level-triggered mode the gate length depends on the level of the gate signal.

The gate length in relation to the sweep is indicated by a line labeled "GL".

In the Spectrum application, the gate length in relation to the sweep is indicated by a line labeled "GL".

For more information, see [Chapter 4.6.2.1, "Gated measurements"](#), on page 248

Remote command:

`[SENSe:] SWEep:EGATe:LENGth` on page 555

4.6.2.3 How to configure a gated measurement

A gated measurement records data only while the gate conditions are fulfilled. These step-by-step instructions demonstrate how to configure a gated measurement manually.

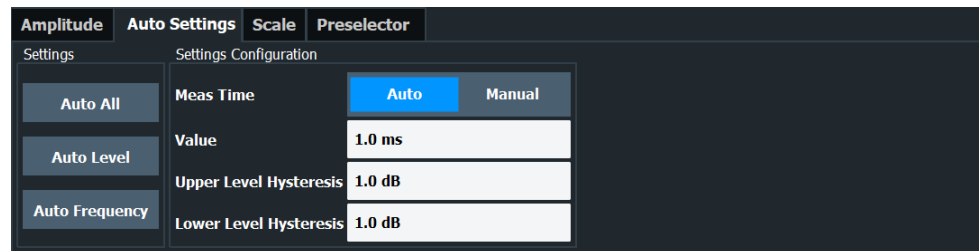
To configure a common gated measurement

1. Determine the required parameters as described in [Chapter 4.6.1.3, "How to determine the required trigger/gate parameters"](#), on page 246.
2. The gate is opened by a trigger event, which must be based on a power source. Define the trigger as described in [Chapter 4.6.1.3, "How to determine the required trigger/gate parameters"](#), on page 246.
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".

4.7 Adjusting settings automatically

Access: "Overview" > "Amplitude"/"Frequency" > "Auto Settings"



Some settings can be adjusted by the R&S EPL1000 automatically according to the current measurement settings. To do so, a measurement is performed. You can configure this measurement.



Adjusting settings automatically during triggered measurements

When you select an auto adjust function, a measurement is performed to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how the R&S EPL1000 should behave:

- (Default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger. The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows for "IF Power" and "RF Power" triggers:
Trigger level = Reference level - 15 dB

Remote command:

`[SENSe:]ADJust:CONFigure:TRIGger` on page 559

Adjusting all Determinable Settings Automatically (Auto All).....	252
Adjusting the Center Frequency Automatically (Auto Frequency).....	253
Setting the Reference Level Automatically (Auto Level).....	253
Resetting the Automatic Measurement Time (Meas Time Auto).....	253
Changing the Automatic Measurement Time (Meas Time Manual).....	253
Upper Level Hysteresis.....	254
Lower Level Hysteresis.....	254

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings, including:

- [Auto Frequency](#)
- [Auto Level](#)

Remote command:

[\[SENSe:\]ADJust:ALL](#) on page 557

Adjusting the Center Frequency Automatically (Auto Frequency)

The R&S EPL1000 adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest S/N ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

This function is not available during signal tracking (see [Chapter 4.3.3, "Keeping the center frequency stable - signal tracking"](#), on page 213).

Remote command:

[\[SENSe:\]ADJust:FREQuency](#) on page 559

Setting the Reference Level Automatically (Auto Level)

Automatically determines a reference level which ensures that no overload occurs at the R&S EPL1000 for the current input data. At the same time, the internal attenuators are adjusted. As a result, the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S EPL1000.

If necessary, you can optimize the reference level further. Decrease the attenuation level manually to the lowest possible value before an overload occurs, then decrease the reference level in the same way.

You can change the measurement time for the level measurement if necessary (see ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 253).

Remote command:

[\[SENSe:\]ADJust:LEVel](#) on page 560

Resetting the Automatic Measurement Time (Meas Time Auto)

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

(Spectrum and AM/FM/PM modulation analysis application: 1 ms)

Remote command:

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) on page 558

Changing the Automatic Measurement Time (Meas Time Manual)

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

Note: The maximum measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration actually used to determine the automatic settings can be shorter than the value you define here.

Remote command:

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) on page 558

[\[SENSe:\]ADJust:CONFigure:LEVel:DURation](#) on page 557

Upper Level Hysteresis

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:HYSTeresis:UPPer](#) on page 558

Lower Level Hysteresis

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

Remote command:

[\[SENSe:\]ADJust:CONFigure:HYSTeresis:LOWer](#) on page 558

5 Common analysis and display functions

Access: "Overview" > "Analysis"

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings and functions that may deviate from these common settings.

- [Result display configuration](#).....255
- [Zoomed displays](#).....262
- [Configuring traces](#).....268
- [Marker Usage](#).....317
- [Display and limit lines](#).....354

5.1 Result display configuration

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Thus, the result display is highly configurable to suit your specific requirements and optimize analysis. Here you can find out how to optimize the display for your measurement results.

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 EPL1000 User Manual.

- [Basic evaluation methods](#).....255
- [Laying out the result display with the smartgrid](#).....258

5.1.1 Basic evaluation methods

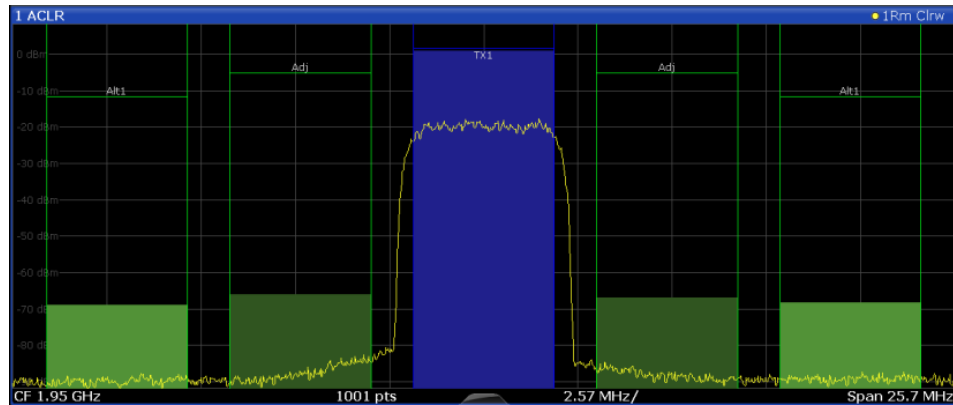
Measurement results can be displayed and evaluated using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

The evaluation methods described here are available for most measurements in the Spectrum application.

- [Diagram](#).....256
- [Marker Table](#).....256
- [Marker Peak List](#).....256
- [Result Summary](#).....257
- [Spectrogram](#).....257

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 384

Results:

[TRACe<n>\[:DATA\]](#) on page 564

Marker Table

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

This table is displayed automatically if configured accordingly.

2 Marker							
Type	Ref	Trc	Stimulus	Response	Function	Function Result	
N1		1	13.197 GHz	-25.87 dBm	Count	13.197057	
D1	N1	1	-7.942 GHz	-49.41 dB			
D2	N1	2	-3.918 GHz	-21.90 dB			
D3	N1	3	4.024 GHz	-21.99 dB			

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

Remote command:

LAY:ADD? '1',RIGH, MTAB, see [LAYout:ADD\[:WINDow\]?](#) on page 384

Results:

[CALCulate<n>:MARKer<m>:X](#) on page 593

[CALCulate<n>:MARKer<m>:Y?](#) on page 608

Marker Peak List

The marker peak list determines the frequencies and levels of peaks in the spectrum or time domain. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

You can define search and sort criteria to influence the results of the analysis.

[More information](#)

3 Marker Peak List				
Wnd	No	X-Value	Y-Value	
2	1	1.086245 ms	-75.810 dBm	
2	2	2.172490 ms	-6.797 dBm	
2	3	3.258736 ms	-76.448 dBm	
2	4	4.831918 ms	-76.676 dBm	
2	5	6.255274 ms	-76.482 dBm	
2	6	6.798397 ms	-6.800 dBm	
2	7	9.233084 ms	-76.519 dBm	
2	8	10.075861 ms	-76.172 dBm	
2	9	11.405574 ms	-6.801 dBm	

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

Remote command:

LAY:ADD? '1',RIGH, PEAK, see LAYout:ADD[:WINDow]? on page 384

Results:

CALCulate<n>:MARKer<m>:X on page 593

CALCulate<n>:MARKer<m>:Y? on page 608

Result Summary

Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.

2 Result Summary				
Channel	Bandwidth	Offset	Power	
TX1 (Ref)	1.229 MHz		-0.86 dBm	
Tx Total			-0.86 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	30.000 kHz	750.000 kHz	-79.59 dB	-80.34 dB
Alt1	30.000 kHz	1.980 MHz	-85.04 dB	-83.85 dB

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

Remote command:

LAY:ADD? '1',RIGH, RSUM, see LAYout:ADD[:WINDow]? on page 384

Spectrogram

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency or sweep time, the y-axis shows the measurement time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

The spectrogram display consists of two diagrams: the standard spectrum result display (upper diagram) and the spectrogram result display (lower diagram).

For details see [Chapter 5.3.1.7, "Working with spectrograms"](#), on page 281.

Remote command:

LAY:ADD? '1',RIGH, SGR, see LAYout:ADD[:WINDow]? on page 384

5.1.2 Laying out the result display with the smartgrid

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Each type of evaluation is displayed in a separate window in the channel setup tab. Up to 16 individual windows can be displayed per channel setup (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.

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](#).....258
 - [How to activate smartgrid mode](#).....260
 - [How to add a new result window](#).....260
 - [How to close a result window](#).....261
 - [How to arrange the result windows](#).....261

5.1.2.1 Background information: the smartgrid principle

SmartGrid display

During any positioning action, the underlying SmartGrid is displayed. Different colors and frames indicate the possible new positions. The position in the SmartGrid where you drop the window determines its position on the screen.

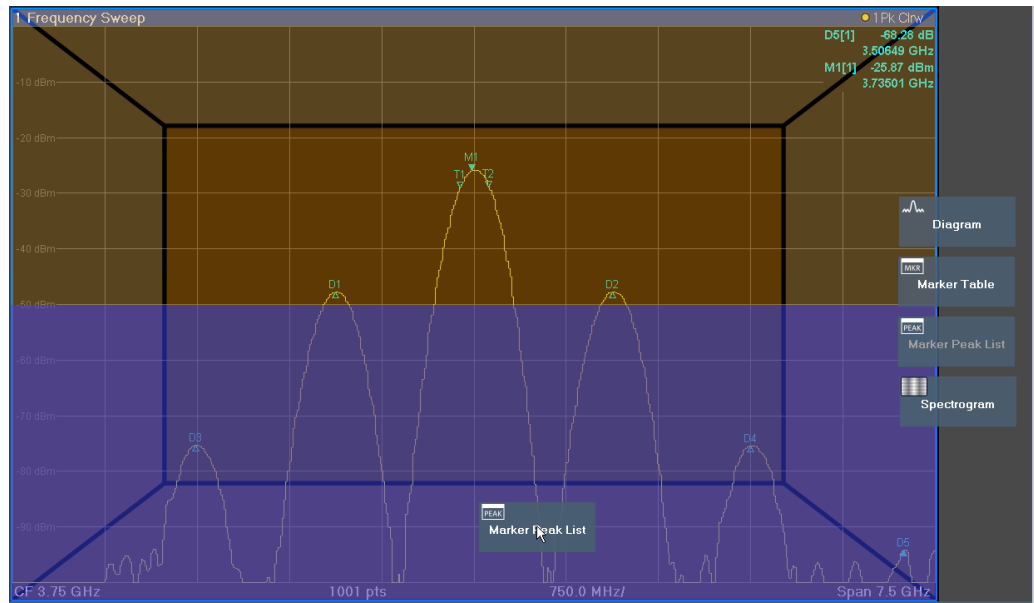


Figure 5-1: Moving a window in SmartGrid mode

The brown area indicates the possible "drop area" for the window, i.e. the area in which the window can be placed. A blue area indicates the (approximate) layout of the window as it would be if the icon were dropped at the current position. The frames indicate the possible destinations of the new window with respect to the existing windows: above/below, right/left or replacement (as illustrated in Figure 5-2). If an existing window would be replaced, the drop area is highlighted in a darker color shade.

Positioning the window

The screen can be divided into up to four rows. Each row can be split into up to four columns, where each row can have a different number of columns. However, rows always span the entire width of the screen and may not be interrupted by a column. A single row is available as the drop area for the window in the SmartGrid. The row can be split into columns, or a new row can be inserted above or below the existing row (if the maximum of 4 has not yet been reached).

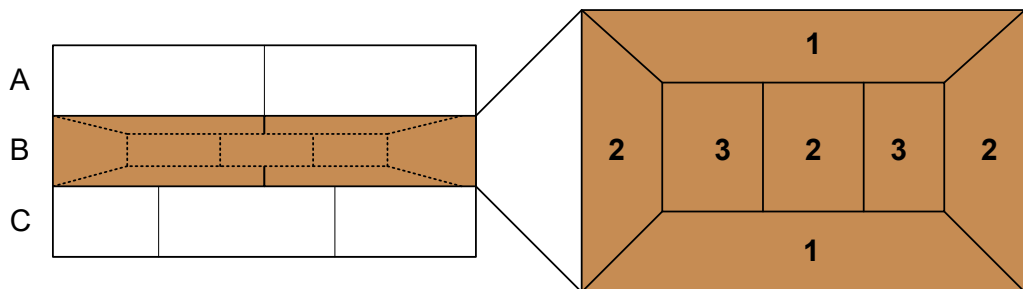


Figure 5-2: SmartGrid window positions

- 1 = Insert row above or below the existing row
- 2 = Create a new column in the existing row
- 3 = Replace a window in the existing row

SmartGrid functions

Once the evaluation icon has been dropped, icons in each window provide delete and move functions.



The "Move" icon allows you to move the position of the window, possibly changing the size and position of the other displayed windows.



The "Delete" icon allows you to close the window, enlarging the display of the remaining windows.

5.1.2.2 How to activate smartgrid mode

All display configuration actions are only possible in SmartGrid mode. In SmartGrid mode the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.

► To activate SmartGrid mode, do one of the following:



Select the "SmartGrid" icon from the toolbar.

- Select "Display Config" in the configuration "Overview".
- Select "Display Config" from the [Meas Config] menu.

The SmartGrid functions and the evaluation bar are displayed.



To close the SmartGrid mode and restore the previous softkey menu, select the "Close" icon, or press any key.

5.1.2.3 How to add a new result window

Each type of evaluation is displayed in a separate window. Up to 16 individual windows can be displayed per channel setup (i.e. per tab).

1. Activate SmartGrid mode.

All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar.

2. Select the icon for the required evaluation method from the evaluation bar.

If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. Touch the evaluation bar between the icons and move it up or down until the required icon appears.

3. Drag the required icon from the evaluation bar to the SmartGrid, which is displayed in the diagram area, and drop it at the required position. (See [Chapter 5.1.2.5](#),

"How to arrange the result windows", on page 261 for more information on positioning the window).

Remote command:

`LAYout:ADD[:WINDow]?` on page 384 / `LAYout:WINDow<n>:ADD?` on page 389

5.1.2.4 How to close a result window

- ▶ To close a window, activate SmartGrid mode and select the "Delete" icon for the window.



Remote command:

`LAYout:REMove[:WINDow]` on page 387 / `LAYout:WINDow<n>:REMove` on page 390

5.1.2.5 How to arrange the result windows

1. Select an icon from the evaluation bar or the "Move" icon for an existing evaluation window.



2. Drag the evaluation over the SmartGrid.
A blue area shows where the window will be placed.
3. Move the window until a suitable area is indicated in blue.
4. Drop the window in the target area.
The windows are rearranged to the selected layout, and "Delete" and "Move" icons are displayed in each window.
5. To close a window, select the corresponding "Delete" icon.



Remote command:

`LAYout:REPLace[:WINDow]` on page 387 / `LAYout:WINDow<n>:REPLace` on page 390

LAYout:MOVE[:WINDow] on page 386

5.2 Zoomed displays

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touchscreen or a mouse pointer you can easily define the area to be enlarged.

Graphical Zoom Versus Measurement Zoom

Graphical zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points, the frequency range, or the reference level. Graphical zooming only changes the resolution of the displayed trace points temporarily. You must explicitly activate the graphical zoom function (see [Chapter 5.2.2, "Zoom functions"](#), on page 264).



Graphical zoom and the number of sweep points

Note that (graphical) 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 resolution of the trace in the zoomed region is poor (see [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230).



Zoom and the number of sweep points

Note that zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points!

You should increase the number of sweep points before zooming, as otherwise the function has no real effect (see [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230).

- [Single zoom versus multiple zoom](#).....262
- [Zoom functions](#).....264
- [How to zoom into a diagram](#)..... 266

5.2.1 Single zoom versus multiple zoom

Two different (graphical) zoom modes are available: single zoom and multiple zoom. A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible. In multiple zoom mode, you can enlarge up to four different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom areas can be moved and resized any time. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.



In the receiver application, multiple zoom is not available.

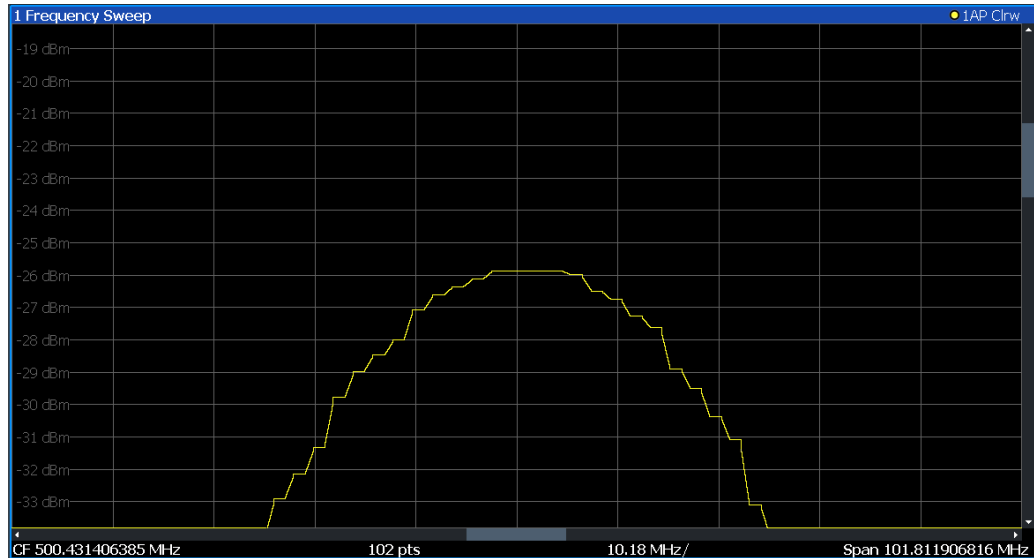


Figure 5-3: Single zoom

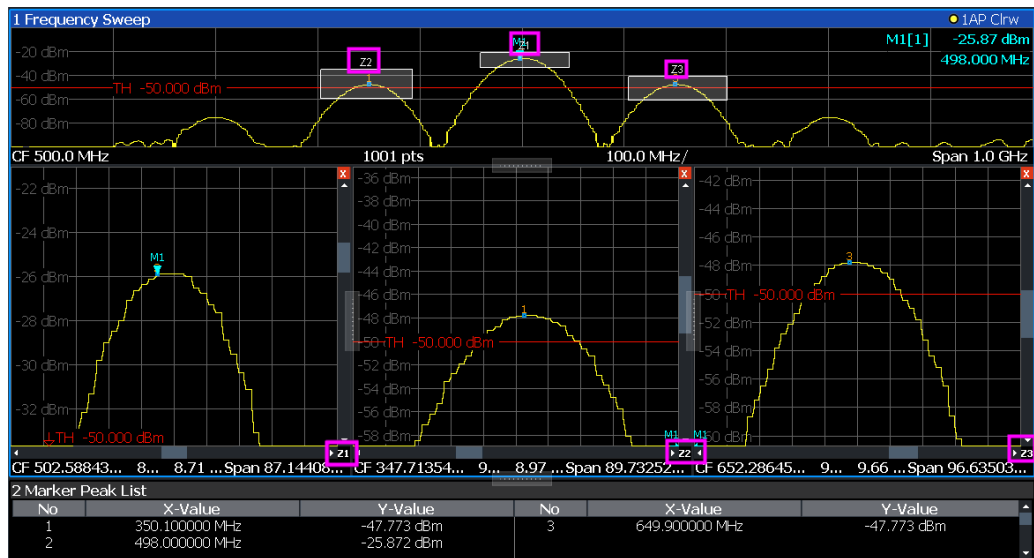


Figure 5-4: Multiple zoom



Using the zoom area to restrict a peak search

In the Spectrum application, the selected zoom area can be used to restrict the search range for a peak search, but only in single zoom mode (see ["Use Zoom Limits"](#) on page 328).

5.2.2 Zoom functions

Access: "Zoom" icons in toolbar

Single Zoom.....	264
Multi-Zoom.....	264
Measurement Zoom.....	264
L Level Lock.....	265
L X-Lock.....	265
L Y-Lock.....	265
L Adapt Measurement to Zoom (selected diagram).....	265
Restore Original Display.....	265

Single Zoom



A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 563

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA` on page 560

Multi-Zoom



In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`
on page 562

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA`
on page 561

Measurement Zoom

As opposed to the graphical zoom, which is merely a visual tool, the measurement zoom adapts the measurement settings such that the data you are interested in is displayed in the required detail. In measurement zoom mode, you can change the display using touch gestures. This is the default operating mode of the R&S EPL1000.

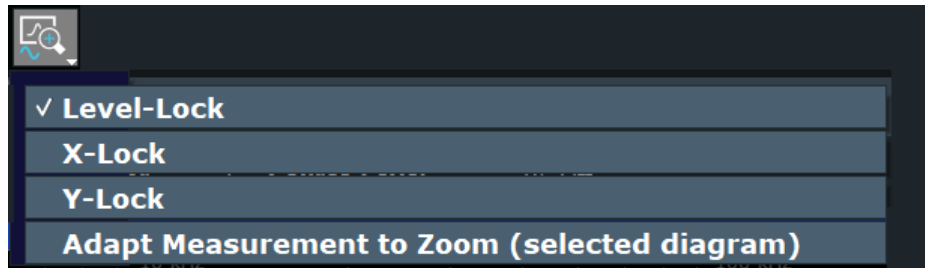
For details on touch gestures see "Operating Basics" in the R&S EPL1000 Getting Started manual.

Note: The measurement settings are adapted to practical values based on a suitable grid for the current settings, rather than to unwieldy values that reflect precisely the pixel you happen to tap.

If the measurement zoom leads to undesirable results, you can easily return to the original measurement settings using the "UNDO" function.

When you select the "Measurement Zoom" icon, then tap in a diagram, a dotted rectangle is displayed which you can drag to define the zoom area. This allows you to define the zoom area more precisely than by spreading two fingers in the display.

The measurement zoom function provides further options in a context-sensitive menu, which is displayed when you tap the icon for about a second (or right-click it). These options concern the behavior of the firmware for subsequent touch gestures on the screen. Note that these settings remain unchanged after a channel preset.



Level Lock ← Measurement Zoom

If activated (default), the reference level (and thus the attenuation) is locked, that is: remains unchanged during touch gestures on the screen.

X-Lock ← Measurement Zoom

If activated, the x-axis of the diagram is not changed during subsequent touch gestures.

Y-Lock ← Measurement Zoom

If activated, the y-axis of the diagram is not changed during subsequent touch gestures.

Adapt Measurement to Zoom (selected diagram) ← Measurement Zoom

If you already performed a graphical zoom using the "Single Zoom" on page 264 or "Multi-Zoom" on page 264 functions, this function automatically adapts the measurement settings to maintain the currently zoomed display.

Restore Original Display



Restores the original display, that is, the originally calculated displays for the entire capture buffer, and closes all zoom windows.

Note: This function only restores graphically zoomed displays. Measurement zooms, for which measurement settings were adapted, are recalculated based on the adapted measurement settings. In this case, the zoomed display is maintained.

Remote command:

Single zoom:

`DISPlay[:WINDow<n>] [:SUBWindow<w>]:ZOOM[:STATe]` on page 563

Multiple zoom:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`
on page 562 (for each multiple zoom window)

5.2.3 How to zoom into a diagram

The remote commands required to zoom into a display are described in [Chapter 6.9.1, "Zoom"](#), on page 560.

The following tasks are described here:

- ["To zoom into the diagram at one position"](#) on page 266
- ["To return to original display"](#) on page 267
- ["To zoom into multiple positions in the diagram"](#) on page 267
- ["To maintain a zoomed display permanently"](#) on page 268

To zoom into the diagram at one position

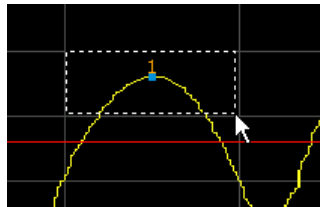
1.



Click on the "Single Zoom" icon in the toolbar.

Zoom mode is activated.

2. Tap and drag your finger in the diagram to select the area to be enlarged. The selected area is indicated by a dotted rectangle.



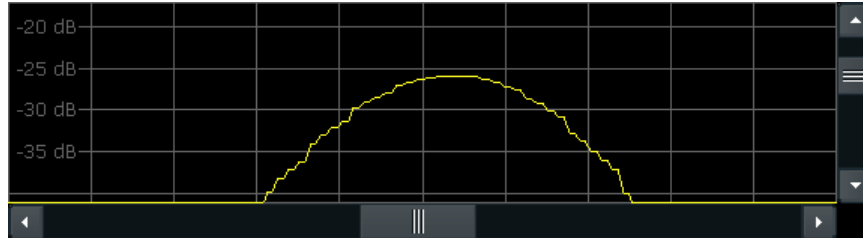
When you leave the touchscreen, the diagram is replaced by the zoomed trace area.

3. Repeat these steps, if necessary, to enlarge the diagram further.



Scrolling in the zoomed display

You can scroll the diagram area to display the entire diagram using the scrollbars at the right and at the bottom of the diagram.



To return to original display



Click on the "Zoom Off" icon in the toolbar.

The original trace display is restored. Zoom mode remains active, however.

To zoom into multiple positions in the diagram



Click on the "Multi-Zoom" icon in the toolbar.

Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged as described in ["To zoom into the diagram at one position"](#) on page 266. The selected area is indicated by a dotted rectangle.

When you have completed your selection, the original trace is shown in an overview diagram with the selected area indicated by a dotted rectangle. The zoomed trace area is displayed in a separate window (see [Figure 5-4](#)).



Click on the "Multi-Zoom" icon in the toolbar again.

4. In the overview diagram, select the next area to be enlarged.
The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.
5. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

- ▶ To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.
To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.
- The contents of the zoom windows are adapted accordingly.

To maintain a zoomed display permanently

Graphical zooming only changes the resolution of the displayed trace points temporarily. In order to change the display permanently, you must change the corresponding measurement settings.

(Note: Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display, see ["To perform a measurement zoom"](#) on page 268).

1. Perform a graphical zoom as described in the previous procedures.
2. Select the "Measurement Zoom" icon from the toolbar.
3. Select "Adapt Measurement to Zoom (selected diagram)".



The measurement settings are adapted as required to obtain the zoomed result display.

To perform a measurement zoom

Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display.



1. Select the "Measurement Zoom" icon from the toolbar.
2. Do one of the following to define the zoom area:
 - Stretch two fingers in the diagram to enlarge the area between them.
 - Tap and drag one finger in the diagram to select the area to be enlarged. The selected area is indicated by a dotted rectangle.

The measurement settings are adapted as required to obtain the zoomed result display.

5.3 Configuring traces

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

• Basic information about traces	269
• Trace configuration	290
• How to configure traces	306
• References	312

5.3.1 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	269
• Analyzing several traces - trace mode	276
• How many traces are averaged - sweep count + Sweep mode	277
• How trace data is averaged - the averaging mode	278
• Trace smoothing	279
• Displaying a reference trace - importing trace data	280
• Working with spectrograms	281

5.3.1.1 Mapping samples to sweep points with the trace detector

A trace displays the values measured at the measurement points (also known as sweep points in some applications). However, the number of samples taken during a measurement can be much larger than the number of measurement points that are displayed in the measurement trace.

Example:

Assume the following measurement parameters:

- Sample rate: 32 MSamples / s
- Measurement points: 1000
- Measurement time: 100 ms
- Span: 5 GHz

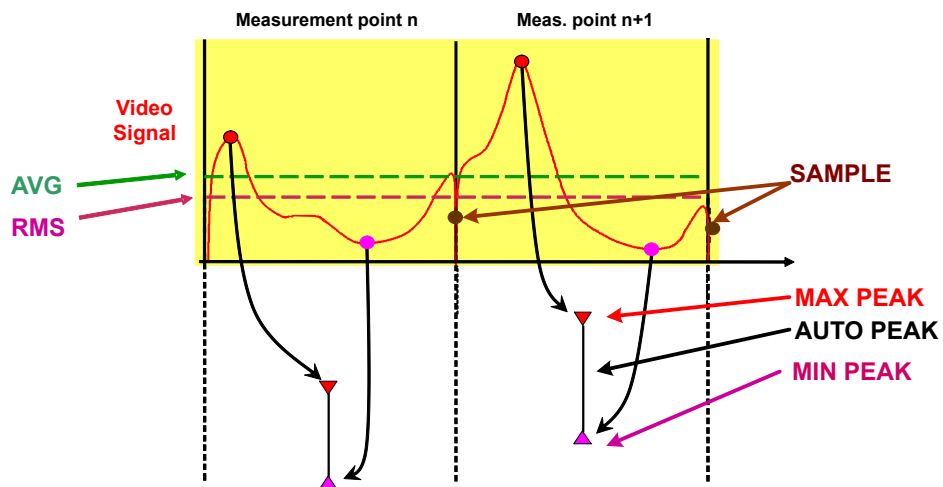
During a single measurement, $3.2 \cdot 10^6$ samples are collected and distributed to 1000 measurement points, i.e. 3200 samples are collected per measurement point. For each measurement point, the measured data for a frequency span of 5 MHz (span/<measurement points>) is analyzed.

Note that if you increase the number of measurement points, the frequency span analyzed for each point in the trace decreases, making the trace more reliable. The analyzed results become more accurate. On the other hand, for detectors that average the samples within the span, the trace becomes less stable because fewer samples are averaged.

See also [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230.

Obviously, the data must be reduced to determine which of the samples are displayed for each measurement point. This is the trace detector's task. The trace detector can analyze the measured data using various methods.

The result obtained from the selected detector for a measurement point is displayed as the value at this frequency point in the trace.



You can define the trace detector to be used for the individual traces manually, or the R&S EPL1000 can select the appropriate detector automatically.

The detectors of the R&S EPL1000 are implemented as pure digital devices. All detectors work in parallel in the background, which means that the measurement speed is independent of the detector combination used for different traces.

However, you should select a measurement time that is sufficient for the detector that requires the longest measurement time.

Auto detector

If the R&S EPL1000 is set to define the appropriate detector automatically, the detector is set depending on the selected trace mode and average mode:

Trace mode	Detector
"Clear Write"	Auto peak
"Max Hold"	Positive peak
"Min Hold"	Negative peak
"Average"	Sample peak (for average mode "Power": RMS)
"View"	–
"Blank"	–



The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation. Not all detector types are supported by all applications available for the R&S EPL1000.

Table 5-1: Detector types

Detector	Abbrev.
Positive peak	"Pk"
Negative peak	"Mi"
Auto peak	"Ap"
RMS	"Rm"
Average	"Av"

EMI measurement detectors

Some additional detectors are available if the EMI (R&S EPL1-K54) measurement option is installed. However, the EMI measurement need not be active. The additional detectors are especially designed for and required by EMI applications.

Table 5-2: Detector types

Detector	Abbrev.
Quasi Peak	"QP"
CISPR Average detector	"CISPR AV"
RMS Average detector	"RMS AV"

Measurement time

The measurement time defines how long the R&S EPL1000 measures the signal at the individual frequencies. Each detector needs a different period of time to fully charge and discharge; the individual requirements on the measurement time are described for each detector.

- [Positive peak \(max peak\) and negative peak \(min peak\) detector](#)..... 271
- [Auto peak detector](#).....272
- [RMS detector](#).....272
- [Average detector](#).....273
- [Sample detector](#).....274
- [Quasipeak detector](#).....274
- [CISPR average detector](#).....275
- [RMS average detector](#).....275

Positive peak (max peak) and negative peak (min peak) detector

The positive (maximum) detector determines the largest of all positive peak values measured at the individual measurement points which are combined in one sample point.

The negative (minimum) peak detector determines the smallest of all negative peak values measured at the individual measurement points which are combined in one sample point.

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.

- For pulsed signals, measurement time must be longer than the expected pulse length, that is: it must cover at least one pulse.

Auto peak detector

The auto peak detector combines the "Positive peak (max peak) and negative peak (min peak) detector" on page 271. The maximum and the minimum values determined for each sample point are displayed.

Available in the spectrum application, but not for the Spectrum Emission Mask measurement.

RMS detector

The RMS detector calculates the root mean square of all samples combined in a sweep point. The whole IF envelope is used to calculate the power for each measurement point. The IF envelope is digitized using a sample rate which is at least five times the selected resolution bandwidth. Based on the sample values, the power is calculated for each measurement point using the following formula:

$$P_{RMS} = \frac{U_{RMS}^2}{R} = \frac{\left(\sqrt{\frac{1}{N} * \sum_{i=1}^N s_i} \right)^2}{R} = \frac{1}{N * R} * \sum_{i=1}^N s_i^2$$

Where:

- P_{RMS} = power represented by a measurement point
- N = number of A/D converter values (samples) per measurement point
- R = electrical impedance
- s_i = linear digitized video voltage at the output of the A/D converter

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

$$P(dBm) = 30dBm + 10 \cdot \log_{10} \cdot P_{RMS} = 30dBm + 10 \cdot \log_{10} \left(\frac{1}{N * R} * \sum_{i=1}^N s_i^2 \right)$$

Where:

- P (dB) = logarithmic power represented by a measurement point

Each sweep point thus corresponds to the root mean square of the measured values combined in the sweep point.

The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors to measure the power of the different signal classes are not required.

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.

- For modulated signals, the measurement time must be long enough to make sure the averaging considers all variations due to the modulation characteristics of the signal.
- For pulsed signals, the measurement time must be long enough to capture a sufficient number of pulses. For averaging, a sufficient number of pulses is greater than 10.



The RMS detector and the video bandwidth

When using the RMS detector in the Spectrum application, the video bandwidth (VBW) in the hardware is bypassed. However, if the measurement time is determined automatically, the VBW is still considered. The measurement time is then set to the minimum time required by the current VBW setting. Thus, a similar averaging effect is achieved, while providing a correct RMS power result.

Video filtering together with the RMS detector would result in logarithmic averaging.

Average detector

The average detector calculates the linear average of all samples combined in a sweep point.

For average detection, the video voltage (envelope of IF signal) is averaged over the measurement time. Averaging is digital, i.e. the digitized values of the video voltage are summed up and divided by the number of samples at the end of the measurement time. This corresponds to a filtering with a rectangular window in the time domain and a filtering with sin x/x characteristic in the frequency domain.

To this effect, R&S EPL1000 uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). For linear display, the average value is displayed.

$$P_{Avg} = \frac{U_{Avg}^2}{R} = \frac{1}{R} * \left(\frac{1}{N} * \sum_{i=1}^N s_i \right)^2$$

Where:

- P_{AVG} = power represented by a measurement point
- N = number of A/D converter values per measurement point
- R = electrical impedance
- s_i = linear digitized video voltage at the output of the A/D converter

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

$$P(dBm) = 30dBm + 10 \cdot \log_{10} \cdot P_{Avg} = 30dBm + 10 \cdot \log_{10} \left(\frac{1}{R} * \left(\frac{1}{N} * \sum_{i=1}^N s_i \right)^2 \right)$$

Where:

- P (dBm) = logarithmic power represented by a measurement point

Each measurement point thus corresponds to the average of the measured values combined in the measurement point.

The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).

Tips regarding measurement time:

- For unmodulated signals, you can use the shortest possible measurement time.
- For modulated signals, the measurement time must be long enough to make sure the averaging considers all variations due to the modulation characteristics of the signal.
- For pulsed signals, the measurement time must be long enough to capture a sufficient number of pulses. For averaging, a sufficient number of pulses is greater than 10.

Sample detector

The sample detector selects and displays a single sample (always the first or always the last) from all samples that are combined in the sweep point. All other measured values for the sample point are ignored.

Quasipeak detector

The quasipeak detector resembles the behavior of an analog voltmeter by analyzing the measured values for a sample point. The quasipeak detector is especially designed for the requirements of EMI measurements and is used to analyze pulse-shaped spurs.

This detector is only available for the CISPR filter.

The quasipeak detector is not available for an RBW of 1 MHz.

Also note the "[Restrictions for the R&S EPL1000 using CISPR detectors](#)" on page 163.

The quasipeak detector displays the weighted maximum signal level according to CISPR 16-1-1 that was detected during the specified measurement time.

The filter bandwidth and time parameters of the detector depend on the measured frequency. The time lag of the simulated pointer instrument reflects the weighting factor of the signal depending on its form, modulation, etc.

Depending on the selected frequency, the R&S EPL1000 automatically selects the detectors and IF bandwidths defined for bands A and B listed in the following table:

Table 5-3: Required parameters depending on frequency for CISPR quasi-peak detector

	Band A	Band B
Frequency range	< 150 kHz	150 kHz to 30 MHz
Resolution bandwidth	200 Hz	9 kHz

Tips regarding measurement time:

- The relatively long time constants of the quasipeak detector result in long measurement times to yield valid results.
- For unknown signals, use a measurement time of at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.

- For known signals, you can use a much shorter measurement time.

CISPR average detector

The CISPR Average detector displays a weighted average signal level according to CISPR 16-1-1.

The average value according to CISPR 16-1-1 is the maximum value detected while calculating the linear average value during the specified measurement time.

This detector is only available for the CISPR filter.

The CISPR Average detector is applied to measure pulsed sinusoidal signals with a low pulse frequency, for example. It is calibrated with the RMS value of an unmodulated sinusoidal signal. The average value is determined by lowpass filters of the 2nd order (simulating a mechanical pointer instrument).

The lowpass time constants and the IF bandwidths depend on the measured frequency. The main parameters are listed in the following table:

Table 5-4: Required parameters depending on frequency for CISPR Average detector

	Band A	Band B
Frequency range	<150 kHz	150 kHz to 30 MHz
IF bandwidth	200 Hz	9 kHz

Tips regarding measurement time:

- The relatively long time constants of the CISPR average detector result in long measurement times to yield valid results.
- For unknown signals, use a measurement time of at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.
- For unmodulated sinusoidal signals and signals with a high modulation frequency, you can use a much shorter measurement time.
- For slowly fluctuating signals or pulsed signals, use longer measurement times.

RMS average detector

The RMS Average detector is a combination of the RMS detector (for pulse repetition frequencies above a corner frequency) and the Average detector (for pulse repetition frequencies below the corner frequency). It thus achieves a pulse response curve with the following characteristics:

- 10 dB/decade above the corner frequency
- 20 dB/decade below the corner frequency

The average value is determined by lowpass filters of the 2nd order (simulation of a mechanical pointer instrument).

The RMS Average detector is only available for the CISPR filter.

The detector is used to measure broadband emissions, for example, and can possibly replace the quasipeak detector in the future.

The detector parameters depend on the measured frequency.

Table 5-5: Required parameters depending on frequency for RMS Average detector

	Band A	Band B
Frequency range	<150 kHz	150 kHz to 30 MHz
IF bandwidth	200 Hz	9 kHz
Corner frequency	10 Hz	100 Hz

Tips regarding measurement time:

- The relatively long time constants of the CISPR average detector result in long measurement times to yield valid results.
- For unknown signals, use a measurement time of at least 1 s. This ensures correct weighting of pulses down to a pulse frequency of 5 Hz.
- For unmodulated sinusoidal signals and signals with a high modulation frequency, you can use a much shorter measurement time.
- For slowly fluctuating signals or pulsed signals, use longer measurement times.



Measurement times shorter than 20 ms

With measurement times shorter than 20 ms, the detector weighting changes to plain RMS weighting.

5.3.1.2 Analyzing several traces - trace mode

If several sweeps are performed one after the other, or continuous sweeps are performed, the trace mode determines how the data for subsequent traces is processed. After each sweep, the trace mode determines whether:

- The data is frozen ("View")
- The data is hidden ("Blank")
- The data is replaced by new values ("Clear Write")
- The data is replaced selectively ("Max Hold", "Min Hold", "Average")



Each time you change the trace mode, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 269.

The R&S EPL1000 supports the following trace modes:

Table 5-6: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting. All available detectors can be selected.

Trace Mode	Description
Max Hold	<p>The maximum value is determined over several measurements and displayed. The R&S EPL1000 saves the sweep result in the trace memory only if the new value is greater than the previous one.</p> <p>This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope.</p> <p>This mode is not available for statistics measurements.</p>
Min Hold	<p>The minimum value is determined from several measurements and displayed. The R&S EPL1000 saves the sweep result in the trace memory only if the new value is lower than the previous one.</p> <p>This mode is useful for example for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level.</p> <p>This mode is not available for statistics measurements.</p>
Average	<p>The average is formed over several measurements and displayed.</p> <p>The Sweep/Average Count determines the number of averaging procedures.</p> <p>This mode is not available for statistics measurements.</p>
View	The current contents of the trace memory are frozen and displayed.



If a trace is frozen ("View" mode), you can change the measurement settings, apart from scaling settings, without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk * on the tab label.

If you change any parameters that affect the scaling of the diagram axes, the R&S EPL1000 automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.

5.3.1.3 How many traces are averaged - sweep count + Sweep mode

In "Average" trace mode, the sweep count and sweep mode determine how many traces are averaged. The more traces are averaged, the smoother the trace is likely to become.

The algorithm for averaging traces depends on the sweep mode and sweep count.

- **sweep count = 0** (default)
 - In "**Continuous**" sweep mode, a continuous average is calculated for 10 sweeps, according to the following formula:

$$Trace = \frac{9 * Trace_{old} + MeasValue}{10}$$

Figure 5-5: Equation 1

Due to the weighting between the current trace and the average trace, past values have practically no influence on the displayed trace after about ten

sweeps. With this setting, signal noise is effectively reduced without need for restarting the averaging process after a change of the signal.

- In **"Single"** sweep mode, the current trace is averaged with the previously stored averaged trace. No averaging is carried out for the first sweep but the measured value is stored in the trace memory. The next time a sweep is performed, the trace average is calculated according to the following formula:

$$Trace = \frac{Trace_{old} + MeasValue}{2}$$

The averaged trace is then stored in the trace memory.

- **sweep count = 1**

The currently measured trace is displayed and stored in the trace memory. No averaging is performed.

- **sweep count > 1**

For both **"Single"** sweep mode and **"Continuous"** sweep mode, averaging takes place over the selected number of sweeps. In this case the displayed trace is determined during averaging according to the following formula:

$$Trace_n = \frac{1}{n} \cdot \left[\sum_{i=1}^{n-1} (T_i) + MeasValue_n \right]$$

Figure 5-6: Equation 2

Where n is the number of the current sweep (n = 2 ... sweep count).

No averaging is carried out for the first sweep but the measured value is stored in the trace memory. With increasing n, the displayed trace is increasingly smoothed since there are more individual sweeps for averaging.

After the selected number of sweeps, the average trace is saved in the trace memory. Until this number of sweeps is reached, a preliminary average is displayed.

When the averaging length defined by the "Sweep Count" is attained, averaging is continued in continuous sweep mode or for "Continue Single Sweep" according to the following formula:

$$Trace = \frac{(N-1) * Trace_{old} + MeasValue}{N}$$

Where N is the sweep count

5.3.1.4 How trace data is averaged - the averaging mode

When the trace is averaged over several sweeps (Trace mode: "Average"), different methods are available to determine the trace average.

With logarithmic averaging, the dB values of the display voltage are averaged or subtracted from each other with trace mathematical functions.

With linear averaging, the level values in dB are converted into linear voltages or powers before averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals, the two methods yield the same result.

Logarithmic averaging is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals, the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved. The negative peak values are increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the R&S EPL1000 offers the selection of linear averaging. The trace data is linearized before averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

5.3.1.5 Trace smoothing

A video bandwidth filter (VBW) is a hardware-based method of smoothing the trace (see also [Chapter 4.5.1.2, "Smoothing the trace using the video bandwidth"](#), on page 227). However, other sweep and bandwidth settings can be coupled to the VBW. For some signals, a VBW may not be freely selectable to obtain the required smoothing effect. Therefore, a software-based trace smoothing function is also available.

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

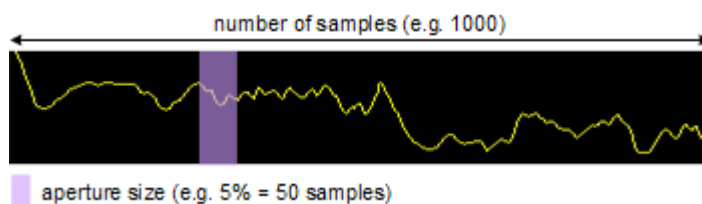


Figure 5-7: Sample size included in trace smoothing



Effects of smoothing on post-processing functions

Note that in Spectrum mode, all functions performed after the sweep, such as limit checks, markers, or channel power measurements, are based on the smoothed trace data. Thus, the results differ from results based on the original trace.

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

Linear smoothing is based on the following algorithm:

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

Equation 5-1: Linear trace smoothing

With:

s = sample number

x = sample offset from s

n = aperture size

5.3.1.6 Displaying a reference trace - importing trace data

Trace data that was stored during a previous measurement can be imported to the Spectrum application, for example as a reference trace.

The data in the import file must have a specified format (see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312), and can be stored in .CSV or .DAT format.

Trace Mode

The trace mode for the imported traces is set to "View" so that the data is not overwritten immediately during the next sweep. Other trace settings remain unchanged. Thus, **the displayed trace may not comply with the displayed trace settings in the channel bar.**

Detector type and number of sweep points

In particular, the detector type and the number of sweep points remain unchanged.

If the detector type of the active trace requires two points per x-value ("Auto Peak"), but the file contains only one, each point is duplicated. If the detector type requires only one point per x-value, but the file contains two, each second point is ignored.

If the file contains more sweep points than the active trace requires, the superfluous points are ignored. If the file does not contain enough sweep points, the missing points are inserted as -200 dBm.

Units

If the unit of the y-axis values in the file does not correspond to the active result display, the imported values are converted. If no unit is defined in the file, it is assumed to be dBm.

Importing multiple traces in one file

If the import file contains more than one trace, you can import several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

Alternatively, you can import a single trace only, which is displayed for the trace number specified in "Import to Trace". This list contains all currently active traces in the result display. If a trace with the specified number exists in the import file, that trace is imported. Otherwise, the first trace in the file is imported (indicated by a message in the status bar).

Example:

The import file contains trace 1, trace 2, and trace 4. The current result display has 4 active traces.

"Import to Trace" = 2: trace 2 of the import file is displayed as trace 2 in the result display.

"Import to Trace" = 3: trace 3 is not available in the import file, thus trace 1 is imported and displayed as trace 3 in the result display

"Import to Trace" is enabled: Trace 1 is imported from the file and replaces trace 1 in the result display.

Trace 2 is imported from the file and replaces trace 2 in the result display.

Trace 4 is imported from the file and replaces trace 4 in the result display.

Trace 3 in the result display remains unchanged.

Importing spectrogram traces

Trace data can also be imported to an active Spectrogram result display.

Note the following differences that apply in this case:

- The measurement must be stopped before import.
- Only trace 1 is imported to the spectrogram. Any other traces may be imported to a Spectrum display, if available. However, they do not change the spectrogram display, which always refers to trace 1.
- A single spectrum is inserted as a new frame number 0.
- The trace mode is *not* changed to "View" as for Spectrum trace imports.

5.3.1.7 Working with spectrograms

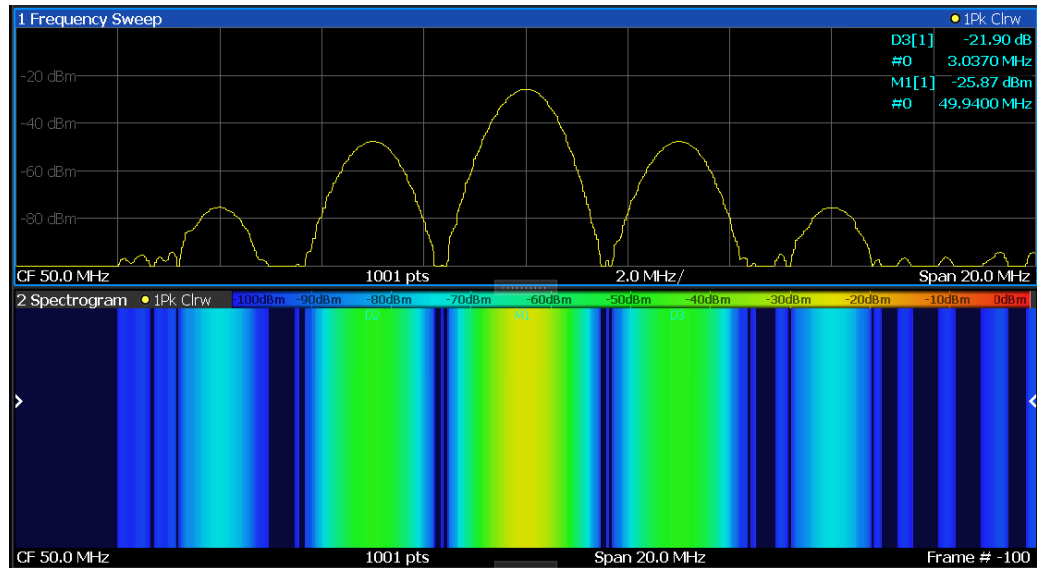
In addition to the standard "level versus frequency" or "level versus time" traces, the R&S EPL1000 also provides a spectrogram display of the measured data.

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.



Three-dimensional spectrograms are also available and are described in "[Three-dimensional spectrograms](#)" on page 285. Most basic information described in the following sections applies similarly to both two- and three-dimensional spectrograms.

Example:



In this example, you see the spectrogram for the calibration signal of the R&S EPL1000, compared to the standard spectrum display. Since the signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend above the spectrogram display describes the power levels the colors represent.

Result display

The spectrogram result can consist of the following elements:

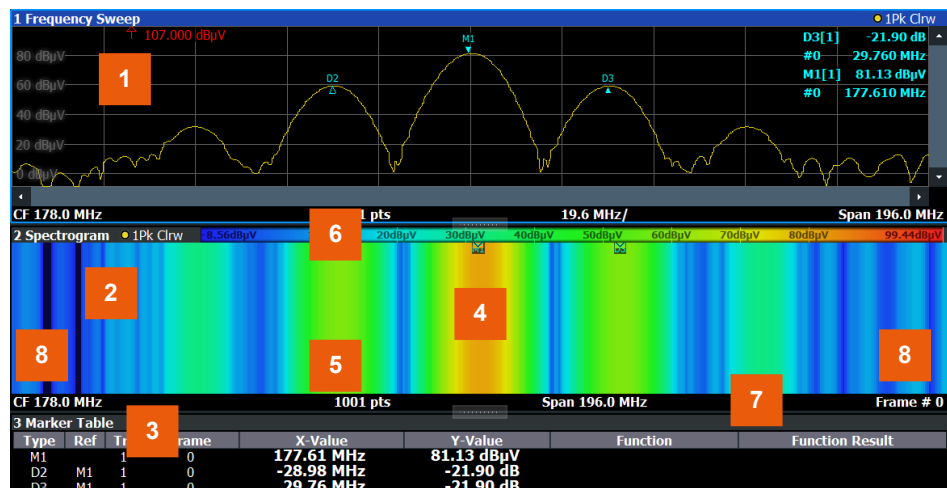


Figure 5-8: Screen layout of the spectrogram result display

- 1 = Spectrum result display
- 2 = Spectrogram result display
- 3 = Marker list

- 4 = Marker
- 5 = Delta marker
- 6 = Color map
- 7 = Timestamp / frame number
- 8 = Current frame indicator

For more information about spectrogram configuration, see [Chapter 5.3.2.6, "Spectrogram settings"](#), on page 301.

Remote commands:

Activating and configuring spectrograms:

[Chapter 6.9.2.7, "Spectrogram configuration"](#), on page 579

Storing results:

`MMEMory:STORe<n>:SPECTrogram` on page 584

- [Time frames](#)..... 283
- [Markers in the spectrogram](#)..... 285
- [Three-dimensional spectrograms](#).....285
- [Color maps](#).....287

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.



In three-dimensional spectrograms, frames are displayed vertically. The most recently recorded frame (frame 0) is added at the front of the display (in the default position). For more information, see ["Three-dimensional spectrograms"](#) on page 285.

The maximum number of frames that you can capture depends on the number of sweep points that are analyzed during the measurement.

Table 5-7: Correlation between number of sweep points and number of frames stored in the history buffer

Sweep Points	Max. History Depth
≤1250	20000
2001	12488
4001	6247
8.001	3124

Sweep Points	Max. History Depth
16.001	1562
32.001	781



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



Frame analysis - Frame count vs. sweep count

As described for standard spectrum sweeps, the sweep count defines how many sweeps are analyzed to create a single trace. Thus, for a trace in "Average" mode, for example, a sweep count of 10 means that 10 sweeps are averaged to create a single trace, or frame.

The frame count, on the other hand, determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). For a frame count of 2, for example, 2 frames will be plotted during each single sweep. For continuous sweep mode, the frame count is irrelevant; one frame is plotted per sweep until the measurement is stopped.

If you combine the two settings, 20 sweeps will be performed for each single sweep measurement. The first 10 will be averaged to create the first frame, the next 10 will be averaged to create the second frame.

As you can see, increasing the sweep count increases the accuracy of the individual traces, while increasing the frame count increases the number of traces in the diagram.

Especially for "Average" or "Min Hold" and "Max Hold" trace modes, the number of sweeps that are analyzed to create a single trace has an effect on the accuracy of the results. Thus, you can also define whether the results from frames in previous traces are considered in the analysis for each new trace ("Continue Frame").

Tracking absolute time - timestamps

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

When active, the timestamp replaces the display of the frame number in the diagram footer (see [Figure 5-8](#)).

Displaying individual frames

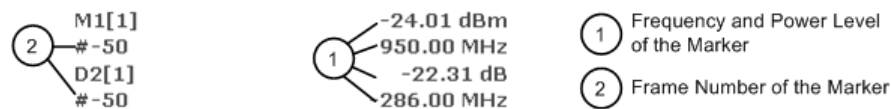
The spectrogram diagram contains all stored frames since it was last cleared. Arrows on the left and right border of the spectrogram indicate the currently selected frame. The scan or spectrum diagrams always display the spectrum for the currently selected frame.

The current frame number is indicated in the diagram footer, or alternatively a 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.

Markers in the spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They are only displayed in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

In the spectrum result display, the markers and their frequency and level values (1) are displayed as usual. Additionally, the frame number is displayed to indicate the position of the marker in time (2).



In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers.

In the spectrum result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode, this means that only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the spectrum result display, you must stop the measurement and select the corresponding frame.

Three-dimensional spectrograms

A common spectrogram shows the frequency on the x-axis, while the y-axis shows the time (in frames). The power level is indicated by different colors of the 2-dimensional points.

In the 3-dimensional spectrogram, the power is indicated by a value in a third dimension, the z-axis. The color mapping is maintained for the point in the 3-dimensional result display.

This new display provides an even better overview of how the strength of the signal varies over time for different frequencies.

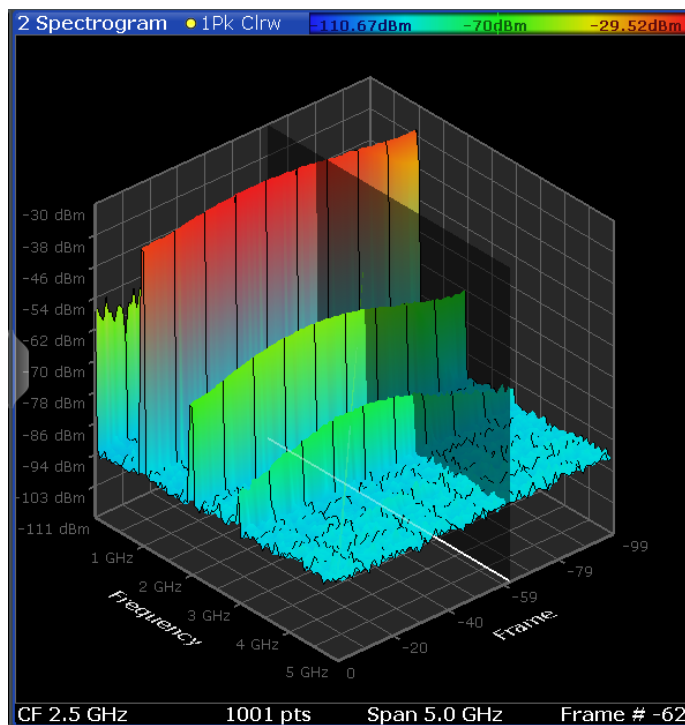


Figure 5-9: Three-dimensional spectrogram

The number of frames displayed on the time (y-)axis is user-definable, whereas for 2-dimensional spectrograms, the number of frames is determined automatically according to the size of the window. All other spectrogram settings are identical for 3-dimensional and 2-dimensional spectrograms.

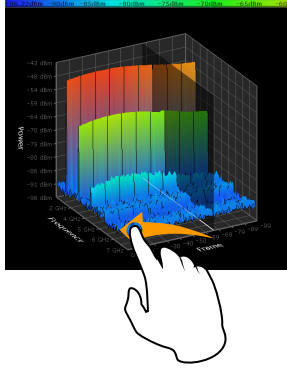
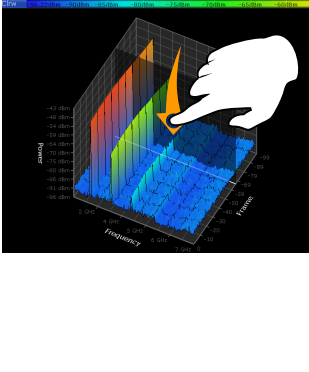
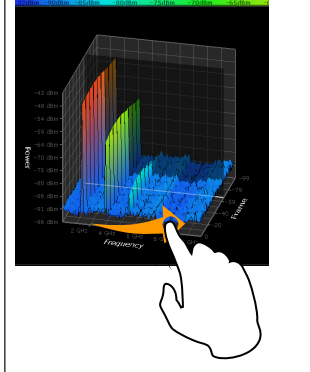
When the measurement is stopped or completed, the currently selected frame is indicated by a gray vertical plane. (As opposed to the small white arrows at the borders of the 2-dimensional display.) The spectrum diagram always displays the spectrum for the currently selected frame.

By default, the most recently recorded frame (frame 0) is selected, and added at the front of the diagram.

Rotating the spectrogram in three dimensions

Depending on which aspect of the spectrogram is currently of interest, you can rotate the display to have a closer look at the frequency, the time, or the power dimension. Simply drag your finger or the mouse pointer over the spectrogram in the direction you want to rotate it. You can rotate the display left or right, up and down. Note, however, that the degree of rotation is restricted in the upward direction to avoid confusing views. If you rotate the spectrogram such that you see the frequency-frame-plane directly from above, the display is identical to the 2-dimensional spectrogram.

Table 5-8: Effect of rotating the spectrogram in three dimensions

		
Rotation to the left > focus on frame	Rotation down > focus on frequency and frame	Rotation to the right > focus on frequency

Markers in three-dimensional spectrograms

In three-dimensional spectrograms, the markers are indicated by the common arrows used in the spectrum display, for example. New markers are automatically placed on the current frame. You can move the markers to any position in all dimensions of the diagram. When you select a marker on the screen, three-dimensional cross-hairs indicate the position on all axes.

Sometimes, a marker can be hidden by other frames. If necessary, rotate the spectrogram or select a different frame as the current frame.

Color maps

Spectrograms assign power levels to different colors to visualize them. The legend above the spectrogram display describes the power levels the colors represent.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use (Color scheme)
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e. where the focus of the visualization lies (shape of the color curve)

The individual colors are assigned to the power levels automatically by the R&S EPL1000.

The Color Scheme

- **Hot**



Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

- **Cold**



Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

The "Cold" color scheme is the inverse "Hot" color scheme.

- **Radar**



Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high ones.

- **Grayscale**



Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high ones.

The value range of the color map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range. Then it becomes easier to distinguish between values that are close together. Display only parts of interest.

The shape and focus of the color curve

The color-mapping function assigns a specified color to a specified power level in the spectrogram display. By default, colors on the color map are distributed evenly. However, to visualize a certain area of the value range in greater detail than the rest, you can set the focus of the color mapping to that area. Changing the focus is performed by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large range of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.

Example:

In the color map based on the linear color curve, the range from -100 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.

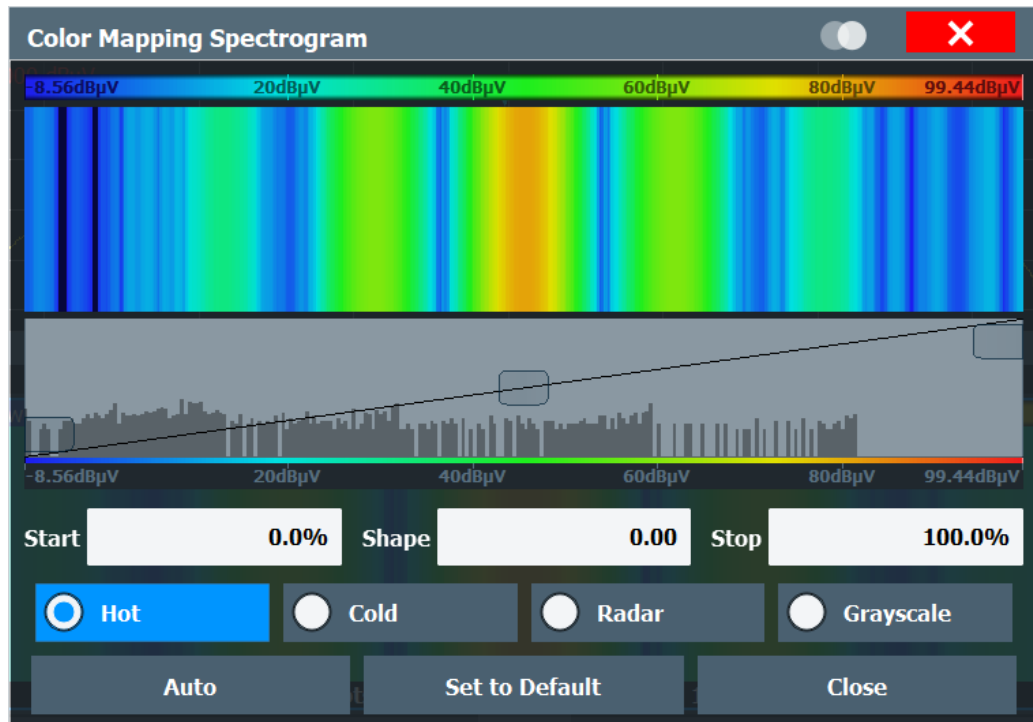


Figure 5-10: Spectrogram with (default) linear color curve shape = 0

The sample spectrogram is dominated by blue and green colors. After shifting the color curve to the left (negative value), more colors cover the range from -100 dBm to -60 dBm (blue, green and yellow). This range occurs more often in the example. The range from -60 dBm to -20 dBm, on the other hand, is dominated by various shades of red only.

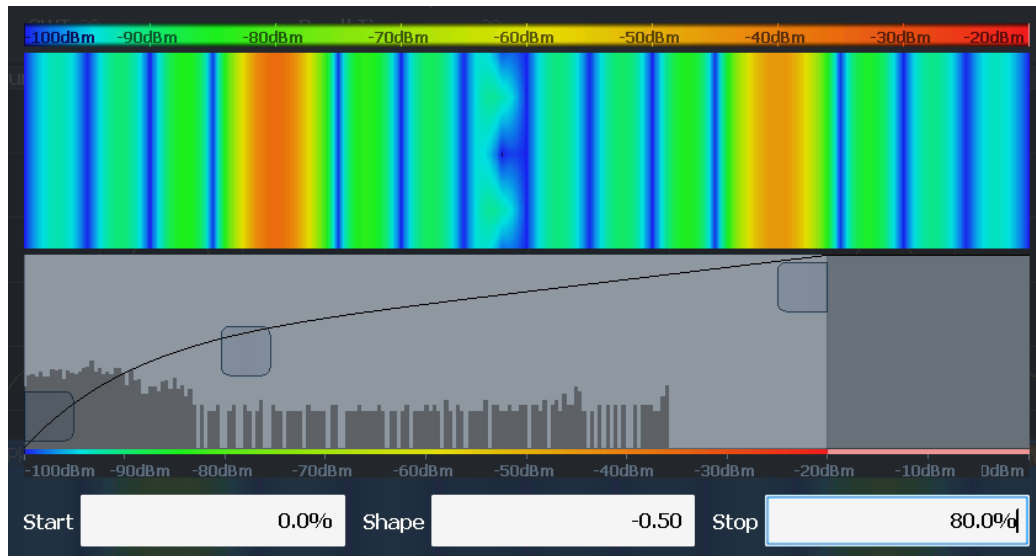


Figure 5-11: Spectrogram with non-linear color curve (shape = -0.5)

5.3.2 Trace configuration

- [Trace settings](#).....290
- [Exporting and importing traces](#)..... 294
- [Copying traces](#)..... 298
- [Trace math](#)..... 299
- [Trace Labels](#)..... 300
- [Spectrogram settings](#)..... 301

5.3.2.1 Trace settings

Access: "Overview" > "Analysis" > "Traces" > "Traces"

The Spectrum application supports six traces that can have a different configuration.

Traces	Trace / Data Ex/Import	Copy Trace	Trace Math	Trace Label	Spectrogram			
	Mode	Detector	Auto	Type	Smoothing	Average		
					Hold	State		
						Value		
Trace 1	Clear Write	<input checked="" type="checkbox"/>	Auto Peak		<input type="checkbox"/>	<input type="checkbox"/>	2 %	Linear
Trace 2	Blank	<input checked="" type="checkbox"/>	Auto Peak		<input type="checkbox"/>	<input type="checkbox"/>	2 %	Logarithmic
Trace 3	Blank	<input checked="" type="checkbox"/>	Auto Peak		<input type="checkbox"/>	<input type="checkbox"/>	2 %	Power
Trace 4	Blank	<input checked="" type="checkbox"/>	Auto Peak		<input type="checkbox"/>	<input type="checkbox"/>	2 %	
Trace 5	Blank	<input checked="" type="checkbox"/>	Auto Peak		<input type="checkbox"/>	<input type="checkbox"/>	2 %	
Trace 6	Blank	<input checked="" type="checkbox"/>	Auto Peak		<input type="checkbox"/>	<input type="checkbox"/>	2 %	
Quick Config								Count:
								0
Preset All Traces			Set Trace Mode Max Avg Min			Set Trace Mode Max ClrWrite Min		

The remote commands required to configure traces are described in [Chapter 6.9.2.2, "Trace settings"](#), on page 567.

Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6	291
Trace Mode	291
Detector	292
Hold	292
Smoothing	292
Average Mode	293
Average Count	293
Predefined Trace Settings - Quick Config	293
Trace 1/ Trace 2/ Trace 3/ Trace 4 (Softkeys)	294

Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6

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

Remote command:

Selected via numeric suffix of:TRACe<1 . . . 6> commands

DISPlay[:WINDow<n>] [:SUBWindow<w>]:TRACe<t>[:STATe] on page 570

Trace Mode

Defines the update mode for subsequent traces.

For details, see [Chapter 5.3.1.2, "Analyzing several traces - trace mode"](#), on page 276.

"Clear/ Write"	Overwrite mode (default): the trace is overwritten by each sweep. All available detectors can be selected. In Spectrum mode, the "Detector" is automatically set to "Auto Peak".
"Max Hold"	The maximum value is determined over several measurements and displayed. The R&S EPL1000 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. The "Detector" is automatically set to "PositivePeak". This mode is not available for statistics measurements.
"Min Hold"	The minimum value is determined from several measurements and displayed. The R&S EPL1000 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. 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 "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.

Note: If a trace is frozen, you can change the measurement settings, apart from scaling settings, without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk * on the tab label. If you change any parameters that affect the scaling of the diagram axes, the R&S EPL1000 automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.

"Blank" Removes the selected trace from the display.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE` on page 568

Detector

Defines the trace detector to be used for trace analysis.

For details see [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 269.

"Auto" (default:) Selects the optimum detector for the selected trace and filter mode

"Type" Defines the selected detector type.

Remote command:

`[SENSe:] [WINDow<n>:] DETector<t>[:FUNction]` on page 567

`[SENSe:] [WINDow<n>:] DETector<t>[:FUNction]:AUTO` on page 567

Hold

If activated, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started again after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONTinuous` on page 569

Smoothing

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

Note: Effects of smoothing on post-processing functions. Note that in Spectrum mode, all functions performed after the sweep, such as limit checks, markers, or channel power measurements, are based on the smoothed trace data. Thus, the results differ from results based on the original trace.

For more information, see [Chapter 5.3.1.5, "Trace smoothing"](#), on page 279.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]`
on page 570

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture`
on page 568

Average Mode

Defines the mode with which the trace is averaged over several sweeps.

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

For FFT sweeps, the setting also affects the VBW (regardless of whether the trace is averaged).

(See also "[Video bandwidth \(VBW\)](#)" on page 45).

How many sweeps are averaged is defined by the "[Sweep/Average Count](#)" on page 235.

For details see [Chapter 5.3.1.4, "How trace data is averaged - the averaging mode"](#), on page 278.

"Linear"	The power level values are converted into linear units before averaging. After the averaging, the data is converted back into its original unit.
"Logarithmic"	For logarithmic scaling, the values are averaged in dBm. For linear scaling, the behavior is the same as with linear averaging.
"Power"	Activates linear power averaging. The power level values are converted into unit Watt before 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. In particular, for small VBW values (smaller than the RBW), use power averaging mode for correct power measurements in FFT sweep mode.

Remote command:

`[SENSe:]AVERAge<n>:TYPE` on page 546

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 545

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 5.3.3.1, "How to configure a standard trace"](#), on page 306.

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 570

5.3.2.2 Exporting and importing traces

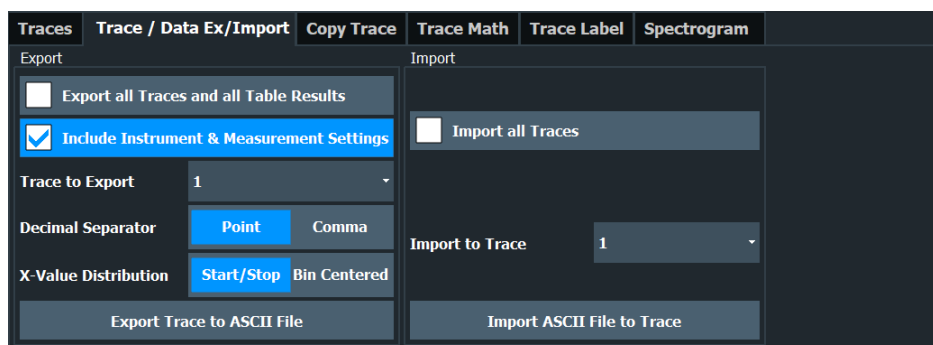
Access: "Overview" > "Analysis" > "Traces" > "Trace / Data Ex/Import"

The R&S EPL1000 provides various evaluation methods for the results of the performed measurements. If you want to evaluate the data with other, external applications, you can export the measurement data to a standard ASCII format file (DAT or CSV).

You can also import existing trace data from a file, for example as a reference trace. The trace import is available in the spectrum application.



The standard data management functions (for example saving or loading instrument settings) that are available for all R&S EPL1000 applications are not described here. Refer to the R&S EPL1000 user manual for a description of the standard functions.



The remote commands required to export and import traces are described in [Chapter 6.9.2.3, "Trace import and export"](#), on page 571.

Export all Traces and all Table Results	295
Include Instrument & Measurement Settings	295
Trace to Export	296
Export Trace to ASCII File	296
L File Type	297
L Decimal Separator	297
L Column Separator	297
L File Explorer	297
Importing Traces	297
L Import All Traces/Import to Trace	297
L Import ASCII File to Trace	298
L File Explorer	298

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 574

Include Instrument & Measurement Settings

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

See [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312 for details.

Remote command:

`FORMat:DEXPort:HEADer` on page 573

Trace to Export

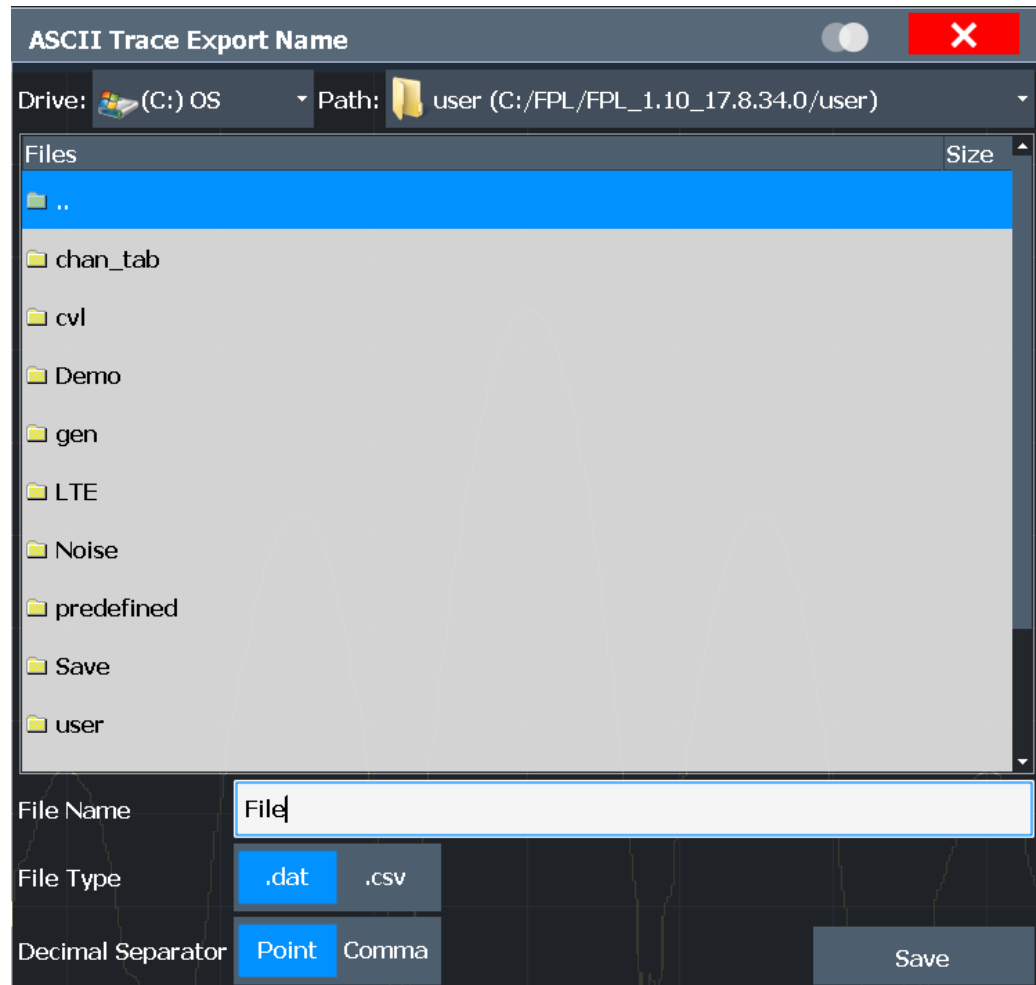
Defines an individual trace to be exported to a file.

This setting is not available if [Export all Traces and all Table Results](#) is selected.

Export Trace to ASCII File

Saves the selected trace or all traces in the currently active result display to the specified file and directory in the selected ASCII format.

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.



If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data for a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation can take some time.

For details on the file format in the Spectrum application, see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312.

Remote command:

[MMEMory:STORe<n>:TRACe](#) on page 564

[MMEMory:STORe<n>:SPECTrogram](#) on page 584

File Type ← Export Trace to ASCII File

Determines the format of the ASCII file to be imported or exported.

Depending on the external program in which the data file was created or is evaluated, a comma-separated list (CSV) or a plain data format (DAT) file is required.

Remote command:

`FORMat:DEXPort:FORMat` on page 573

Decimal Separator ← Export Trace to ASCII File

Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:

`FORMat:DEXPort:DSEParator` on page 573

Column Separator ← Export Trace to ASCII File

Selects the character that separates columns in the exported ASCII file. The character can be either a semicolon, a comma or a tabulator (tab).

Example for semicolon:

```
Type;EPL1004;Version;1.00;Date;01.Jan 3000;
```

Example for comma:

```
Type,EPL1004,
Version,1.00,
Date,01.Jan 3000,
```

Example for tabulator (tab after the last column is not visible):

```
Type      EPL1004
Version   1.00
Date     01.Jan 3000
```

The selected column separator setting remains the same, even after a preset.

Remote command:

`FORMat:DEXPort:CSEParator` on page 572

File Explorer ← Export Trace to ASCII File

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

Importing Traces

Trace data that was stored during a previous measurement can be imported to the Spectrum application, for example as a reference trace.

Import All Traces/Import to Trace ← Importing Traces

If the import file contains more than one trace, you can import several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

Alternatively, you can import a single trace only, which is displayed for the trace number specified in "Import to Trace". This list contains all currently active traces in the result display. If a trace with the specified number exists in the import file, that trace is imported. Otherwise, the first trace in the file is imported (indicated by a message in the status bar).

Remote command:

[FORMat:DImport:TRACes](#) on page 574

Import ASCII File to Trace ← Importing Traces

Loads one trace or all traces from the selected file in the selected ASCII format (.DAT or .CSV) to the currently active result display.

Remote command:

[FORMat:DImport:TRACes](#) on page 574

File Explorer ← Import ASCII File to Trace ← Importing Traces

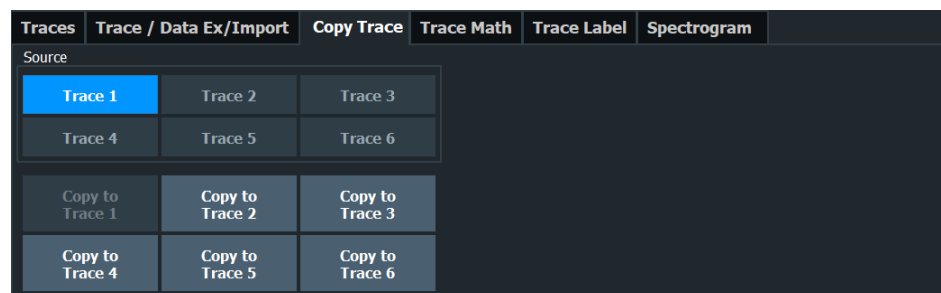
Opens the Microsoft Windows File Explorer.

Remote command:

not supported

5.3.2.3 Copying traces

Access: "Overview" > "Analysis" > "Traces" > "Copy Trace"



The remote commands required to copy traces are described in [Chapter 6.9.2.4, "Trace copy"](#), on page 576.

[Copy Trace](#).....298

Copy Trace

Access: "Overview" > "Analysis" > "Traces" > "Copy Trace"

Or: [TRACE] > "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 Tace 6") selects the destination.

Remote command:

[TRACe<n>:COPY](#) on page 576

5.3.2.4 Trace math

Access: [TRACE] > "Trace Math"

If you have several traces with different modes, for example an average trace and a maximum trace, it may be of interest to compare the results of both traces. In this example, you could analyze the maximum difference between the average and maximum values. To analyze the span of result values, you could subtract the minimum trace from the maximum trace. For such tasks, the results from several traces can be combined using mathematical functions.

Trace Math Function.....	299
Trace Math Off.....	299
Trace Math Position.....	299
Trace Math Mode.....	299

Trace Math Function

Defines which trace is subtracted from trace 1. The result is displayed in trace 1.

The result refers to the zero point defined with the [Trace Math Position](#) setting. The following subtractions can be performed:

"T1-T2->T1"	Subtracts trace 2 from trace 1.
"T1-T3->T1"	Subtracts trace 3 from trace 1
"T1-T4->T1"	Subtracts trace 4 from trace 1
"T1-T5->T1"	Subtracts trace 5 from trace 1
"T1-T6->T1"	Subtracts trace 6 from trace 1

To switch off the trace math, use the [Trace Math Off](#) button.

Remote command:

[CALCulate<n>:MATH<t>\[:EXPRession\] \[:DEFine\]](#) on page 576

[CALCulate<n>:MATH<t>:STATe](#) on page 578

Trace Math Off

Deactivates any previously selected trace math functions.

Remote command:

[CALC:MATH:STAT OFF](#), see [CALCulate<n>:MATH<t>:STATe](#) on page 578

Trace Math Position

Defines the zero point on the y-axis of the resulting trace in % of the diagram height. The range of values extends from -100 % to +200 %.

Remote command:

[CALCulate<n>:MATH<t>:POSition](#) on page 577

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<t>:MODE` on page 577

5.3.2.5 Trace Labels

Access: "Overview" > "Analysis" > "Traces" > "Trace Label"

Trace labels are a way to assign a descriptive label to traces instead of the general "Trace <x>" label (default). The labels you use are arbitrary and are displayed in the diagram area. The font color corresponds to the color of the respective trace (for example yellow trace: yellow font).



Figure 5-12: Example: the yellow and blue traces have a label.

You can define trace labels in the "Trace Label" tab of the "Trace" dialog box.

Traces	Trace / Data Export	Copy Trace	Trace Math	Trace Label	Spectrogram
	State	Text			
Trace 1	<input checked="" type="checkbox"/>	Name of first trace			
Trace 2	<input checked="" type="checkbox"/>	Name of another trace			
Trace 3	<input type="checkbox"/>	Trace 3			
Trace 4	<input type="checkbox"/>	Trace 4			
Trace 5	<input type="checkbox"/>	Trace 5			
Trace 6	<input type="checkbox"/>	Trace 6			

How to assign trace labels

Trace labels can be configured via the "Trace Labels" dialog box.

1. Turn on the trace label for a specific trace and assign a label in the corresponding input field.
Note that a trace must be active. Otherwise assigning a label is not possible.
2. Move the trace label to any position on the display by dragging it to the new position.

Remote command:

State: `DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe]` on page 578

Label: `DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT` on page 578

5.3.2.6 Spectrogram settings

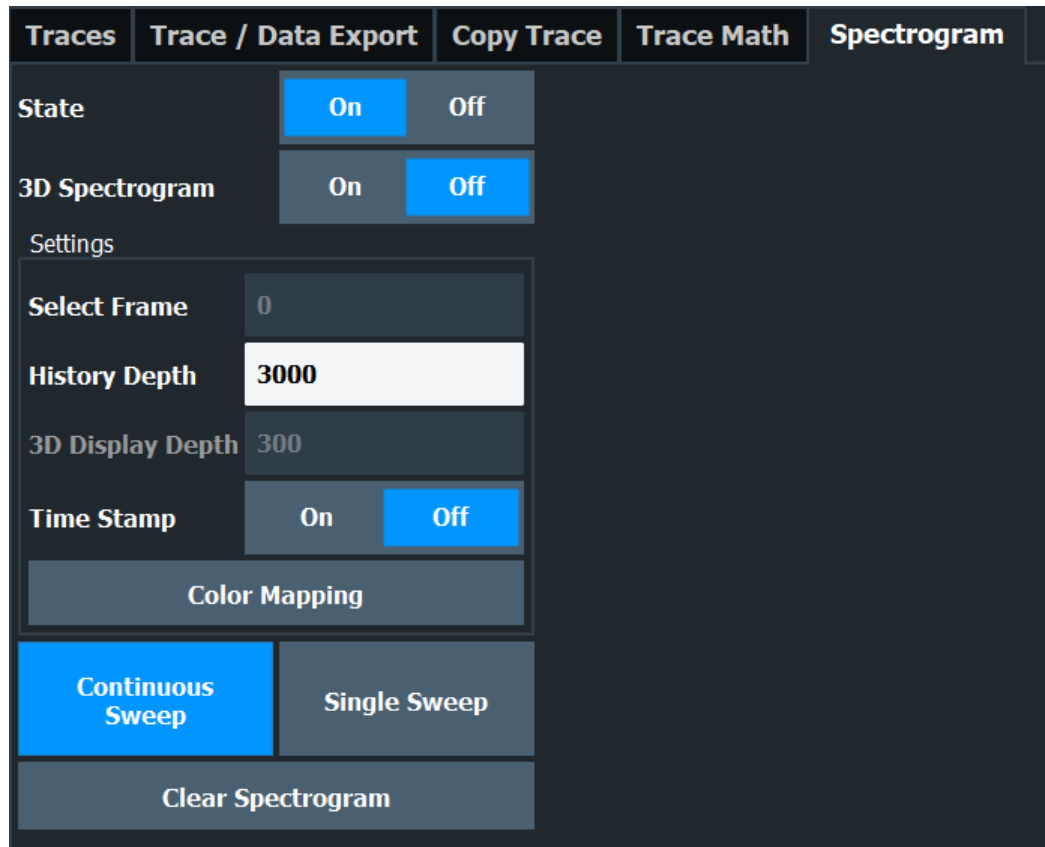
Access: "Overview" > "Analysis" > "Traces" > "Spectrogram"

Functions to configure spectrograms described elsewhere:

- Color mapping: "[Color map settings](#)" on page 304
- Sweep configuration: "[Spectrogram Frames](#)" on page 238
- Markers: [Chapter 5.4.3, "Marker search settings and positioning functions"](#), on page 325
- [General spectrogram settings](#)..... 301
- [Color map settings](#)..... 304

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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Select Frame.....	302
History Depth.....	303
Time Stamp.....	303
Color Mapping.....	303
Continuous Sweep / Run Cont.....	303
Single Sweep / Run Single.....	303
Clear Spectrogram.....	304

State

Activates and deactivates the spectrogram result display

Remote command:

`CALCulate<n>:SPECTrogram[:STATe]` on page 582

Select Frame

Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

The most recent frame is number 0, all previous frames have a negative number.

For more details, see ["Time frames"](#) on page 283.

Remote command:

[CALCulate<n>:SPECTrogram:FRAMe:SELEct](#) on page 580

History Depth

Sets the number of frames that the R&S EPL1000 stores in its memory.

The maximum size of the spectrogram history depends on the available memory.

If the memory is full, the R&S EPL1000 deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:

[CALCulate<n>:SPECTrogram:HDEPth](#) on page 581

Time Stamp

Activates and deactivates the timestamp. The timestamp shows the system time while the measurement is running. In single sweep mode or if the sweep is stopped, the timestamp shows the time and date of the end of the sweep.

When active, the timestamp replaces the display of the frame number.

Remote command:

[CALCulate<n>:SPECTrogram:TSTamp\[:STATe\]](#) on page 582

[CALCulate<n>:SPECTrogram:TSTamp:DATA?](#) on page 581

Color Mapping

Opens the "Color Mapping" dialog.

For details see ["Color maps"](#) on page 287.

Continuous Sweep / Run Cont

After triggering, starts the measurement and repeats it continuously until stopped.

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, "Continuous Sweep" only controls the sweep mode for the currently selected channel setup. However, the sweep mode only takes effect the next time the Sequencer activates that channel setup, and only for a channel-defined sequence. In this case, a channel setup in continuous sweep mode is swept repeatedly.

Furthermore, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see the R&S EPL1000 User Manual.

Remote command:

Measurement mode: [INITiate<n>:CONTinuous](#) on page 393

Run measurement: [INITiate<n>\[:IMMediate\]](#) on page 392

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, "Single Sweep" only controls the sweep mode for the currently selected channel setup. However, the sweep mode only takes effect the next time the Sequencer activates that channel setup, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel setup in single sweep mode only once.

Furthermore, [RUN SINGLE] controls the Sequencer, not individual sweeps. [RUN SINGLE] starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed channel setup is updated.

For details on the Sequencer, see the R&S EPL1000 User Manual.

Remote command:

Measurement mode: [INITiate<n>:CONTinuous](#) on page 393

Run measurement: [INITiate<n>\[:IMMediate\]](#) on page 392

[CALCulate<n>:SPECTrogram:CONTinuous](#) on page 579

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 579

Color map settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

or: [TRACE] > "Spectrogram Config" > "Color Mapping"

For more information on color maps, see ["Color maps"](#) on page 287. For details on changing color-mapping settings, see ["How to configure the color mapping"](#) on page 310.

In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.

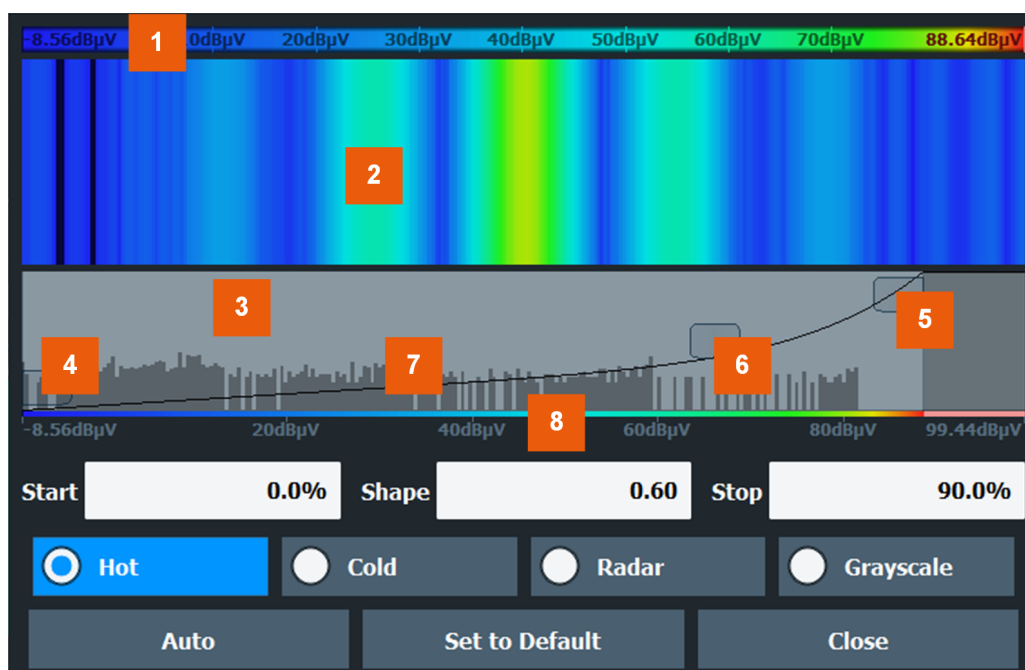


Figure 5-13: Color Mapping dialog box

- 1 = Color map: shows the current color distribution
- 2 = Preview pane: shows a preview of the spectrogram with any changes that you make to the color scheme
- 3 = Color curve pane: graphical representation of all settings available to customize the color scheme
- 4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
- 6 = Color curve slider: adjusts the focus of the color curve
- 7 = Histogram: shows the distribution of measured values
- 8 = Scale of the horizontal axis (value range)

The remote commands required to configure the color map are described in [Chapter 6.9.2.7, "Spectrogram configuration"](#), on page 579.

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Shape.....	305
Hot/Cold/Radar/Grayscale.....	306
Auto.....	306
Set to Default.....	306
Close.....	306

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 583

`DISPlay[:WINDow<n>]:SPECTrogram:COLor:UPPer` on page 583

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 583

Hot/Cold/Radar/Grayscale

Sets the color scheme for the spectrogram.

Remote command:

`DISPlay[:WINDow<n>]:SPECTrogram:COLor[:STYLE]` on page 584

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 583

Close

Saves the changes and closes the dialog box.

5.3.3 How to configure traces

- [How to configure a standard trace](#)..... 306
- [How to export trace data and numerical results](#).....307
- [How to import traces](#)..... 308
- [How to display and configure a spectrogram](#)..... 308

5.3.3.1 How to configure a standard trace

Step-by-step instructions on configuring the trace settings are provided here.

For details on individual functions and settings see [Chapter 5.3.2.1, "Trace settings"](#), on page 290.

The remote commands required to perform these tasks are described in [Chapter 6.9.2, "Trace configuration"](#), on page 563.

Trace settings are configured in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Press [TRACE] and then select "Trace Config".
 - Select "Analysis" from the "Overview", then select the "Traces" tab.
1. For each trace, select the "Trace Mode" and "Trace Detector". Traces with the trace mode "Blank" are not displayed.
 2. To configure several traces to predefined display modes in one step, press the button for the required function:

- "Preset All Traces"
- "Set Trace Mode Max | Avg | Min"
- "Set Trace Mode Max | ClrWrite | Min"

For details see [Chapter 5.3.2.1, "Trace settings"](#), on page 290.

3. For "Average" trace mode, define the number of sweeps to be averaged in the "Count:" field.
4. If linear scaling is used, select the "Average Mode": "Linear".
5. To improve the trace stability, increase the number of "Sweep Points" or the "Sweep Time" (in the "Sweep" settings).

All configured traces (not set to "Blank") are displayed after the next sweep.

How to Copy Traces

1. A trace copy function is provided in a separate tab of the "Traces" dialog box. To display this tab do one of the following:
 - Select [TRACE] and then "Trace Copy".
 - Select "Analysis" from the "Overview", then select the "Trace Copy" tab.
2. Select the "Source" trace to be copied.
3. Select "Copy to Trace" for the trace to which the settings are to be applied.

The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next sweep.

5.3.3.2 How to export trace data and numerical results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each sweep point, the measured trace position and value are output.

The file is stored with a .DAT or .CSV extension. For details on the storage format, see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312.



For the results of a Spectrum Emission Mask (SEM) or Spurious Emissions measurement, special file export functions are available, see [Chapter 3.6.6.2, "How to save SEM result files"](#), on page 102(SEM) and ["Save Evaluation List"](#) on page 121 (Spurious).

To export trace data and table results

1. Select [TRACE] > "Trace Config" > "Trace / Data Export" tab.
2. Select "Export all Traces and all Table Results" to export all available measurement result data for the current application, or select a specific "Trace to Export".
3. Optionally, select "Include Instrument & Measurement Settings" to insert additional information in the export file header.

4. Select "Export Trace to ASCII File".
5. In the file selection dialog box, select the storage location and file name for the export file.
6. If necessary, change the decimal separator for the ASCII export file.
7. Select the data format of the ASCII file.
8. Select "Save" to close the dialog box and export the data to the file.

5.3.3.3 How to import traces

Trace data that was stored during a previous measurement can be imported to the Spectrum application, for example as a reference trace.

To import trace data

1. Press [Trace].
2. Select "Trace Config" > "Trace / Data Export"/"Import".
3. Select "Import All Traces" to import traces for all the currently active traces, or select a specific trace to be imported in "Import to Trace".
4. Select "Import ASCII File to Trace".
5. Select the file format in which the data is stored.
6. Select the file that contains the trace data.
7. Select "Select" to close the dialog box and start the import.

5.3.3.4 How to display and configure a spectrogram

Step-by-step instructions on how to display and configure a spectrogram are provided here. For details on individual functions and settings see [Chapter 5.3.2.6, "Spectrogram settings"](#), on page 301.

The remote commands required to perform these tasks are described in [Chapter 6.9.2.7, "Spectrogram configuration"](#), on page 579.

The following tasks are described here:

- ["To display a spectrogram"](#) on page 309
- ["To remove the spectrogram display"](#) on page 309
- ["To set a marker in the spectrogram"](#) on page 309
- ["To configure a spectrogram"](#) on page 309
- ["To select a color scheme"](#) on page 310
- ["To set the value range graphically using the color range sliders"](#) on page 310
- ["To set the value range of the color map numerically"](#) on page 311
- ["To set the color curve shape graphically using the slider"](#) on page 312
- ["To set the color curve shape numerically"](#) on page 312

To display a spectrogram

1. In the "Overview", select "Display", then drag the evaluation type "Spectrogram" to the diagram area.
Alternatively:
 - a) Select [TRACE] and then "Spectrogram Config".
 - b) Toggle "Spectrogram" to "On".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using [RUN SINGLE] or [RUN CONT].
The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific time frame:
 - a) Stop the continuous measurement or wait until the single sweep is completed.
 - b) Select the frame number in the diagram footer.
 - c) Enter the required frame number in the edit dialog box.
Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

To remove the spectrogram display

1. Select [TRACE] and then "Spectrogram Config".
2. Toggle "Spectrogram" to "Off".
The standard spectrum display is restored.

To set a marker in the spectrogram

1. While a spectrogram is displayed, select [MARKER].
2. Select a "Marker" softkey.
3. Enter the frequency or time (x-value) of the marker or delta marker.
4. Enter the frame number for which the marker is to be set, for example 0 for the current frame, or -2 for the second to last frame. Note that the frame number is always 0 or a negative value!
The marker is only visible in the spectrum diagram if it is defined for the currently selected frame. In the spectrogram result display all markers are visible that are positioned on a visible frame.

To configure a spectrogram

1. Configure the spectrogram frames:
 - a) Select [SWEEP].
 - b) Select "Sweep Config".
 - c) In the "Sweep/Average Count" field, define how many sweeps are to be analyzed to create a single frame.
 - d) In the "Frame Count" field, define how many frames are to be plotted during a single sweep measurement.

- e) To include frames from previous sweeps in the analysis of the new frame (for "Max Hold", "Min Hold" and "Average" trace modes only), select "Continue Frame" = "On".
2. Define how many frames are to be stored in total:
 - a) Select [TRACE] and then "Spectrogram Config".
 - b) Select "History Depth".
 - c) Enter the maximum number of frames to store.
3. Optionally, replace the frame number by a time stamp by toggling "Time Stamp" to "On".
4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in ["How to configure the color mapping"](#) on page 310.

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.

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.



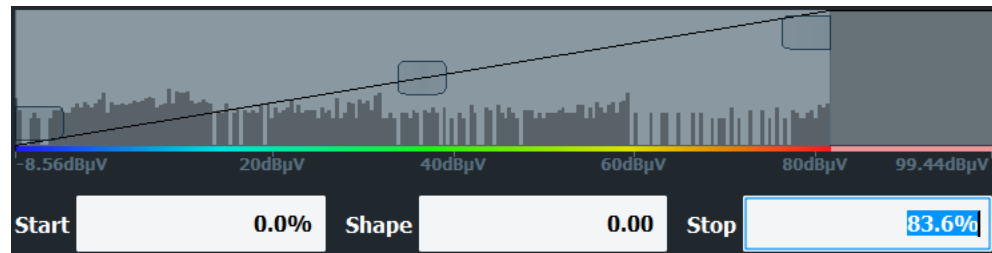
The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram, that means, the difference between the start and stop values must be at least 10%.

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 EPL1000 shifts the start point 10% to the right, to -90 dBm.



Adjusting the reference level and level range

Since the color map is configured using percentages of the total value range, changing the reference level and level range of the measurement (and thus the power value range) also affects the color mapping in the spectrogram.

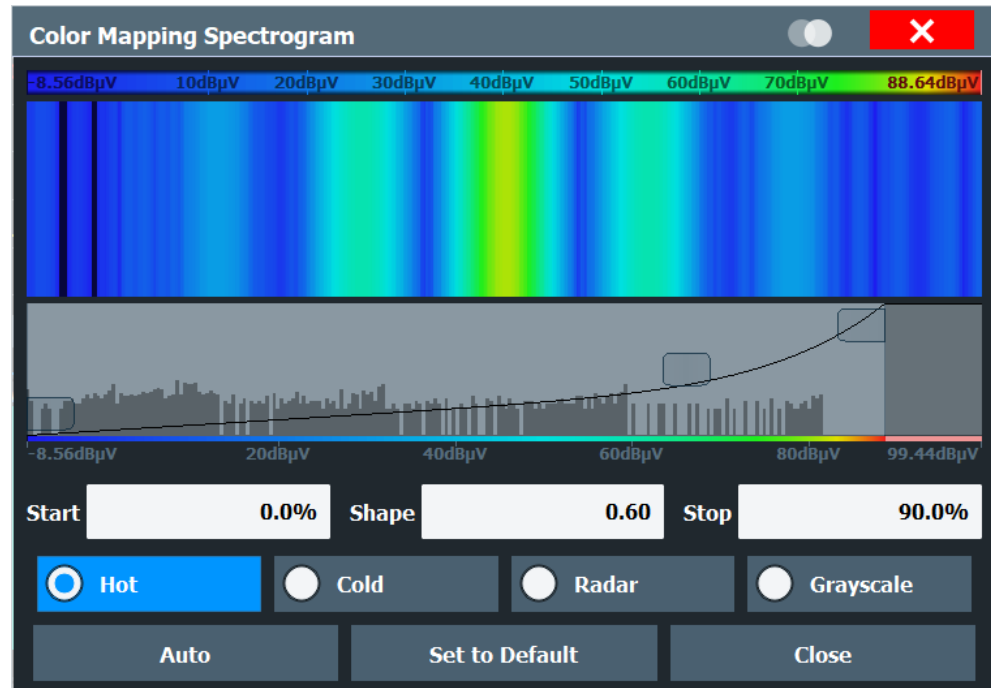
Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large number of results, while the other end distributes several colors over a relatively small result range.

The color curve shape can be set numerically or graphically.

To set the color curve shape graphically using the slider

- ▶ Select and drag the color curve shape slider (indicated by a gray box in the middle of the color curve) to the left or right. The area beneath the slider is focused, i.e. more colors are distributed there.



To set the color curve shape numerically

- ▶ In the "Shape" field, enter a value to change the shape of the curve:
 - A negative value (-1 to <0) focuses the lower values
 - 0 defines a linear distribution
 - A positive value (>0 to 1) focuses the higher values

5.3.4 References

- [Reference: ASCII file export format](#)..... 312
- [Formats for returned values: ASCII format and binary format](#)..... 316

5.3.4.1 Reference: ASCII file export format

Trace data can be exported to a file in ASCII format for further evaluation in other applications. This reference describes in detail the format of the export files for result data.

(For details see [Chapter 5.3.3.2, "How to export trace data and numerical results"](#), on page 307).



For a description of the file formats for spectrum emission mask (SEM) measurement settings and results, see [Chapter 3.6.8, "Reference: SEM file descriptions"](#), on page 104.

The file format for Spurious Emissions measurement results is described in [Chapter 3.7.6, "Reference: ASCII export file format \(spurious\)"](#), on page 123.

The file consists of the header information (general configuration of the measurement) and the measurement results. Optionally, the header can be excluded from the file.

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section starts with the keyword "Trace <n>" (<n> = number of stored trace). The measured data follows in one or several columns (depending on the measurement), which are also separated by a semicolon.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS Excel. Different language versions of evaluation programs can require a different handling of the decimal point. Thus, you can define the decimal separator to use (decimal point or comma).

If the spectrogram display is selected when you select "ASCII Trace Export", the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Table 5-9: ASCII file format for trace export in the Spectrum application

File contents	Description
Header data	
Type;R&S EPL1000;	Instrument model
Version;1.00;	Firmware version
Date;01.Oct 2022;	Date of data set storage
Mode;ANALYZER;	Operating mode
Preamplifier;OFF	Preamplifier status
Transducer; OFF	Transducer status
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Start;10000;Hz 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

File contents	Description
Rf Att;20;dB	Input attenuation
EI Att;2.0;dB	Electrical attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Sweep Count;20;	Number of sweeps set
Ref Position;75;%	Position of reference level referred to diagram limits (0 % = lower edge)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
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,QUASPEAK
Values; 1001;	Number of measurement points
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...	Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 ...;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

Table 5-10: ASCII file format for spectrogram trace export

File contents	Description
Header	
Type;R&S EPL1000;	Instrument model
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER; SPECTROGRAM	Operating mode
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Ref Position;75; %	Position of reference level referred to diagram limits (0 % = lower edge)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
Rf Att;20;dB	Input attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Selected detector
Sweep Count;20;	Number of sweeps set
Data section	
Trace 1;;;	Selected trace
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Values; 1001;	Number of measurement points
Frames;2;	Number of exported frames

File contents	Description
Frame;0;	Most recent frame number
Timestamp;17.Mar 11;11:27:05.990	Timestamp of this frame
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values, identical to spectrum data: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Frame;-1;	Next frame
Timestamp;17.Mar 11;11:27:05.342	Timestamp of this frame
...	

5.3.4.2 Formats for returned values: ASCII format and binary format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMat[:DATA]` on page 572. The possible formats are described here.

- **ASCII Format (FORMat ASCII):**
The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.
- **Binary Format (FORMat REAL,16/32/64):**
The data is stored as binary data (definite length block data according to IEEE 488.2), each measurement value being formatted in 16-bit/32-bit/64-bit IEEE 754 floating-point-format.
The schema of the result string is as follows:
#<Length of length><Length of data><value1><value2>...<value n>
with:

<Length of length>	Number of digits of the following number of data bytes
<Length of data>	Number of following data bytes
<Value>	2-byte/4-byte/8-byte floating point value

Example: #41024<Data>... contains 1024 data bytes

Data blocks larger than 999,999,999 bytes

According to SCPI, the header of the block data format allows for a maximum of 9 characters to describe the data length. Thus, the maximum REAL 32 data that can be represented is 999,999,999 bytes. However, the R&S EPL1000 is able to send larger data blocks. In this case, the length of the data block is placed in brackets, e.g.
#(1234567890) <value1><value2>...



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

5.4 Marker Usage

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display both in the time and frequency domain. In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.



Markers in Spectrogram Displays

In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame.

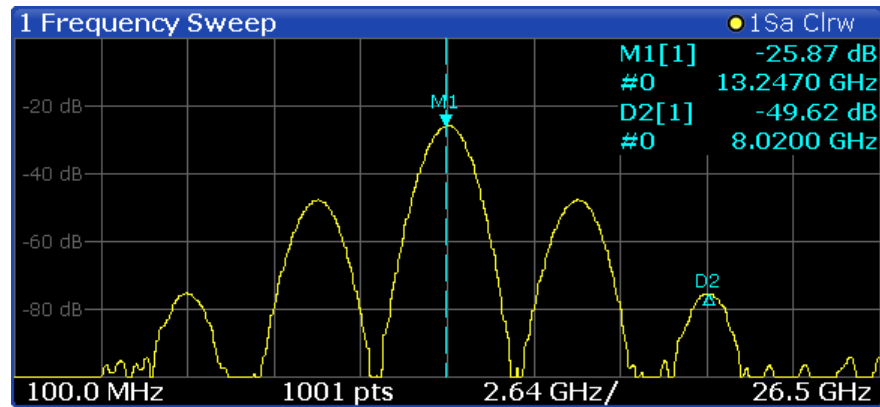
- [Basics on markers](#).....317
- [Marker settings](#).....320
- [Marker search settings and positioning functions](#)..... 325
- [Marker \(measurement\) functions](#)..... 331
- [How to work with markers](#)..... 351
- [Measurement example: measuring harmonics using marker functions](#)..... 352

5.4.1 Basics on markers

Some background knowledge on marker settings and functions is provided here for a better understanding of the required configuration settings.

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. R&S EPL1000 provides 17 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- To set individual markers very quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- The easiest way to work with markers is using a mouse. Simply drag the marker and drop it at the required position.
- When you select a marker in a diagram, a vertical line is displayed which indicates the marker's current x-value.



- Alternatively, change the position of the selected marker using the rotary knob. By default, the marker is moved from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (General Marker Setting).
- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touch screen and hold your finger for about 2 seconds until the context menu is opened, then select the required entry.
- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.
- [Marker types](#)..... 318
- [Activating markers](#)..... 319
- [Marker results](#)..... 319

5.4.1.1 Marker types

All markers can be used either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta marker indicates the value of the marker relative to the specified reference marker (by default marker 1).

The Spectrum application also features special functions that you can assign to individual markers. The availability of special marker functions depends on whether the measurement runs in the frequency or time domain.

Temporary markers are used in addition to the markers and delta markers to analyze the measurement results for special marker functions. They disappear when the associated function is deactivated.

5.4.1.2 Activating markers

Only active markers are displayed in the diagram and in the marker table.

Active markers are indicated by a highlighted softkey.

By default, marker 1 is active and positioned on the maximum value (peak) of trace 1 as a normal marker. If several traces are displayed, the marker is set to the maximum value of the trace which has the lowest number and is not frozen (View mode). The next marker to be activated is set to the frequency of the next lower level (next peak) as a delta marker; its value is indicated as an offset to marker 1.

A marker can only be activated when at least one trace in the corresponding window is visible. If a trace is switched off, the corresponding markers and marker functions are also deactivated. If the trace is switched on again, the markers along with coupled functions are restored to their original positions, provided the markers have not been used on another trace.

5.4.1.3 Marker results

Normal markers point to a trace point on the x-axis and display the associated numeric value for that trace point. Delta markers indicate an offset between the level at the delta marker position and the level at the position of the assigned reference marker, in dB.

Signal count markers determine the frequency of a signal at the marker position very accurately.

The results can be displayed directly within the diagram area or in a separate table. By default, the first two active markers are displayed in the diagram area. If more markers are activated, the results are displayed in a marker table.

Marker information in diagram area

By default, the results of the last two markers or delta markers that were activated are displayed in the diagram area.

D2[1]	-21.90 dB
	-3.9180 GHz
M1[1]	-25.87 dBm
	13.1970 GHz

The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number
- The assigned trace number in square brackets []
- The marker value on the y-axis, or the result of the marker function
- The marker position on the x-axis

For n dB down markers, additional information is displayed, see [Table 5-12](#).

Marker information in marker table

In addition to the marker information displayed within the diagram area, a separate marker table may be displayed beneath the diagram. This table provides the following information for all active markers:

Table 5-11: Contents of the marker table in the Spectrum application

Type	Marker type: N (normal), D (delta), T (temporary, internal) and number
Ref	Reference marker for delta markers
Trc	Trace to which the marker is assigned
Frame	Spectrogram frame the marker is positioned in. Displayed only when the Spectrogram is displayed.
X-value	X-value of the marker
Y-value	Y-value of the marker
Function	Activated marker or measurement function
Function Result	Result of the active marker or measurement function

5.4.2 Marker settings

Access: "Overview" > "Analysis" > "Marker"

Marker settings can be configured via the [Marker] menu or in the "Marker" dialog box.

The remote commands required to define these settings are described in [Chapter 6.9.3, "Marker configuration"](#), on page 587.

- [Individual Marker Setup](#)..... 320
- [General Marker Settings](#)..... 323

5.4.2.1 Individual Marker Setup

Access: "Overview" > "Analysis" > "Marker" > "Markers"

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.

Markers	Marker Settings	Search	Marker Functions				
	Selected	State	X-Value	Type	Ref Marker	Link to Marker	Trace
1-5	Marker 1	On Off	9.6683761 MHz	Norm Delta		Off	1
6-11	Delta 1	On Off	13.545 MHz	Norm Delta	1	Off	1
	Delta 2	On Off	704.0 kHz	Norm Delta	FXD	Off	1
12-16	Delta 3	On Off	1.0 Hz	Norm Delta	FXD	Off	1
	Delta 4	On Off	1.0 Hz	Norm Delta	FXD	Off	1
	Delta 5	On Off	1.0 Hz	Norm Delta	FXD	Off	1
All Markers Off							

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

Selected Marker.....	321
Marker State.....	321
Marker Position X-value.....	321
Frame (Spectrogram only).....	322
Marker Type.....	322
Reference Marker.....	322
Linking to Another Marker.....	322
Assigning the Marker to a Trace.....	323
Select Marker.....	323
All Markers Off.....	323

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 592

`CALCulate<n>:DELTAmarker<m>[:STATe]` on page 590

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 593

`CALCulate<n>:DELTAmarker<m>:X` on page 591

Frame (Spectrogram only)

Spectrogram frame the marker is assigned to.

Remote command:

[CALCulate<n>:MARKer<m>:SPECTrogram:FRAMe](#) on page 608

[CALCulate<n>:DELTAmarker<m>:SPECTrogram:FRAMe](#) on page 612

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 592

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 590

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 325), the reference point ("FXD") can also be selected instead of another marker.

Remote command:

[CALCulate<n>:DELTAmarker<m>:MREFerence](#) on page 590

Linking to Another Marker

Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:

[CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>](#) on page 592

[CALCulate<n>:DELTAmarker<ms>:LINK:TO:MARKer<md>](#) on page 589

[CALCulate<n>:DELTAmarker<m>:LINK](#) on page 588

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 593

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 592

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 590

All Markers Off

Deactivates all markers in one step.

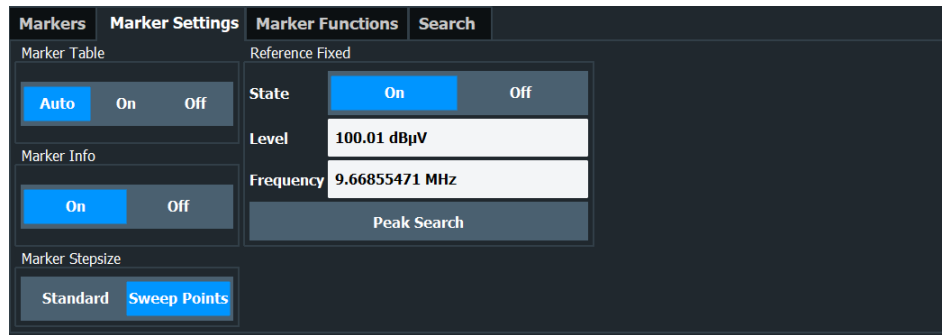
Remote command:

[CALCulate<n>:MARKer<m>:AOFF](#) on page 592

5.4.2.2 General Marker Settings

Access: "Overview" > "Analysis" > "Marker" > "Marker Settings"

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



Marker Table Display.....	324
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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" No separate marker table is displayed.
If **Marker Info** is active, the marker information is displayed within the diagram area.
- "Auto" (Default) If more than two markers are active, the marker table is displayed automatically.
If **Marker Info** is active, the marker information for up to two markers is displayed in the diagram area.

Remote command:

`DISPlay[:WINDow<n>]:MTABLE` on page 597

Marker Info

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

1AP Clrw	
M1[1]	81.13 dBµV 177.610 MHz
D2[1]	-22.18 dB -28.980 MHz

Remote command:

`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 596

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 596

Defining a Fixed Reference

Instead of using a reference marker whose position can vary depending on the measurement results, you can define a fixed reference marker for trace analysis.

Note that this function is not available in all result displays.

For "State" = "On", a vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value. The delta marker refers to the fixed reference marker.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference marker. To move the fixed reference, move the red display lines marked "FXD" in the diagram, or change the position settings in the "Marker Settings" tab of the "Marker" dialog box.

Peak Search sets the fixed reference marker to the current maximum value of the trace assigned to marker 1.

If activated, the fixed reference marker ("FXD") can also be selected as a [Reference Marker](#) instead of another marker.

Remote command:

[CALCulate<n>:DELTaMarker<m>:FUNCTION:FIXed\[:STATe\]](#) on page 595

[CALCulate<n>:DELTaMarker<m>:FUNCTION:FIXed:RPoint:Y](#) on page 594

[CALCulate<n>:DELTaMarker<m>:FUNCTION:FIXed:RPoint:X](#) on page 594

[CALCulate<n>:DELTaMarker<m>:FUNCTION:FIXed:RPoint:MAXimum\[:PEAK\]](#) on page 594

5.4.3 Marker search settings and positioning functions

Access: "Overview" > "Analysis" > "Marker" > "Search"

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

The remote commands required to define these settings are described in [Chapter 6.9.3.3, "Marker search"](#), on page 597 and [Chapter 6.9.3.4, "Marker positioning"](#), on page 601.

- [Marker search settings](#).....326
- [Marker search settings for spectrograms](#).....328
- [Positioning functions](#)..... 329

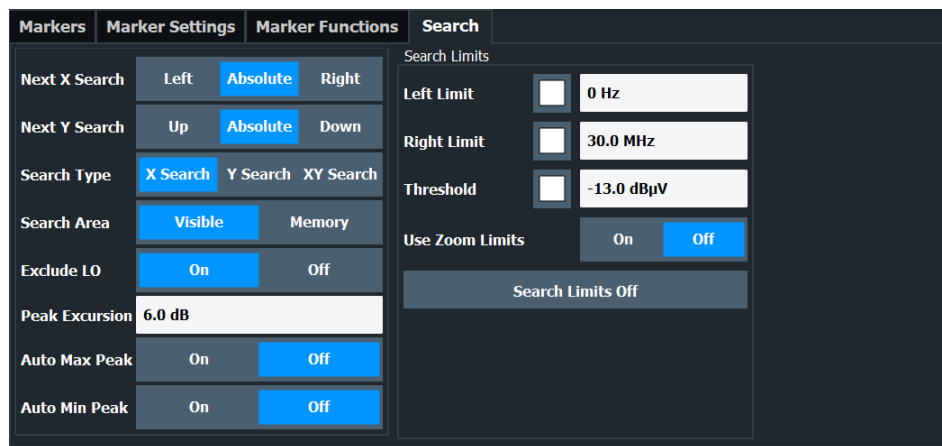
5.4.3.1 Marker search settings

Access: "Overview" > "Analysis" > "Marker" > "Search"

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



For Spectrograms, special marker settings are available, see [Chapter 5.4.3.2, "Marker search settings for spectrograms"](#), on page 328.



Search Mode for Next Peak	326
Exclude LO	327
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Auto Max Peak Search / Auto Min Peak Search	327
Search Limits	327
└ Search Limits (Left / Right)	327
└ Search Threshold	328
└ Use Zoom Limits	328
└ Search Limits Off	328

Search Mode for Next Peak

Selects the search mode for the next peak search.

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

Remote command:

Find a list of remote commands in [Chapter 6.9.3.4, "Marker positioning"](#), on page 601.

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 597

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see [Chapter 5.4.4.8, "Marker peak list"](#), on page 347.

Remote command:

`CALCulate<n>:MARKer<m>:PEXCursion` on page 598

Auto Max Peak Search / Auto Min Peak Search

If activated, a maximum or minimum peak search is performed automatically for marker 1 after each sweep.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:

`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 604

`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 605

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 348.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 600

[CALCulate<n>:MARKer<m>:X:SLIMits:LEFT](#) on page 598

[CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT](#) on page 599

Search Threshold ← Search Limits

Defines an absolute threshold as an additional condition for the peak search. If enabled, only peaks that exceed the threshold are detected.

Remote command:

[CALCulate<n>:THReshold:STATe](#) on page 600

[CALCulate<n>:THReshold](#) on page 600

Use Zoom Limits ← Search Limits

If activated, the peak search is restricted to the active zoom area defined for a single zoom.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM\[:STATe\]](#) on page 599

Search Limits Off ← Search Limits

Deactivates the search range limits.

Remote command:

[CALCulate<n>:MARKer<m>:X:SLIMits\[:STATe\]](#) on page 600

[CALCulate<n>:THReshold:STATe](#) on page 600

5.4.3.2 Marker search settings for spectrograms

Access: "Overview" > "Analysis" > "Marker" > "Search"

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.

Functions for marker search in spectrograms described elsewhere:

- ["Exclude LO"](#) on page 327
- ["Peak Excursion"](#) on page 327
- ["Auto Max Peak Search / Auto Min Peak Search"](#) on page 327
- ["Search Limits \(Left / Right\)"](#) on page 327
- ["Search Threshold"](#) on page 328
- ["Use Zoom Limits"](#) on page 328
- ["Search Limits Off"](#) on page 328

Search Mode for Next Peak in X-Direction	329
Search Mode for Next Peak in Y-Direction	329
Marker Search Type	329
Marker Search Area	329

Search Mode for Next Peak in X-Direction

Selects the search mode for the next peak search within the currently selected frame.

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

Remote command:

Find a list of remote commands in [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 608.

Search Mode for Next Peak in Y-Direction

Selects the search mode for the next peak search within all frames at the current marker position.

"Up"	Determines the next maximum/minimum above the current peak (in more recent frames).
"Absolute"	Determines the next maximum/minimum above or below the current peak (in all frames).
"Down"	Determines the next maximum/minimum below the current peak (in older frames).

Remote command:

Find a list of remote commands in [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 608.

Marker Search Type

Defines the type of search to be performed in the spectrogram.

"X-Search"	Searches only within the currently selected frame.
"Y-Search"	Searches within all frames but only at the current frequency position.
"XY-Search"	Searches in all frames at all positions.

Remote command:

Defined by the search function, see [Chapter 6.9.3.6, "Spectrogram markers"](#), on page 608

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 609

[CALCulate<n>:DELTAmarker<m>:SPECTrogram:SARea](#) on page 613

5.4.3.3 Positioning functions

Access: [MKR →]

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

Peak Search.....	330
Search Next Peak.....	330
Search Minimum.....	330
Search Next Minimum.....	330
Center Frequency = Marker Frequency.....	331
Reference Level = Marker Level.....	331

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 605

`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 602

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 604

`CALCulate<n>:MARKer<m>:MAXimum:RIGHT` on page 605

`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 604

`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 602

`CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT` on page 602

`CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 601

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 606

`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 603

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 606

`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 606

`CALCulate<n>:MARKer<m>:MINimum:RIGHT` on page 606

`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 603

[CALCulate<n>:DELTAmarker<m>:MINimum:LEFT](#) on page 602

[CALCulate<n>:DELTAmarker<m>:MINimum:RIGHT](#) on page 603

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 534

Reference Level = Marker Level

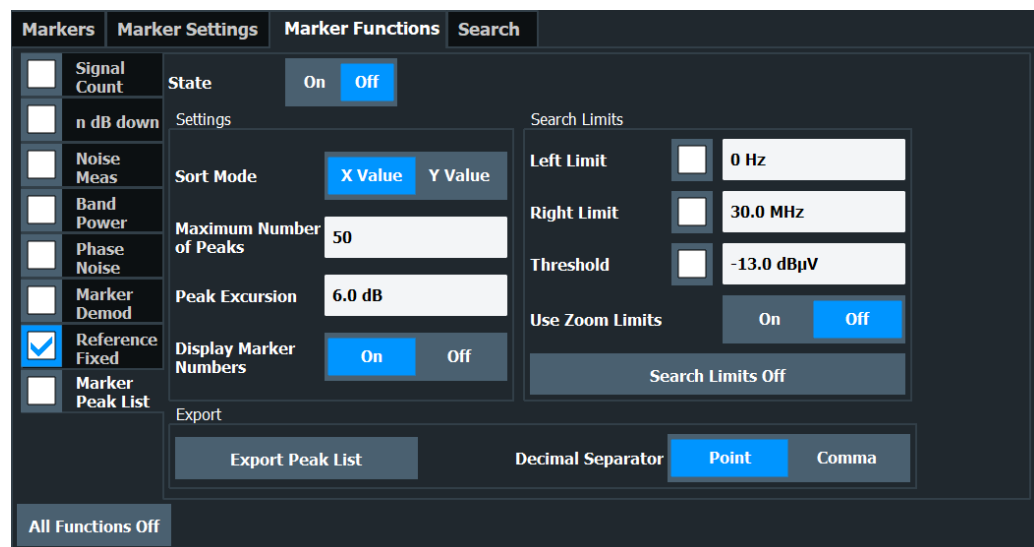
Sets the reference level to the selected marker level.

Remote command:

[CALCulate<n>:MARKer<m>:FUNction:REFerence](#) on page 537

5.4.4 Marker (measurement) functions

Access: "Overview" > "Analysis" > "Marker" > "Marker Functions"



The remote commands required to define these settings are described in [Chapter 6.9.3.7, "Marker functions"](#), on page 615.

- [Precise frequency \(signal count\) marker](#).....332
- [Measuring noise density \(noise meas marker\)](#)..... 333
- [Phase noise measurement marker](#)..... 336
- [Measuring characteristic bandwidths \(n db down marker\)](#)..... 339
- [Fixed reference marker](#)..... 341
- [Measuring the power in a channel \(band power marker\)](#)..... 342
- [Demodulating marker values and providing audio output \(marker demodulation\)](#) 345
- [Marker peak list](#)..... 347
- [Deactivating all marker functions](#)..... 351

5.4.4.1 Precise frequency (signal count) marker

Access: "Overview" > "Analysis" > "Marker Functions" > "Select Marker Function" > "Signal Count" > "Signal Count Config"

A normal marker determines the position of the point on the trace and indicates the signal frequency at this position. The trace, however, contains only a limited number of points. Depending on the selected span, each trace point can contain many measurement values. Thus, the frequency resolution of each trace point is limited.

(See also [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230).

Frequency resolution is further restricted by the RBW and sweep time settings.

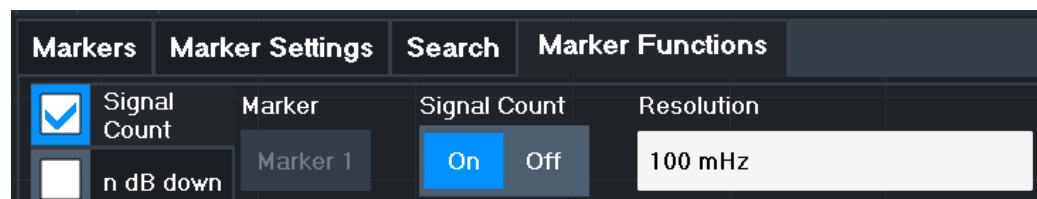
To determine the frequency of a signal point accurately without changing the sweep settings, the R&S EPL1000 is equipped with a signal counter. The signal counter sets the RF to the current marker position, then counts the zero crossings of the IF (thus the term *signal counter*) and derives the precise frequency value.



To determine the frequency accurately using the signal counter function, the marker must be sufficiently close to the actual signal (for a 3-dB Gauss filter, the delta must be less than $2 \cdot \text{RBW}$). Usually, the marker peak function detects a trace point that is close enough. However, for a large span or a small number of sweep points, the result can be inaccurate.

Signal counting can be performed explicitly at the current marker position ("Signal Count" marker function), or implicitly by the R&S EPL1000 for certain functions.

Signal counting is only possible while the instrument is not sweeping. Thus, to perform a signal count for a marker, the sweep is stopped at the marker position. The frequency is determined with the desired resolution and then the sweep is allowed to continue.



A measurement example is described in [Chapter 3.1.3.2, "Measuring the signal frequency using the signal counter"](#), on page 16.



Signal counters are not available for measurements on I/Q-based data.

Remote commands:

"[Example: performing a highly accurate frequency measurement using the signal count marker](#)" on page 642

`CALCulate<n>:MARKer<m>:COUNT` on page 616

[CALCulate<n>:MARKer<m>:COUNT:RESolution](#) on page 617

Signal Count Marker State	333
Resolution	333

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 616

[CALCulate<n>:MARKer<m>:COUNT:FREQuency?](#) on page 616

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 617

5.4.4.2 Measuring noise density (noise meas marker)

Access: "Overview" > "Analysis" > "Marker Functions" > "Select Marker Function" > "Noise Measurement" > "Noise Meas Config"

Using the noise measurement marker function, the noise power density is measured at the position of the marker. In the time domain mode, all points of the trace are used to determine the noise power density. When measurements are performed in the frequency domain, eight points to the right and left of the marker (if available) are used for the measurement to obtain a stable result.

Result display

Noise density is the noise referred to a bandwidth of 1 Hz. With logarithmic amplitude units (dBm, dBmV, dBm μ V, dB μ A), the noise power density is output in dBm/Hz, i.e. as the level in 1 Hz bandwidth with reference to 1 mW. With linear amplitude units (V, A, W), the noise voltage density is analyzed in μ V/ \sqrt Hz; the noise current density in μ A/ \sqrt Hz; the noise power density in μ W/ \sqrt Hz.

The result is indicated as the **function result in the Marker Table**.

Prerequisite settings

The following settings are required to obtain correct values:

- Detector: Sample or RMS
- Video bandwidth:
 - ≤ 0.1 resolution bandwidth with sample detector
 - ≥ 3 x resolution bandwidth with RMS detector
- Trace averaging:
 - In the default setting, the R&S EPL1000 uses the sample detector for the noise function. With the sample detector, you can set the trace to "Average" mode to sta-

bilize the measured values. When the RMS detector is used, trace averaging produces noise levels that are too low and cannot be corrected. Instead, increase the sweep time to obtain stable measurement results.

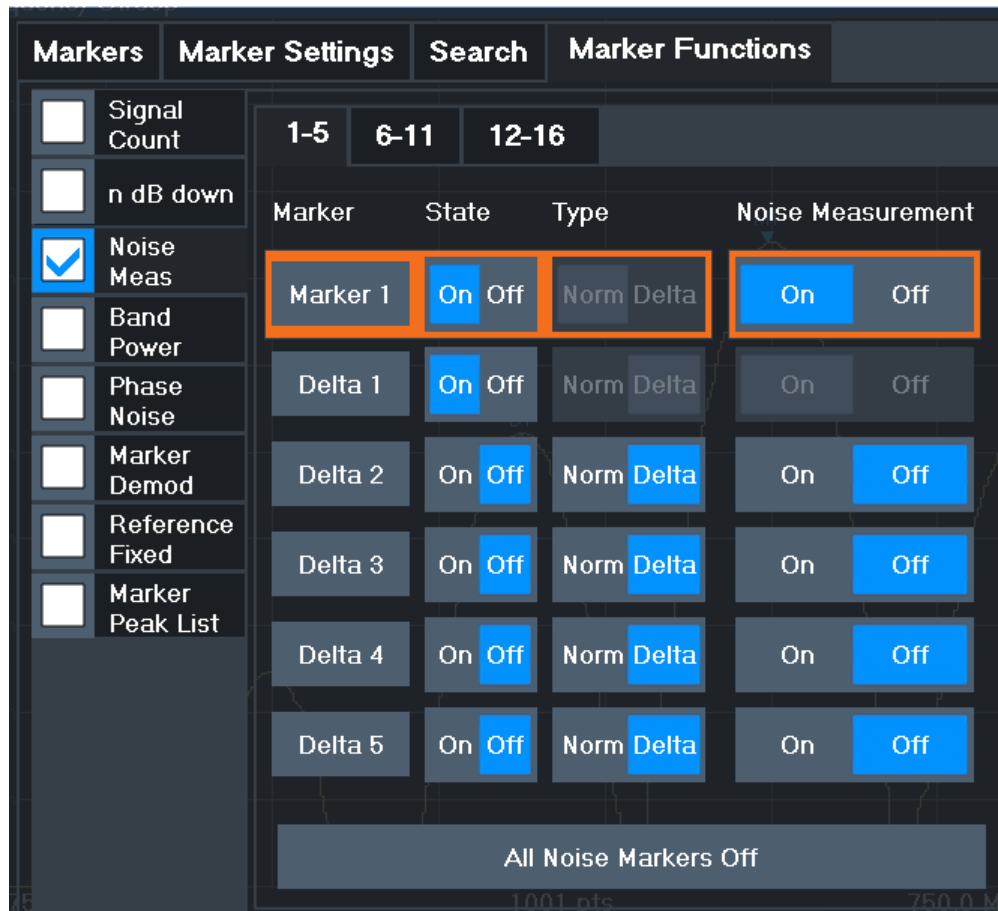
Correction factors

The R&S EPL1000 uses the following correction factors to analyze the noise density from the marker level:

- Since the noise power is indicated with reference to 1 Hz bandwidth, the bandwidth correction value is deducted from the marker level. It is $10 \times \lg(1 \text{ Hz}/\text{BWNoise})$, where BWNoise is the noise or power bandwidth of the set resolution filter (RBW).
- RMS detector: With the exception of bandwidth correction, no further corrections are required since this detector already indicates the power for each point of the trace.
- Sample detector: As a result of video filter averaging and trace averaging, 1.05 dB is added to the marker level. This is the difference between the average value and the RMS value of white noise. With a logarithmic level axis, 1.45 dB is added additionally. Logarithmic averaging is thus fully taken into account, which yields a value that is 1.45 dB lower than that of linear averaging.
- To allow for a more stable noise display, eight trace points on each side of the measurement frequency are averaged.
- For span > 0, the measured values are averaged versus time (after a sweep).



The R&S EPL1000 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:

"Example: measuring noise density" on page 638

CALCulate<n>:MARKer<m>:FUNCTION:NOISE[:STATe] on page 618

CALCulate<n>:MARKer<m>:FUNCTION:NOISE:RESult? on page 617

Marker State.....335
 Marker Type..... 335
 Noise Measurement State.....336
 Switching All Noise Measurement Off..... 336

Marker State

Activates or deactivates the marker in the diagram.

Remote command:

CALCulate<n>:MARKer<m>[:STATe] on page 592

CALCulate<n>:DELTAmarker<m>[:STATe] on page 590

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 592

[CALCulate<n>:DELTAmarker<m>\[:STATe\]](#) on page 590

Noise Measurement State

Activates or deactivates noise measurement for the marker in the diagram.

This function is only available for normal markers.

If activated, the marker displays the noise power density measured at the position of the marker.

For details see [Chapter 5.4.4.2, "Measuring noise density \(noise meas marker\)"](#), on page 333.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe\[:STATe\]](#) on page 618

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe:RESult?](#) on page 617

Switching All Noise Measurement Off

Deactivates noise measurement for all markers.

Remote command:

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe\[:STATe\]](#) on page 618

5.4.4.3 Phase noise measurement marker

Access: "Overview" > "Analysis" > "Marker Functions" > "Phase Noise" > "Phase Noise Config"

For each of the 16 markers, you can activate a phase noise measurement.

Phase noise is unintentional modulation of a carrier; it creates frequencies next to the carrier frequency. A phase noise measurement consists of noise density measurements at defined offsets from the carrier; the results are given in relation to the carrier level (dBc). The phase noise marker function measures the noise power at the delta markers referred to 1 Hz bandwidth. Marker 1 is used as the reference for the phase noise measurement. By default, the current frequency and level of marker 1 are used as the fixed reference marker. However, you can start a peak search to use the current signal peak as the reference point, or you can define a reference point manually.

The reference point for the phase noise measurement is fixed. After phase noise measurement is started, you can set the reference level or the center frequency so that the carrier is outside the displayed frequency range. You can also activate a notch filter to suppress the carrier.

Alternatively, the reference point can be determined automatically by a peak search after each sweep. Use this function to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Thus, the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

The result of the phase noise measurement is the difference in level between the reference point and the noise power density. It is indicated as the function result of the phase noise marker in the "marker table".

The sample detector is automatically used and the video bandwidth set to 0.1 times the resolution bandwidth (RBW). The two settings are considered in the correction values used for the noise power measurement. To obtain stable results, two pixels on the right and the left of the delta marker position are taken for the measurement.

The 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.

Marker

Markers **Marker Settings** **Marker Functions** **Search**

n dB down

Phase Noise

Reference Fixed

Marker Peak List

1-5 6-11 12-16

Marker	State	Type	Phase Noise	
Marker 1	On Off	Norm Delta	On	Off
Delta 1	On Off	Norm Delta	On	Off
Marker 2	On Off	Norm Delta	On	Off
Delta 3	On Off	Norm Delta	On	Off
Delta 4	On Off	Norm Delta	On	Off
Delta 5	On Off	Norm Delta	On	Off

All Phase Noise Markers Off

All Functions Off

Remote commands:

[CALCulate<n>:MARKer<m>:FUNCTION:PNOise\[:STATe\]](#) on page 620

[CALCulate<n>:MARKer<m>:FUNCTION:PNOise:RESult?](#) on page 620

[Phase Noise Measurement State](#)..... 338

[Defining Reference Point](#)..... 339

[Switching All Phase Noise Measurements Off](#)..... 339

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 619

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:RESult?` on page 619

Defining Reference Point

Instead of using marker 1 as the reference marker, a fixed reference marker can be defined for phase noise measurement.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

Alternatively, a **Peak Search** can be performed to set the maximum value of the selected trace as the reference point.

If "Automatic Peak Search" is activated, a peak search is started automatically after each sweep and the result is used as the reference point.

Remote command:

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPoint:Y` on page 594

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPoint:X` on page 594

`CALCulate<n>:DELTAmarker<m>:FUNCTION:FIXed:RPoint:MAXimum[:PEAK]` on page 594

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise:AUTO` on page 618

Switching All Phase Noise Measurements Off

Deactivates phase noise measurement for all markers.

Remote command:

`CALCulate<n>:DELTAmarker<m>:FUNCTION:PNOise[:STATe]` on page 619

5.4.4.4 Measuring characteristic bandwidths (n db down marker)

Access: "Overview" > "Analysis" > "Marker Functions" > "n dB down" > "n dB Down Config"

When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. To measure this bandwidth, you could use several markers and delta markers and determine the bandwidth manually. However, using the n dB down marker function makes the task very simple and quick.

The n dB down marker function uses the current value of marker 1 as the reference point. It activates two temporary markers T1 and T2 located on the signal, whose level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but it can be changed.

If a positive offset is entered, the markers T1 and T2 are placed below the active reference point. If a negative value is entered (for example for notch filter measurements), the markers T1 and T2 are placed above the active reference point.

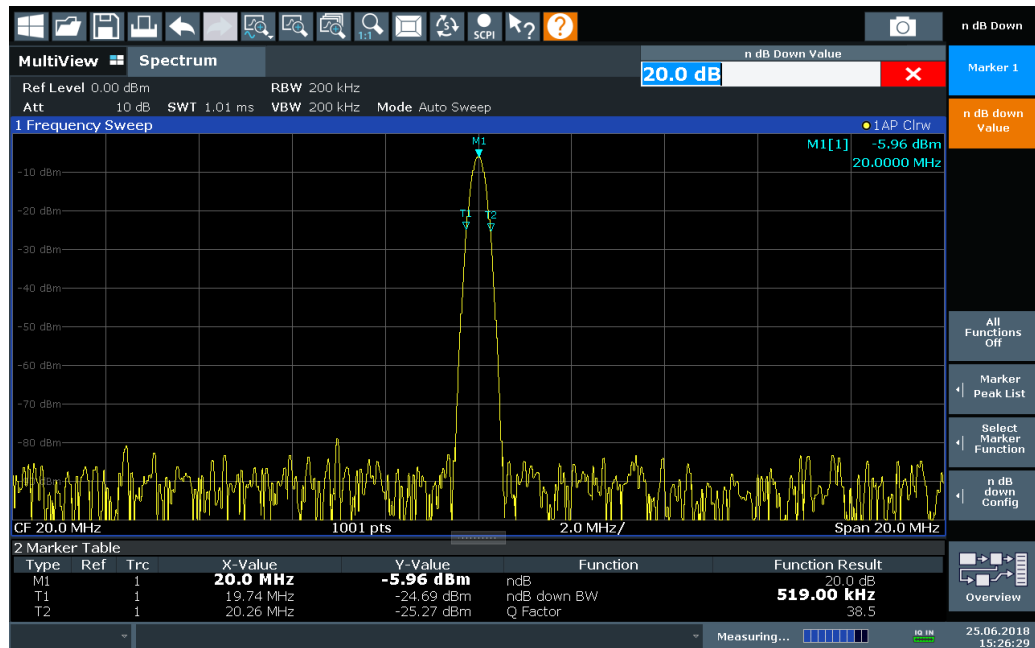


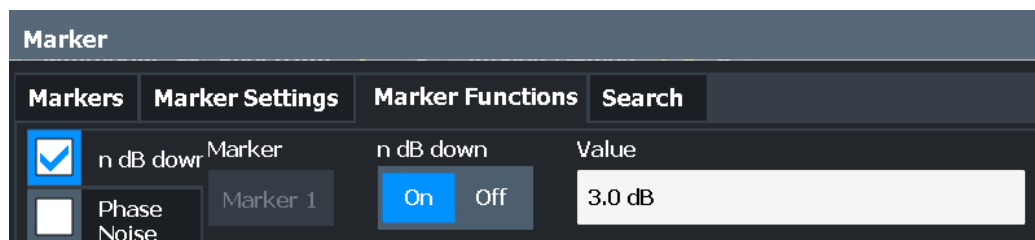
Figure 5-14: n dB down marker function

The following marker function results are displayed:

Table 5-12: n dB down marker function results

Label	Description
M1	Current position and level of marker 1
ndB	Offset value (n dB down)
ndB down Bw / PWid	Determined bandwidth or pulse width (zero span) at the offset
Q-factor	Center frequency / n-dB-down-bandwidth 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 623

CALCulate<n>:MARKer<m>:FUNction:NDBDown:RESult? on page 622

n dB down Marker State.....341
 n dB down Value..... 341

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 623

CALCulate<n>:MARKer<m>:FUNction:NDBDown:RESult? on page 622

n dB down Value

Defines the delta level from the reference marker 1 used to determine the bandwidth or time span.

Remote command:

CALCulate<n>:MARKer<m>:FUNction:NDBDown:FREQuency? on page 621

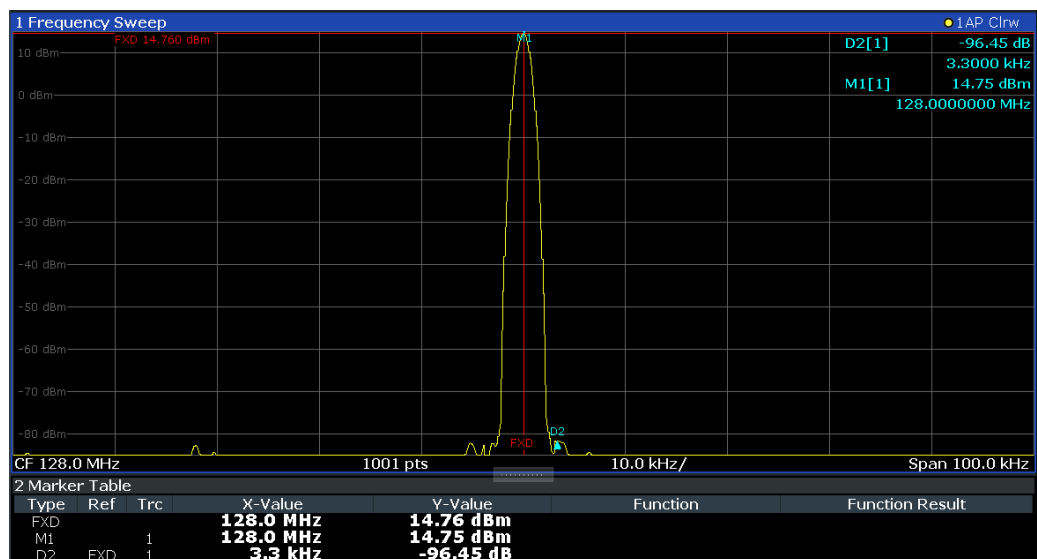
CALCulate<n>:MARKer<m>:FUNction:NDBDown:TIME? on page 623

5.4.4.5 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.

When you select this marker function, a vertical and a horizontal red display line are displayed, marked as "FXD". A normal marker is activated and set to the peak value and a delta marker to the next peak. The fixed reference marker is set to the position of the normal marker at the peak value. The delta marker refers to the fixed reference marker.



You can move the position of the fixed reference marker graphically by dragging the display lines, or numerically by entering values for the marker position and level.

Remote commands:

"Example: using a fixed reference marker" on page 637

CALCulate<n>:DELTAmarker<m>:FUNction:FIXed[:STATe] on page 595

CALCulate<n>:DELTAmarker<m>:FUNction:FIXed:RPoint:X on page 594

CALCulate<n>:DELTAmarker<m>:FUNction:FIXed:RPoint:Y on page 594

5.4.4.6 Measuring the power in a channel (band power marker)

Access: "Overview" > "Analysis" > "Marker Functions" > "Band Power" > "Band Power Config"

or: [MKR FUNC] > "Select Marker Function" > "Band Power"

To determine the noise power in a transmission channel, you can use a noise marker and multiply the result with the channel bandwidth. However, the results are only accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the "marker table" for each band power marker.



Relative band power markers

The results for band power markers which are defined as *delta* markers and thus have a reference value can also be calculated as reference power values (in dB).

In this case, the result of the band power deltamarker is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.

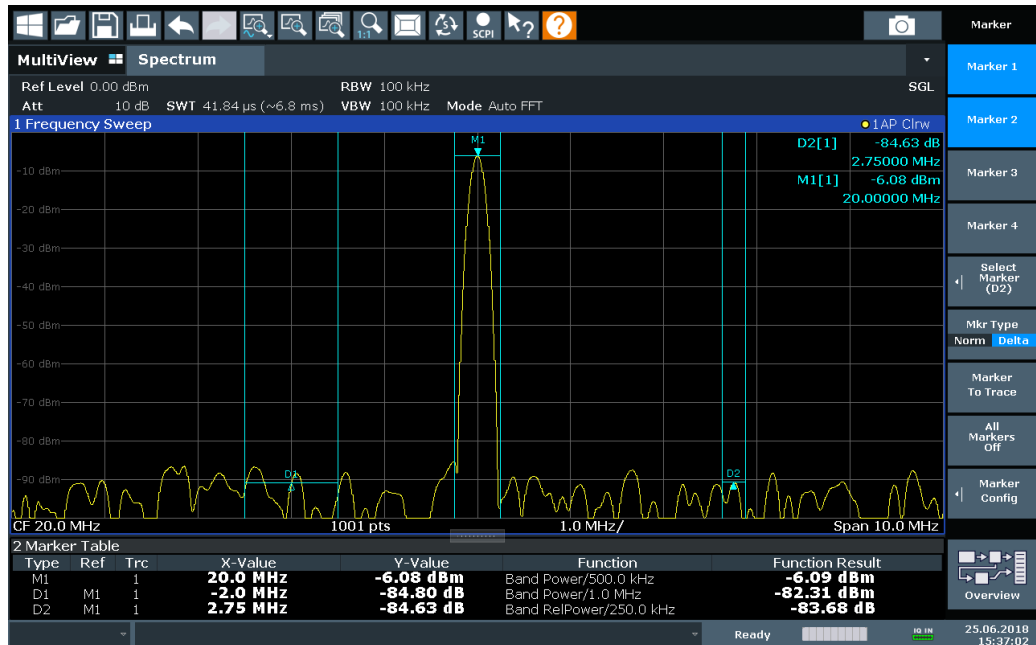
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]

The measured power for the reference marker may be an absolute power at a single point (if the reference marker is not a band power marker), or the power in a band (if the reference marker is a band power marker itself).

If the reference marker for the band power marker is also a delta marker, the absolute power level for the reference marker is used for calculation.



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.

Markers	Marker Settings	Search	Marker Functions
<input type="checkbox"/> Signal Count	1-5 6-11 12-16		
<input type="checkbox"/> n dB down			
<input type="checkbox"/> Noise Meas			
<input checked="" type="checkbox"/> Band Power			
<input type="checkbox"/> Phase Noise			
<input type="checkbox"/> Marker Demod			
<input type="checkbox"/> Reference Fixed			
<input type="checkbox"/> Marker Peak List			
	Marker	State	Type
	Marker 1	On Off	Norm Delta
	Delta 1	On Off	Norm Delta
	Delta 2	On Off	Norm Delta
	Delta 3	On Off	Norm Delta
	Delta 4	On Off	Norm Delta
	Delta 5	On Off	Norm Delta
	Band Power	On Off	375.0 MHz
	Power Mode	Power	Density
	Band Power	On Off	375.0 MHz
	Power	RelPower	Density
	Band Power	On Off	375.0 MHz
	Power	RelPower	Density
	Band Power	On Off	375.0 MHz
	Power	RelPower	Density
	Band Power	On Off	375.0 MHz
	Power	RelPower	Density
	Band Power	On Off	375.0 MHz
	Power	RelPower	Density

All Bandpower Markers Off

Remote commands:

"Example: measuring the power in a channel using band power markers" on page 640

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWer[:STATe]` on page 627

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWer:RESult?` on page 626

Band Power Measurement State.....	344
Span.....	344
Power Mode.....	344
Switching All Band Power Measurements Off.....	345

Band Power Measurement State

Activates or deactivates band power measurement for the marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

If activated, the markers display the power or density measured in the band around the current marker position.

For details see [Chapter 5.4.4.6, "Measuring the power in a channel \(band power marker\)"](#), on page 342.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWer[:STATe]` on page 627

`CALCulate<n>:DELTaMarker<m>:FUNCTION:BPOWer[:STATe]` on page 625

Span

Defines the span (band) around the marker for which the power is measured.

The span is indicated by lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWer:SPAN` on page 626

`CALCulate<n>:DELTaMarker<m>:FUNCTION:BPOWer:SPAN` on page 625

Power Mode

Defines the mode of the power measurement result.

For Analog Modulation Analysis, the power mode is not editable for AM, FM, or PM spectrum results. In this case, the marker function does not determine a power value, but rather the deviation within the specified span.

"Power" The result is an absolute power level.
 The power unit depends on the [Unit](#) setting.

"Relative Power"	<p>This setting is only available for a delta band power marker. The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker (see "Reference Marker" on page 170). The powers are subtracted logarithmically, so the result is a dB value.</p> $[\text{Relative band power (Delta2) in dB}] = [\text{absolute band power (Delta2) in dBm}] - [\text{absolute (band) power of reference marker in dBm}]$ <p>For details see "Relative band power markers" on page 342</p>
"Density"	<p>The result is a power level in relation to the bandwidth, displayed in dBm/Hz.</p>

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWER:MODE` on page 627

`CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER:MODE` on page 624

Switching All Band Power Measurements Off

Deactivates band power measurement for all markers.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:BPOWER[:STATe]` on page 627

`CALCulate<n>:DELTAmarker<m>:FUNCTION:BPOWER[:STATe]` on page 625

5.4.4.7 Demodulating marker values and providing audio output (marker demodulation)

Access: "Overview" > "Analysis" > "Marker Functions" > "Select Marker Function" > "Marker Demodulation" > "Marker Demod Config"

Or: [MKR] > "Select Marker Function" > "Marker Demodulation" > "Marker Demod Config"

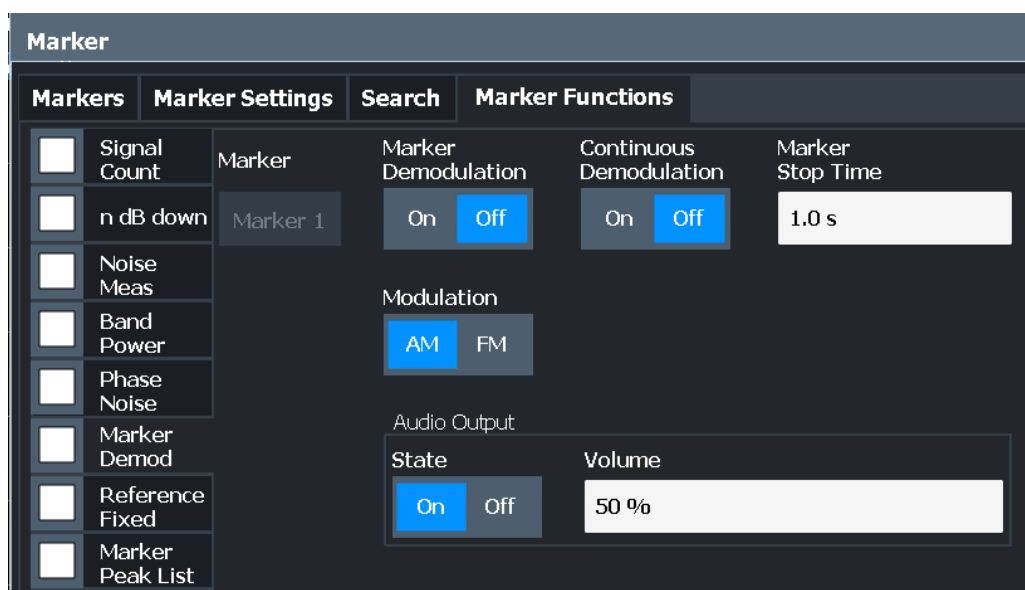
The R&S EPL1000 provides demodulators for AM, FM and PM signals. The demodulation marker function sends the demodulated data at the current marker frequency to the audio output. Thus, a displayed signal can be identified acoustically with the help of the internal loudspeaker or with headphones.



This function is not available for Spectrum Emission Mask measurements or measurements on I/Q-based data.

The sweep stops at the frequency determined by marker 1 for the selected time and the RF signal is demodulated in a bandwidth that corresponds to the RBW. Alternatively, demodulation can be activated continuously, i.e. audio output occurs regardless of the marker position and the marker stop time. For measurements in the time domain (zero span), demodulation is always continuous.

Optionally, a minimum level ("Squelch Level") can be defined so that the signal is only demodulated when it exceeds the set level. This is useful during continuous demodulation to avoid listening to noise.

**Remote commands:**

[Chapter 6.9.3.8, "Programming examples for using markers and marker functions"](#), on page 634

Marker Demodulation State	346
Continuous Demodulation	346
Marker Stop Time	347
Modulation	347
Loudspeaker	347
Audio Output Volume	347

Marker Demodulation State

Activates or deactivates the demodulation output. If activated, the signal is demodulated and sent to the audio output.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:DEModulation[:STATe]` on page 629

Continuous Demodulation

If activated, the signal is demodulated continuously and sent to the audio output, instead of stopping the sweep at the marker frequency of marker 1 and demodulating there for the configured marker stop time. This allows you to monitor the frequency range acoustically (assuming the sweep time is long enough).

For zero span measurements, demodulation is always active continuously.

For EMI measurements, during the initial peak search, demodulation is not stopped at the determined markers, even if "Continuous Demodulation" is disabled.

In sweep mode, the initial peak search is continuously demodulated. In FFT mode, no demodulation is performed.

During the final measurement, demodulation is always performed at the detected peak marker positions only (for the defined dwell time), regardless of the "Continuous Demodulation" setting.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTinuous`

on page 628

Marker Stop Time

Defines how long the sweep is stopped at the marker position to output the demodulated signal.

For zero span measurements, demodulation is always active continuously, regardless of the marker stop time.

For EMI measurements, the duration of the demodulation at each marker position is limited by the dwell time of the EMI measurement marker (see "Dwell Time" on page 174).

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation:HOLDoff` on page 628

Modulation

Defines the demodulation mode for output. The default setting is AM.

Remote command:

`CALCulate<n>:MARKer<m>:FUNction:DEModulation:SElect` on page 628

Loudspeaker

If enabled, the demodulated audio signal is output to the "AF Out" (headphones) connector on the R&S EPL1000, or to the internal loudspeaker.

Note that output to the [Phones] connector is always possible, regardless of the "Loudspeaker" state.

Remote command:

`SYSTem:SPEaker[:STATe]` on page 629

Audio Output Volume

Sets the volume of the built-in loudspeaker for demodulated signals. This setting is used for all applications.

The setting is available in the time domain in Spectrum mode and in Analog Demodulation mode.

Remote command:

`SYSTem:SPEaker:VOLume` on page 630

5.4.4.8 Marker peak list

Access: "Overview" > "Analysis" > "Marker Functions" > "Marker Peak List"

Or: [MKR] > "Select Marker Function" > "Marker Peak List"

A common measurement task is to determine peak values, i.e. maximum or minimum signal levels. The R&S EPL1000 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)

Peak search limits

The peak search can be restricted to a search area. The search area is defined by limit lines which are also indicated in the diagram. In addition, a minimum value (threshold) can be defined as a further search condition.

When is a peak a peak? - Peak excursion

During a peak search, noise values are detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak Excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

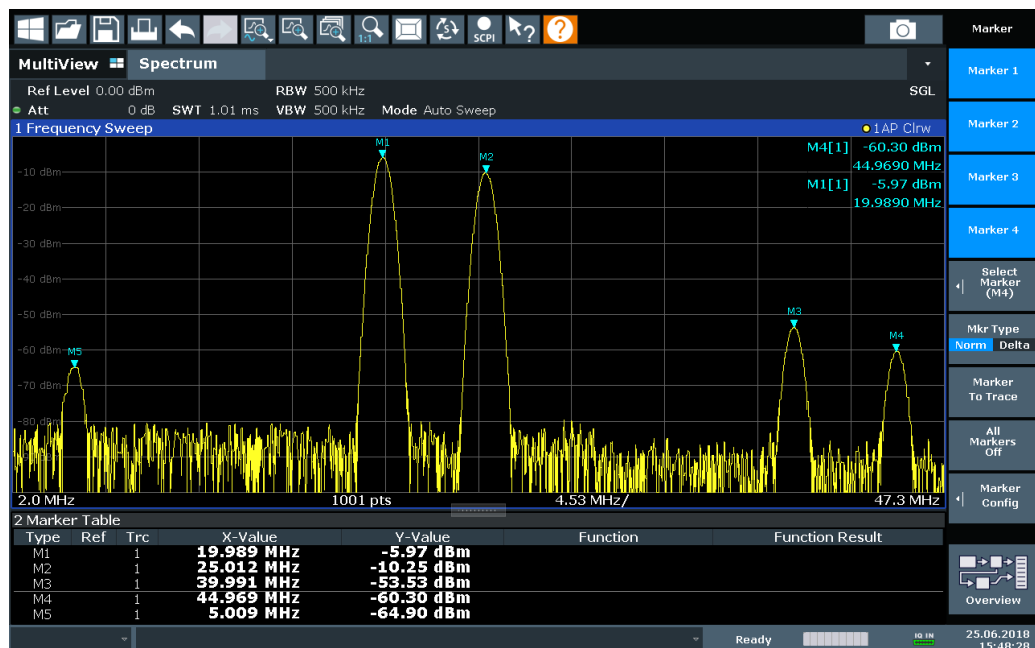


Figure 5-15: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	80 dB
2	80 dB
3	55 dB
4	39 dB
5	32 dB

To eliminate the smaller peaks M3, M4 and M5 in the example above, a peak excursion of at least 60 dB is required. In this case, the amplitude must rise at least 60 dB before falling again before a peak is detected.

Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

Marker

Markers **Marker Settings** **Marker Functions** **Search**

n dB down State **On** Off

Phase Noise Settings

Reference Fixed Sort Mode **X Value** Y Value

Marker Peak List Maximum Number of Peaks 50

Peak Excursion 6.0 dB

Display Marker Numbers **On** Off

Search Limits

Left Limit 0.0 Hz

Right Limit 20.0 MHz

Threshold -120.0 dB

Use Zoom Limits **On** Off

Search Limits Off

Export

Export Peak List Decimal Separator **Point** Comma

All Functions Off

Remote commands:

"Example: obtaining a marker peak list" on page 638

[CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:STATE](#) on page 632

TRAC? LIST,

See [TRACe<n>\[:DATA\]](#) on page 564

Peak List State	350
Sort Mode	350
Maximum Number of Peaks	350
Peak Excursion	350
Display Marker Numbers	350
Export Peak List	351

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 632

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 632

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 632

Peak Excursion

Defines the minimum level value by which a signal must rise or fall so that it is identified as a maximum or a minimum by the search functions.

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see [Chapter 5.4.4.8, "Marker peak list"](#), on page 347.

Remote command:

[CALCulate<n>:MARKer<m>:PEXCursion](#) on page 598

Display Marker Numbers

By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks, the marker numbers can decrease readability; in this case, deactivate the marker number display.

Remote command:

`CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:ANNOtation:LABel[:STATE]`
on page 630

Export 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 634

`FORMat:DEXPort:DSEParator` on page 573

5.4.4.9 Deactivating all marker functions

Access: "Overview" > "Analysis" > "Marker Functions" > "All Functions Off"

All special marker functions can be deactivated in one step.

Remote command:

5.4.5 How to work with markers

The following step-by-step instructions demonstrate in detail how to work with markers.

- [How to analyze a signal point in detail](#)..... 351
- [How to use a fixed reference marker](#)..... 352

5.4.5.1 How to analyze a signal point in detail

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing [Peak Search].
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
 - a) Press [Mkr ->].
 - b) Select "Next Peak" or "Next Min".
 - c) If necessary, change the search settings by selecting "Search Config".
3. Center the display around the determined signal point by setting the marker value to the center frequency. Select "Center = Mkr Freq".
4. Determine the precise frequency of the signal point:
 - a) Select "Select Marker Function".
 - b) Select "Signal Count".
 - c) Select "Signal Count Resolution".

- d) Select the resolution depending on how precise the result needs to be.

5.4.5.2 How to use a fixed reference marker

By default, delta markers refer to marker 1. However, they can also refer to a fixed reference marker.

How to Define and Move a Fixed Reference Marker

1. To display a fixed reference marker, do one of the following:
 - Press [MKR FUNC], then select the "Reference Fixed" marker function.
 - In the "Marker" dialog box, in the "Reference Fixed" area of the "Marker Config" tab, set the "State" to "On".

A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.

2. To move the fixed reference marker, do one of the following:
 - Change the "Level" and "Frequency" of the reference point in the "Marker Config" tab of the "Marker" dialog box, . By default, the current peak value of trace 1 is set.
 - Set the fixed reference marker to the current peak value by selecting "Peak Search" in the "Marker Config" tab of the "Marker" dialog box.
 - Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

How to Assign a Fixed Reference Marker to Delta Markers

1. In the "Marker" dialog box, select the horizontal "Markers" tab.
2. For the active delta marker that is to refer to the fixed reference marker, select "FXD" from the "Reference Marker" list.

The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

5.4.6 Measurement example: measuring harmonics using marker functions

This measurement example describes how to measure harmonics using the provided marker functions. Note that this task can be performed much simpler using the Harmonic Distortion measurement (see [Chapter 3.10, "Harmonic distortion measurement"](#), on page 143).

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

Frequency:	128 MHz
Level:	+15 dBm

Procedure:

1. Preset the R&S EPL1000.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.
4. Select "Auto Level".

The R&S EPL1000 displays the reference signal with a span of 100 kHz and resolution bandwidth of 1 kHz.

5. Switch on the marker by pressing [MKR].
The marker is positioned on the trace maximum.
6. Set the measured signal frequency and the measured level as reference values:
 - a) Press [MKR FUNC]
 - b) Press "Reference Fixed".

The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.

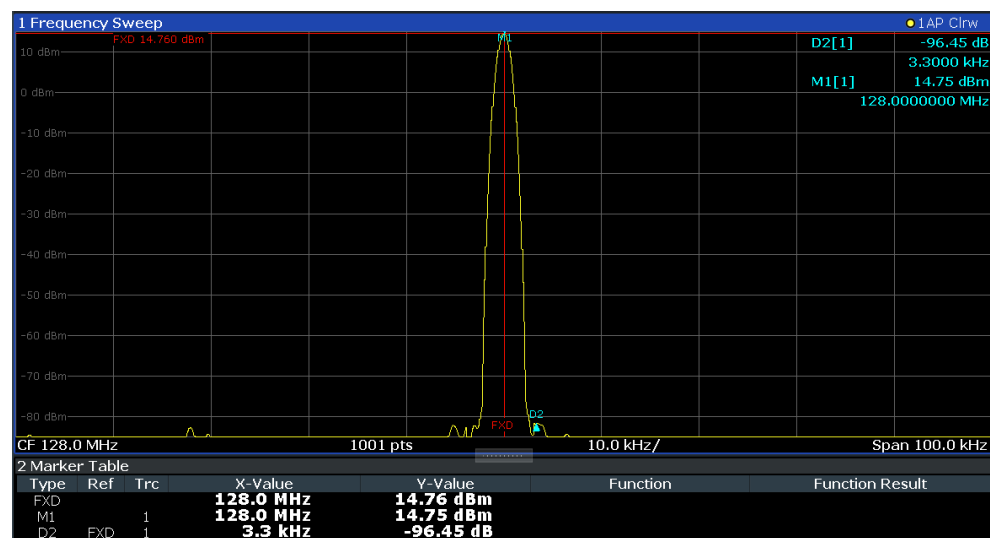


Figure 5-16: Fundamental wave and the frequency and level reference point

7. Make the step size for the center frequency correspond to the signal frequency: in the "Frequency" configuration dialog box, select "Center Frequency Stepsize" = "Marker".

The step size for the center frequency is now equal to the marker frequency.

8. Move the center frequency to the 2nd harmonic of the signal by pressing [UP] (↑).
The center frequency is set to the 2nd harmonic.
9. Select "Auto Level" to ensure the R&S EPL1000 measures the harmonics with a high sensitivity.
10. Place the delta marker on the 2nd harmonic: in the "Marker To" menu, select "Peak".
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 8](#) to [step 10](#), with the center frequency being incremented or decremented in steps of 128 MHz using the [UP] or [DOWN] keys.

5.5 Display and limit lines

Display and limit lines help you analyze a measurement trace.

Access: "Overview" > "Analysis" > "Lines"

For remote operation, see [Chapter 6.9.4, "Lines"](#), on page 643 .

- [Display lines](#)..... 354
- [Limit lines](#)..... 356

5.5.1 Display lines

5.5.1.1 Basics on display lines

Display lines help you analyze a trace – as do markers. The function of a display line is comparable to that of a ruler that can be shifted on the trace in order to mark absolute values. They are used exclusively to visually mark relevant frequencies or points in time (zero span), as well as constant level values. It is not possible to check automatically whether the points are below or above the marked level values - use limit lines for that task (see [Chapter 5.5.2.1, "Basics on limit lines"](#), on page 357).

Two different types of display lines are provided:

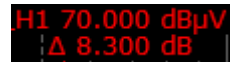
- Two horizontal lines: "Horizontal Line 1" and "Horizontal Line 2".
These lines are continuous horizontal lines across the entire width of a diagram and can be shifted up and down.
- Four vertical lines: "Vertical Line 1" to "Vertical Line 4"
These lines are continuous vertical lines across the entire height of the diagram and can be shifted left and right.

Lables

Each line is identified by one of the following abbreviations in the diagrams:

- H1: "Horizontal Line 1"
- H2: "Horizontal Line 2"
- V1: "Vertical Line 1"
- V2: "Vertical Line 2"
- V3: "Vertical Line 3"
- V4: "Vertical Line 4"
- Each label also shows the absolute position of the corresponding line, for example "H1 70.000 dB μ V".

If you turn on both horizontal lines or both vertical lines, the label of the first line also shows the distance to the second line, for example "H1 70.000 dB μ V, Δ 8.250 dB".



H1 70.000 dB μ V
 Δ 8.300 dB

Note that this feature is not supported by all measurements.

5.5.1.2 Display line settings

Access: "Overview" > "Analysis" > "Lines" > "Display Lines"

Four vertical and two horizontal lines can be defined in the display.

Line Config	
Limit Lines	Display Lines
Vertical Line 1	<input type="checkbox"/> 0.0 s
Vertical Line 2	<input type="checkbox"/> 0.0 s
Vertical Line 3	<input type="checkbox"/> 0.0 s
Vertical Line 4	<input type="checkbox"/> 0.0 s
Horizontal Line 1	<input type="checkbox"/> 0.0 dBm
Horizontal Line 2	<input type="checkbox"/> 0.0 dBm

Vertical Line <x>.....	355
Horizontal Line 1/ Horizontal Line 2.....	356

Vertical Line <x>

Activates a vertical display line in the diagram at the specified point of the x-axis, depending on the scale of the axis.

If you activate both vertical lines, the label of the first vertical line shows the distance to second vertical line.

Note that the display of the delta value is not supported by all measurements.

Remote command:

[CALCulate<n>:FLINE<dl>](#) on page 644

[CALCulate<n>:TLINE<dl>](#) on page 645

[CALCulate<n>:PLINE<dl>](#) on page 645

Horizontal Line 1/ Horizontal Line 2

Activates a horizontal display line (H1 or H2) in the diagram at the specified point of the y-axis.

If you activate both horizontal lines, the label of the first horizontal line shows the distance to second vertical line.

Note that the display of the delta value is not supported by all measurements.

Remote command:

[CALCulate<n>:DLINE<dl>](#) on page 643

[CALCulate<n>:DLINE<dl>](#) on page 643

5.5.1.3 Defining display lines

1. Display lines are configured in the "Lines Config" dialog box. To display this dialog box, press [Lines] and then "Lines Config".
2. Select the "Display Lines" tab.
3. To define a vertical line:
 - a) Select "Vertical Line 1", 2, 3, or 4.
 - b) Enter the x-value at which the line is to be displayed.
4. To define a horizontal line:
 - a) Select "Horizontal Line 1" or 2.
 - b) Enter the y-value at which the line is to be displayed.

5.5.2 Limit lines

Limit lines allow you to check automatically whether the measured points are below or above specified values.

- [Basics on limit lines](#).....357
- [Limit line settings and functions](#)..... 361
- [How to define limit lines](#)..... 368
- [Reference: limit line file format](#).....372

5.5.2.1 Basics on limit lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are allowed from a device under test (DUT). When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a time slot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The R&S EPL1000 supports limit lines with a maximum of 200 data points. Eight of the limit lines stored in the instrument can be activated simultaneously. The number of limit lines stored in the instrument is only limited by the capacity of the storage device used.

Limit line data can also be exported to a file in ASCII (CSV) format for further evaluation in other applications. Limit lines stored in the specified ASCII (CSV) format can also be imported to the R&S EPL1000 for other measurements.

Compatibility

Limit lines are compatible with the current measurement settings, if the following applies:

- The x unit of the limit line has to be identical to the current setting.
- The y unit of the limit line has to be identical to the current setting with the exception of dB based units; all dB based units are compatible with each other.

Validity

Only limit lines that fulfill the following conditions can be activated:

- Each limit line must consist of a minimum of 2 and a maximum of 200 data points.
- The frequencies/times for each data point must be defined in ascending order; however, for any single frequency or time, two data points may be entered (to define a vertical segment of a limit line).
- Gaps in frequency or time are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies or times need not necessarily be selectable in R&S EPL1000. A limit line may also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range representation, negative times may also be entered. The allowed range is -1000 s to +1000 s.

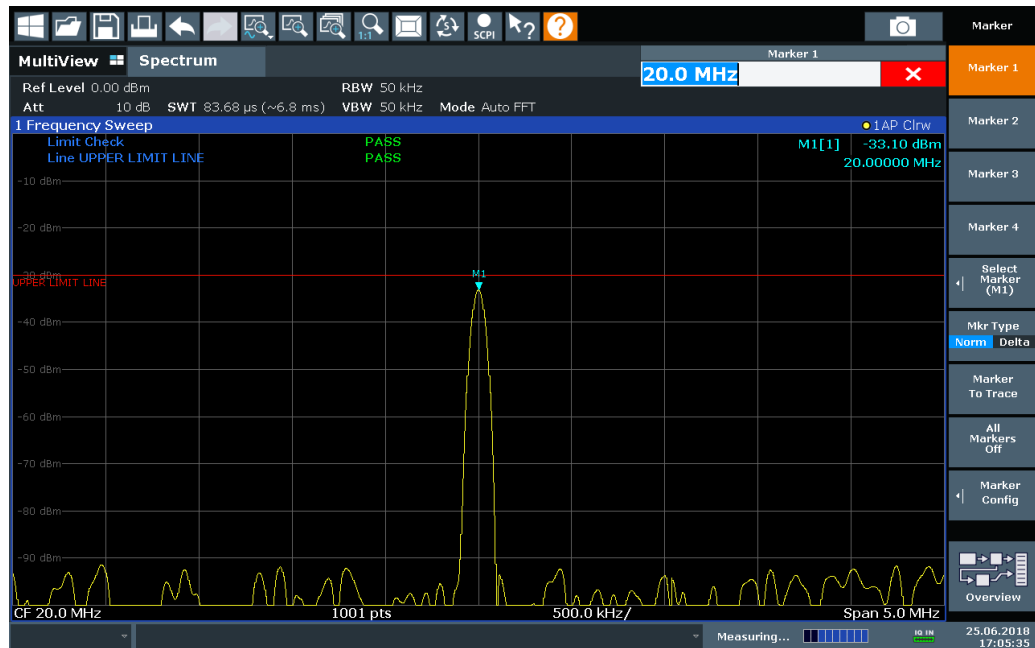


Figure 5-17: Example for an upper limit line

Limits and Margins

Limit lines define strict values that must not be exceeded by the measured signal. A **margin** is similar to a limit, but less strict and it still belongs to the valid data range. It can be used as a warning that the limit is almost reached. The margin is not indicated by a separate line in the display, but if it is violated, a warning is displayed. Margins are defined as lines with a fixed distance to the limit line.

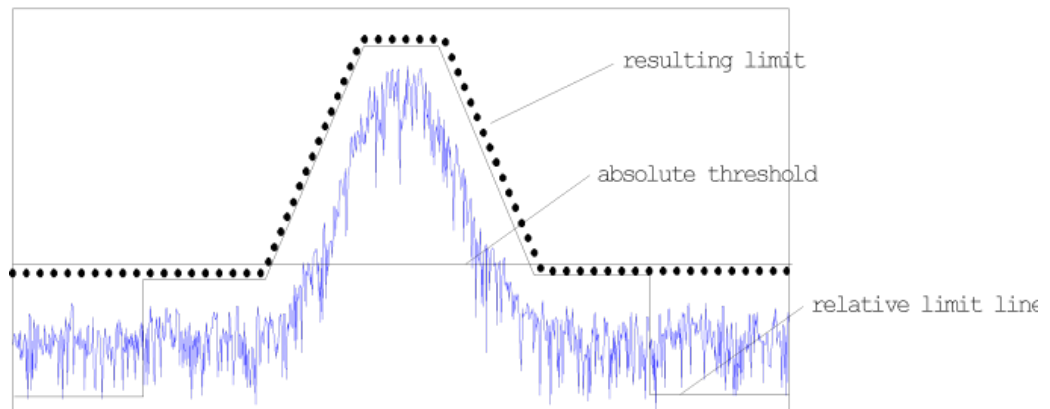
To check the signal for maximum levels you must define an **upper limit**, whereas to check the signal for minimum levels you must define a **lower limit**.

Limits can be defined relative to the reference level, the beginning of the time scale, or the center frequency, or as absolute values.

Relative scaling is suitable, for example, if masks for bursts are to be defined in zero span, or if masks for modulated signals are required in the frequency domain.

Thresholds

If the y-axis for the limit line data points uses relative scaling, an additional absolute **threshold** can be defined for the limit check. In this case, both the threshold value and the relative limit line must be exceeded before a violation occurs.



Offsets and Shifting

A configured limit line can easily be moved vertically or horizontally. Two different methods to do so are available:

- An **offset** moves the entire line in the diagram without editing the configured values or positions of the individual data points. This option is only available if relative scaling is used.
Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally or vertically.
- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

Limit Check Results

A limit check is automatically performed as soon as any of the limit lines is activated ("Visibility" setting). Only the specified "Traces to be Checked" are compared with the active limit lines. The status of the limit check for each limit line is indicated in the diagram. If a violation occurs, the limit check status is set to "MARG" for a margin violation, or to "Fail" for a limit violation.

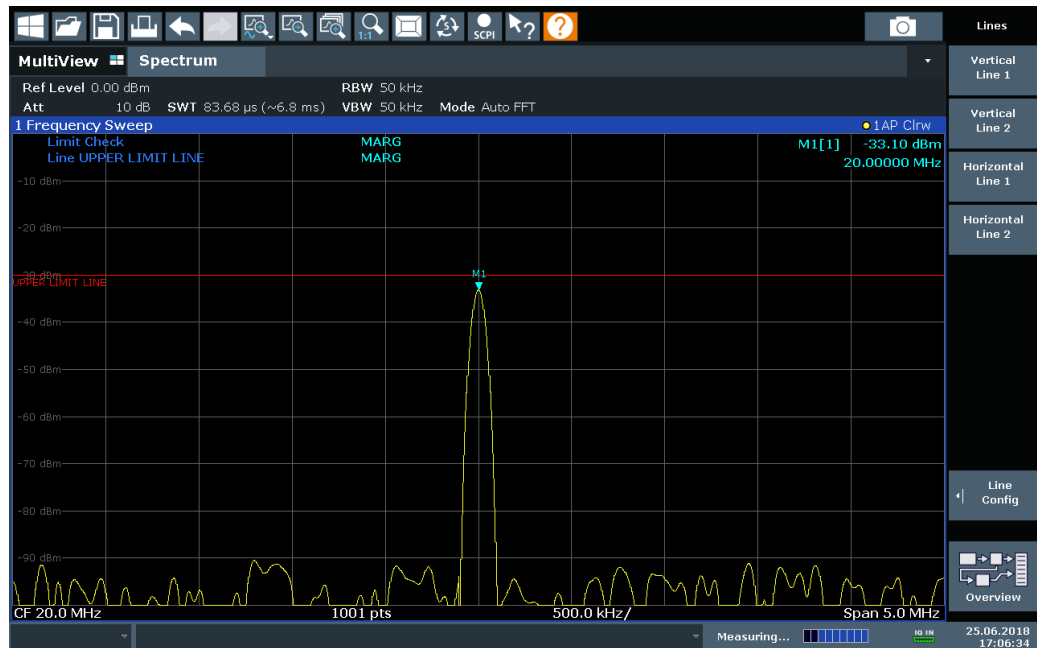


Figure 5-18: Margin violation for limit check

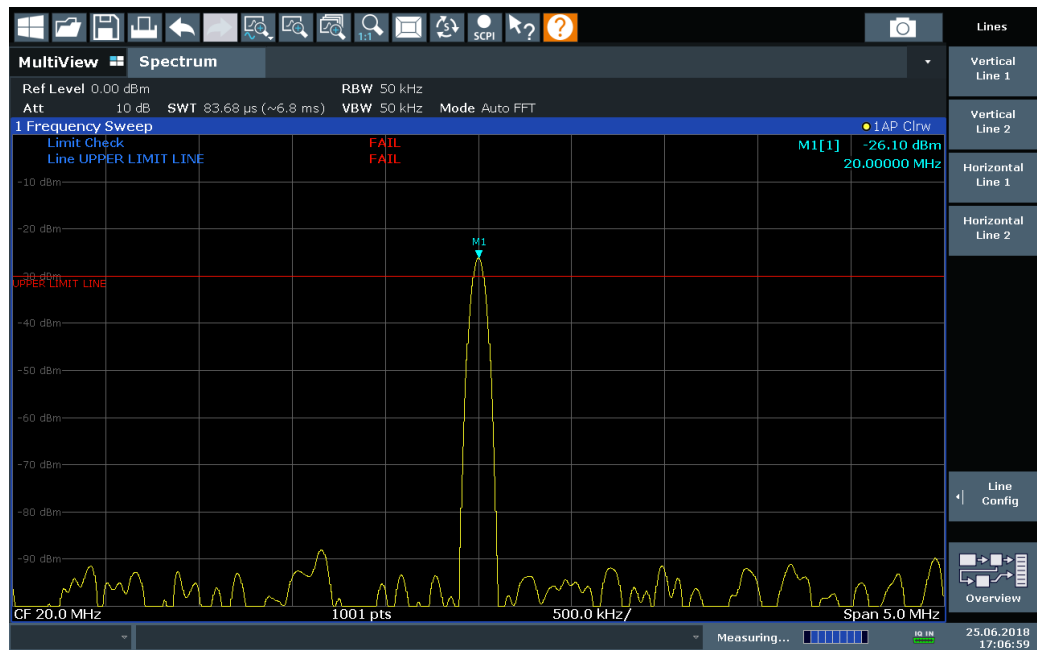


Figure 5-19: Limit violation for limit check



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 EPL1000 User Manual, chapter "Data Management".

5.5.2.2 Limit line settings and functions

Access: "Overview" > "Analysis" > "Lines"

or: [LINES] > "Line Config"

Up to 8 limit lines can be displayed simultaneously in the R&S EPL1000. Many more can be stored on the instrument.



Stored limit line settings

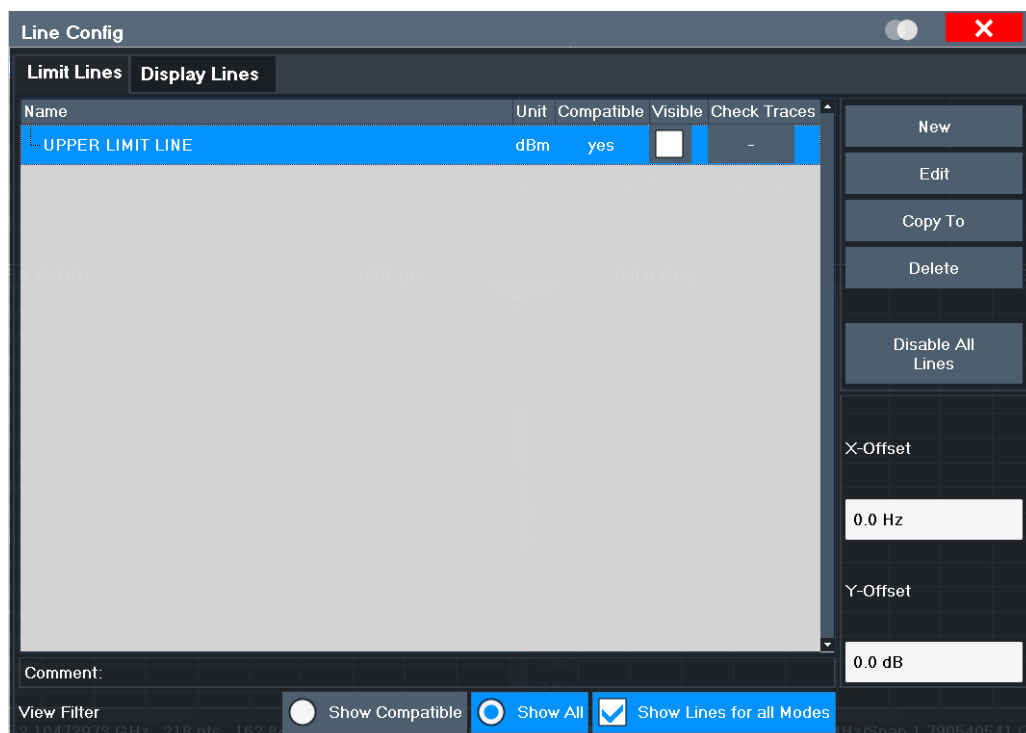
When storing and recalling limit line settings, consider the information provided in the Data Management chapter of the R&S EPL1000 User Manual.

- [Limit line management](#).....361
- [Limit line details](#).....364

Limit line management

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines"

or: [LINES] > "Line Config" > "Limit Lines"



For the limit line overview, the R&S EPL1000 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 364.

For more basic information on limit lines see [Chapter 5.5.2.1, "Basics on limit lines"](#), on page 357.

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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 357.

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:LOWer:STATe](#) on page 653

[CALCulate<n>:LIMit:UPPer:STATe](#) on page 658

[CALCulate<n>:LIMit:ACTive?](#) on page 647

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:TRACe<t>:CHECK](#) on page 655

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.

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:CONTrol:OFFSet](#) on page 649

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:LOWer:OFFSet](#) on page 652

[CALCulate<n>:LIMit:UPPer:OFFSet](#) on page 657

Limit Check

Turns limit checks for pre-measurement on and off.

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:COPY](#) on page 650

Delete Line

Delete the selected limit line configuration.

Remote command:

[CALCulate<n>:LIMit:DELeTe](#) on page 650

Disable All Lines

Disable all limit lines in one step.

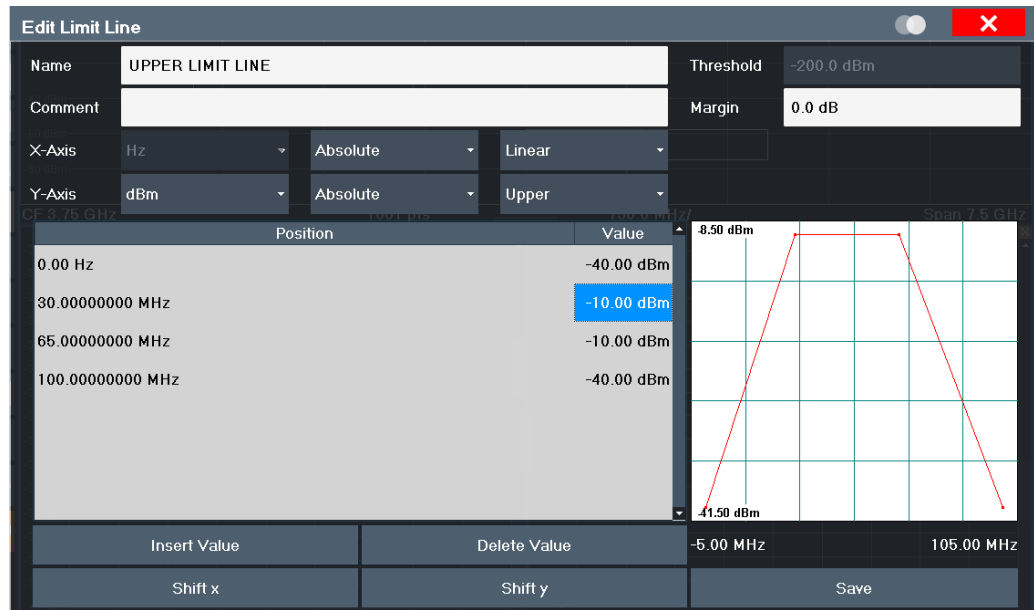
Remote command:

[CALCulate<n>:LIMit:STATe](#) on page 654

Limit line details

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines" > "New" / "Edit" / "Copy To"

or: [LINES] > "Line Config" > "Limit Lines" > "New" / "Edit" / "Copy To"



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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:NAME on page 654

Comment

Defines an optional comment for the limit line.

Remote command:

CALCulate<n>:LIMit:COMMENT on page 647

Threshold

Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see "[Thresholds](#)" on page 358.

Remote command:

[CALCulate<n>:LIMit:LOWer:THReshold](#) on page 654

[CALCulate<n>:LIMit:UPPer:THReshold](#) on page 659

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 358.

Remote command:

[CALCulate<n>:LIMit:LOWer:MARGIn](#) on page 651

[CALCulate<n>:LIMit:UPPer:MARGIn](#) on page 657

X-Axis

Describes the horizontal axis on which the data points of the limit line are defined.

Includes the following settings:

- Unit:
 - "Hz": for frequency domain
 - "s": for time domain
- Scaling mode: absolute or relative values
For relative values, the frequencies are referred to the currently set center frequency. In the time domain, the left boundary of the diagram is used as the reference.
- Scaling: linear or logarithmic

Remote command:

[CALCulate<n>:LIMit:CONTRol:MODE](#) on page 648

[CALCulate<n>:LIMit:CONTRol:DOMain](#) on page 648

[CALCulate<n>:LIMit:CONTRol:SPACing](#) on page 650

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:UNIT](#) on page 656

[CALCulate<n>:LIMit:LOWer:MODE](#) on page 652

[CALCulate<n>:LIMit:UPPer:MODE](#) on page 657

[CALCulate<n>:LIMit:LOWer:SPACing](#) on page 653

[CALCulate<n>:LIMit:UPPer:SPACing](#) on page 658

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:CONTrol[:DATA]` on page 648

`CALCulate<n>:LIMit:LOWer[:DATA]` on page 651

`CALCulate<n>:LIMit:UPPer[:DATA]` on page 656

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 363).

Remote command:

`CALCulate<n>:LIMit:CONTrol:SHIFt` on page 649

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 363).

Remote command:

`CALCulate<n>:LIMit:LOWer:SHIFt` on page 652

`CALCulate<n>:LIMit:UPPer:SHIFt` on page 658

Save

Saves the currently edited limit line under the name defined in the "Name" field.

Import

Opens a file selection dialog box and loads the limit line from the selected file in .CSV format.

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

Note that a valid import file must contain a minimum of required information for the R&S EPL1000.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 372.

Remote command:

`MMEMory:LOAD<n>:LIMit` on page 659

File Explorer ← Import

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

Export

Opens a file selection dialog box and stores the currently displayed limit line to the defined file in .CSV format.

"File Explorer": Instead of using the file manager of the R&S EPL1000 firmware, you can also use the Microsoft Windows File Explorer to manage files.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 372.

The limit line can be imported again later by the R&S EPL1000 for use in other measurements.

Remote command:

[MMEMoRY:STORe<n>:LIMit](#) on page 659

File Explorer ← Export

Opens the Microsoft Windows File Explorer.

Remote command:

not supported

5.5.2.3 How to define limit lines

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines"

or: [LINES] > "Line Config" > "Limit Lines"

**Limit lines for spurious and SEM measurements**

Note that for spurious and SEM measurements, special limit lines can be defined for each frequency range, see [Chapter 3.6.4.2, "Limit lines in SEM measurements"](#), on page 77 and [Chapter 3.7.3.2, "Limit lines in spurious measurements"](#), on page 114. It is strongly recommended that you define limits only via the "Sweep List" dialog for these measurements, not using [Lines].

Any changes to the special limit lines are automatically overwritten when the sweep list settings are changed.

The following tasks are described here:

- ["How to find compatible limit lines"](#) on page 368
- ["How to activate and deactivate a limit check"](#) on page 369
- ["How to edit existing limit lines"](#) on page 369
- ["How to copy an existing limit line"](#) on page 369
- ["How to delete an existing limit line"](#) on page 369
- ["How to configure a new limit line"](#) on page 370
- ["How to move the limit line vertically or horizontally"](#) on page 371

How to find compatible limit lines

- ▶ In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".

All stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder of the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a limit check

A limit check is automatically performed as soon as any of the limit lines is activated.

1. To activate a limit check:
Select the "Check Traces" setting for a limit line in the overview and select the trace numbers to be included in the limit check. One limit line can be assigned to several traces.

The specified traces to be checked are compared with the active limit lines. The status of the limit check is indicated in the diagram.
2. To deactivate a limit line, deactivate all "Traces to be Checked" for it.
To deactivate all limit lines at once, select "Disable All Lines".

The limit checks for the deactivated limit lines are stopped and the results are removed from the display.

How to edit existing limit lines

Existing limit line configurations can be edited.

1. In the "Line Config" dialog box, select the limit line.
2. Select "Edit".
3. Edit the line configuration as described in ["How to configure a new limit line"](#) on page 370.
4. Save the new configuration by selecting "Save".

If the limit line is active, the edited limit line is displayed in the diagram.

How to copy an existing limit line

1. In the dialog box, select the limit line.
2. Select "Line Config" "Copy To".
3. Define a new name to create a new limit with the same configuration as the source line.
4. Edit the line configuration as described in ["How to configure a new limit line"](#) on page 370.
5. Save the new configuration by selecting "Save".

The new limit line is displayed in the overview and can be activated.

How to delete an existing limit line

1. In the "Line Config" dialog box, select the limit line.

2. Select "Delete".
3. Confirm the message.

The limit line and the results of the limit check are deleted.

How to configure a new limit line

1. In the "Line Config" dialog box, select "New".

The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.
3. Define the x-axis configuration:
 - Time domain or frequency domain
 - Absolute or relative limits
 - Linear or logarithmic scaling
4. Define the y-axis configuration:
 - Level unit
 - Absolute or relative limits
 - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:
 - a) Select "Insert Value".
 - b) Define the x-value ("Position") and y-value ("Value") of the first data point.
 - c) Select "Insert Value" again and define the second data point.
 - d) Repeat this to insert all other data points.

To insert a data point before an existing one, select the data point and then "Insert Value".

To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".

To delete a data point, select the entry and then "Delete Value".
6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.

If necessary, shift the entire line vertically or horizontally by selecting "Shift x" or "Shift y" and defining the shift width.
7. Optionally, define a "Margin" at a fixed distance to the limit line.

The margin must be within the valid value range and is not displayed in the diagram or preview area.
8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.
9. Save the new configuration by selecting "Save".

The new limit line is displayed in the overview and can be activated.

How to move the limit line vertically or horizontally

A configured limit line can easily be moved vertically or horizontally. Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally.

1. In the "Line Config" dialog box, select the limit line.
2. To shift the complete limit line parallel in the horizontal direction, select "X-Offset" and enter an offset value.
To shift the complete limit line parallel in the vertical direction, select "Y-Offset" and enter an offset value.
3. To shift the individual data points of a limit line by a fixed value (all at once):
 - a) Select "Edit".
 - b) In the "Edit Limit Line" dialog box, select "Shift x" or "Shift y" and define the shift width.
 - c) Save the shifted data points by selecting "Save".

If activated, the limit line is shifted in the diagram.

How to export a limit line

Limit line configurations can be stored to an ASCII file for evaluation in other programs or to be imported later for other measurements.

1. In the "Line Config" dialog box, select the limit line.
2. Select "New" or "Edit".
3. Define the limit line as described in ["How to configure a new limit line"](#) on page 370.
4. Select "Export" to save the configuration to a file.
You are asked whether you would like to save the configuration internally on the R&S EPL1000 first.
5. Select a file name and location for the limit line.
6. Select the decimal separator to be used in the file.
7. Select "Save".

The limit line is stored to a file with the specified name and the extension `.CSV`.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 372.

How to import a limit line

Limit line configurations that are stored in an ASCII file and contain a minimum of required data can be imported to the R&S EPL1000.

For details on the required file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 372.

1. In the "Line Config" dialog box, select the limit line.

2. Select "New" or "Edit".
3. Select "Import" to load a limit line from a file.
You are asked whether you would like to save the current configuration on the R&S EPL1000 first.
4. Select the file name of the limit line.
5. Select the decimal separator that was used in the file.
6. Select "Select".
The limit line is loaded from the specified file and displayed in the "Edit Limit Line" dialog box.
7. Activate the limit line as described in ["How to activate and deactivate a limit check"](#) on page 369.

5.5.2.4 Reference: limit line file format

Limit line data can be exported to a file in ASCII (CSV) format for further evaluation in other applications. Limit lines stored in the specified ASCII (CSV) format can also be imported to the R&S EPL1000 for other measurements (see ["How to import a limit line"](#) on page 371). This reference describes in detail the format of the export/import files for limit lines. Note that the **bold** data is **mandatory**, all other data is optional.

Different language versions of evaluation programs may require a different handling of the decimal point. Thus, you can define the decimal separator to be used (see ["Decimal Separator"](#) on page 297).

Table 5-13: ASCII file format for limit line files

File contents	Description
Header data	
sep=;	Separator for individual values (required by Microsoft Excel, for example)
Type ;RS_LimitLineDefinition;	Type of data
FileFormatVersion ;1.00;	File format version
Date;01.Oct 2006;	Date of data set storage
OptionID;SpectrumAnalyzer	Application the limit line was created for
Name ;RELFREQ1	Limit line name
Comment;Defines the upper limit line	Description of limit line
Mode;UPPER	Type of limit line (upper, lower)
ThresholdUnit;LEVEL_DBM	Unit of threshold value
ThresholdValue;-200	Threshold value
MarginValue;0	Margin value
XAxisScaling;LINEAR	Scaling of x-axis linear (LIN) or logarithmic (LOG)

File contents	Description
XAxisUnit;FREQ_HZ	Unit of x values
XAxisScaleMode;ABSOLUTE	Scaling of x-axis (absolute or relative)
YAxisUnit;LEVEL_DB	Unit of y values
YAxisScaleMode;ABSOLUTE	Scaling of y-axis (absolute or relative)
NoOfPoints;5	Number of points the line is defined by
Data section for individual data points	
-4500000000;-50	x- and y-values of each data point defining the line
-2000000000;-30	
-1000000000;0	
0;-30	
2500000000;-50	

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6.1 Introduction

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

The syntax of a SCPI command consists of a header and, usually, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, they are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the user manual of the R&S EPL1000.



Remote command examples

Note that some remote command examples mentioned in this general introduction are possibly not supported by this particular application.

6.1.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**
If not specified otherwise, commands can be used both for setting and for querying parameters.

If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.

- **Parameter usage**

If not specified otherwise, a parameter can be used to set a value and it is the result of a query.

Parameters required only for setting are indicated as **Setting parameters**.

Parameters required only to refine a query are indicated as **Query parameters**.

Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**

Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S EPL1000 follow the SCPI syntax rules.

- **Asynchronous commands**

A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.

- **Reset values (*RST)**

Default parameter values that are used directly after resetting the instrument (*RST command) are indicated as ***RST** values, if available.

- **Default unit**

The default unit is used for numeric values if no other unit is provided with the parameter.

- **Manual operation**

If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

6.1.2 Long and short form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in uppercase letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

SENSE:FREQUENCY:CENTer is the same as SENS:FREQ:CENT.

6.1.3 Numeric suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you do not quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

6.1.4 Optional keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.



If an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

6.1.5 Alternative keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

6.1.6 SCPI parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, they are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABLE`

Parameters can have different forms of values.

- [Numeric values](#)..... 377
- [Boolean](#)..... 378
- [Character data](#)..... 378
- [Character strings](#)..... 378
- [Block data](#)..... 378

6.1.6.1 Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. For physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

With unit: `SENSe:FREQuency:CENTer 1GHZ`

Without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. for discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- **MIN/MAX**
Defines the minimum or maximum numeric value that is supported.
- **DEF**
Defines the default value.
- **UP/DOWN**
Increases or decreases the numeric value by one step. The step size depends on the setting. Sometimes, you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. For physical quantities, it applies the basic unit (e.g. Hz for frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

Sometimes, numeric values are returned as text.

- **INF/NINF**
Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- **NAN**

Not a number. Represents the numeric value 9.91E37. NAN is returned if errors occur.

6.1.6.2 Boolean

Boolean parameters represent two states. The "on" state (logically true) is represented by "ON" or the numeric value 1. The "off" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying Boolean parameters

When you query Boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return 1

6.1.6.3 Character data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information, see [Chapter 6.1.2, "Long and short form"](#), on page 375.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMAL`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return NORM

6.1.6.4 Character strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELeTe 'Spectrum'`

6.1.6.5 Block data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. The data bytes follow. During the transmission of these data bytes, all end or other control signs are ignored until

all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

6.2 Common suffixes

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

Table 6-1: Common suffixes used in remote commands in the Spectrum application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 16	Window (in the currently selected channel setup)
<t>	1 to 6	Trace
	1 to 8	Limit line
<k>	1..8 (Limit line) 1 2 (Display line)	Selects a limit or display line.
<pk>	1..3000	Selects a peak.
<ou>	irrelevant	



Selecting windows in multiple channel setups

Note that the suffix <n> always refers to a window in the currently selected channel setup.

6.3 Application Selection

INSTRument:CREate:DUPLicate	379
INSTRument:CREate[:NEW]	380
INSTRument:CREate:REPLace	380
INSTRument:DELeTe	381
INSTRument:LIST?	381
INSTRument:REName	381
INSTRument[:SELeCt]	382

INSTRument:CREate:DUPLicate

Duplicates the currently selected channel setup, i.e creates a new channel setup of the same type and with the identical measurement settings. The name of the new channel setup is the same as the copied channel setup, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer 2").

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

Example: `INST:SEL 'Receiver'`
`INST:CRE:DUPL`
 Duplicates the channel setup named 'Receiver' and creates a new channel setup named 'Receiver 2'.

Usage: Event

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

Adds a measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
 For a list of available channel types, see [INSTrument:LIST?](#) on page 381.

<ChannelName> String containing the name of the channel.
 Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

Example: `INST:CRE SAN, 'Spectrum 2'`
 Adds a spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>, <ChannelType>, <ChannelName2>

Replaces a channel setup with another one.

Setting parameters:

<ChannelName1> String containing the name of the channel setup you want to replace.

<ChannelType> Channel type of the new channel setup.
 For a list of available channel setup types, see [INSTrument:LIST?](#) on page 381.

<ChannelName2> String containing the name of the new channel setup.
Note: If the specified name for a new channel setup already exists, the default name, extended by a sequential number, is used for the new channel setup (see [INSTrument:LIST?](#) on page 381).
 Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:CRE:REPL 'Receiver', REC, 'REC2'`
 Replaces the channel setup named "Receiver" by a new channel setup of type "Receiver" named "REC2".

Usage: Setting only

INSTrument:DELeTe <ChannelName>

Deletes a channel setup.

If you delete the last channel setup, the default "Receiver" channel setup is activated.

Setting parameters:

<ChannelName> String containing the name of the channel setup you want to delete.
A channel setup must exist to delete it.

Example: `INST:DEL 'Receiver'`
Deletes the channel setup with the name 'Receiver'.

Usage: Setting only

INSTrument:LIST?

Queries all active channel setups. The query is useful to obtain the names of the existing channel setups, which are required to replace or delete the channel setups.

Return values:

<ChannelType>, <ChannelName> For each channel setup, the command returns the channel setup type and channel setup name (see tables below).
Tip: to change the channel setup name, use the [INSTrument:REName](#) command.

Example: `INST:LIST?`
Result for 2 channel setups:
'REC', 'Receiver', 'REC', 'Receiver 2'

Usage: Query only

Table 6-2: Available channel setup types and default channel setup names

Application	<ChannelType> Parameter	Default Channel setup Name*)
Receiver	RECeiver	Receiver
Spectrum	SANalyzer	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Analog Modulation Analysis	ADEMod	Analog Demod
Click Rate Analyzer	CRANalyzer	Click Rate Analyzer

Note: the default channel setup name is also listed in the table. If the specified name for a new channel setup already exists, the default name, extended by a sequential number, is used for the new channel setup.

INSTrument:REName <ChannelName1>, <ChannelName2>

Renames a channel setup.

Setting parameters:

<ChannelName1> String containing the name of the channel setup you want to rename.

<ChannelName2> String containing the new channel setup name.
 Note that you cannot assign an existing channel setup name to a new channel setup. If you do, an error occurs.
 Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:REN 'Receiver', 'REC'`
 Renames the channel setup with the name 'Receiver' to 'REC'.

Usage: Setting only

INSTrument[:SElect] <ChannelType> | <ChannelName>

Activates a new channel setup with the defined channel setup type, or selects an existing channel setup with the specified name.

Also see

- [INSTrument:CREate\[:NEW\]](#) on page 380

Parameters:

<ChannelType> Channel type of the new channel setup.
 For a list of available channel setup types see [INSTrument:LIST?](#) on page 381.

<ChannelName> String containing the name of the channel setup.

Example: `INST IQ`
 Activates a channel setup for the I/Q Analyzer application (evaluation mode).
`INST 'MyIQSpectrum'`
 Selects the channel setup named 'MyIQSpectrum' (for example before executing further commands for that channel setup).

6.4 General Window Commands

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

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see [INSTrument\[:SElect\]](#) on page 382).

DISPlay:FORMat	383
DISPlay[:WINDow<n>][:SUBWindow<w>]:SElect	383
DISPlay[:WINDow<n>]:SIZE	383
DISPlay:WSElect?	384

DISPlay:FORMat <Format>

Determines which tab is displayed.

Parameters:

<Format>

SPLit

Displays the MultiView tab with an overview of all active channels
(See [Chapter 2.3, "R&S multiview"](#), on page 9).

SINGLE

Displays the measurement channel that was previously focused.

*RST: SING

Example:

```
DISP:FORM SPL
```

DISPlay[:WINDow<n>][:SUBWindow<w>]:SElect

Sets the focus on the selected result display window.

This window is then the active window.

For measurements with multiple results in subwindows, the command also selects the subwindow. Use this command to select the (sub)window before querying trace data.

Suffix:

<n>

[Window](#)

<w>

subwindow

Not supported by all applications

Example:

```
//Put the focus on window 1
DISP:WIND1:SEL
```

Example:

```
//Put the focus on subwindow 2 in window 1
DISP:WIND1:SUBW2:SEL
```

DISPlay[:WINDow<n>]:SIZE <Size>

Maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see [LAYout:SPLitter](#) on page 387).

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: SMAL

Example: DISP:WIND2:SIZE LARG

DISPlay:WSElect?

Queries the currently active window (the one that is focused) *in the currently selected measurement channel*.

Return values:

<SelectedWindow> Index number of the currently active window.

Range: 1 to 16

Usage: Query only

6.5 Screen Layout

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

Note that the suffix <n> always refers to the window *in the currently selected measurement channel* (see [INSTrument\[:SElect\]](#) on page 382).

LAYout:ADD[:WINDow]?	384
LAYout:CATalog[:WINDow]?	385
LAYout:IDENtify[:WINDow]?	386
LAYout:MOVE[:WINDow]	386
LAYout:REMove[:WINDow]	387
LAYout:REPLace[:WINDow]	387
LAYout:SPLitter	387
LAYout:WINDow<n>:ADD?	389
LAYout:WINDow<n>:IDENtify?	389
LAYout:WINDow<n>:REMove	390
LAYout:WINDow<n>:REPLace	390

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active channel setup.

Is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the [LAYout:REPLace\[:WINDow\]](#) command.

Query parameters:

- <WindowName> String containing the name of the existing window the new window is inserted next to.
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 256

Table 6-3: <WindowType> parameter values for the spectrum application

Parameter value	Window type
DIAGram	Diagram
FACCes	"Fast Access" panel
MTABle	Marker table
NOTes	Notes display
PEAKlist	Marker peak list
PRESelection	"Preselector" configuration
RSUMmary	"Result summary"
SGRam	"Spectrogram"

LAYout:CATalog[:WINDow]?

Queries the name and index of all active windows in the active channel setup from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

```
<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>
```

Return values:

<WindowName> string
Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example:

```
LAY:CAT?
```

Result:

```
'2',2,'1',1
```

Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENTify[:WINDow]? <WindowName>

Queries the **index** of a particular display window in the active channel setup.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENTify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example:

```
LAY:IDEN:WIND? '2'
```

Queries the index of the result display named '2'.

Response:

```
2
```

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>**Setting parameters:**

<WindowName> String containing the name of an existing window that is to be moved.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel setup, use the `LAYout:CATalog[:WINDow]?` query.

<WindowName> String containing the name of an existing window the selected window is placed next to or replaces.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel setup, use the `LAYout:CATalog[:WINDow]?` query.

<Direction>	LEFT RIGHT ABOVE BELOW REPLACE Destination the selected window is moved to, relative to the reference window.
Example:	LAY:MOVE '4', '1', LEFT Moves the window named '4' to the left of window 1.
Example:	LAY:MOVE '1', '3', REPL Replaces the window named '3' by window 1. Window 3 is deleted.
Usage:	Setting only

LAYout:REMove[:WINDow] <WindowName>

Removes a window from the display in the active channel.

Setting parameters:

<WindowName> String containing the name of the window. In the default state, the name of the window is its index.

Example: LAY:REM '2'
Removes the result display in the window named '2'.

Usage: Setting only

LAYout:REPLace[:WINDow] <WindowName>, <WindowType>

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel setup while keeping its position, index and window name.

To add a new window, use the [LAYout:ADD\[:WINDow\]?](#) command.

Setting parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel setup, 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 384 for a list of available window types.

Example: LAY:REPL:WIND '1', MTAB
Replaces the result display in window 1 with a marker table.

Usage: Setting only

LAYout:SPLitter <Index1>, <Index2>, <Position>

Changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command does not work, but does not return an error.

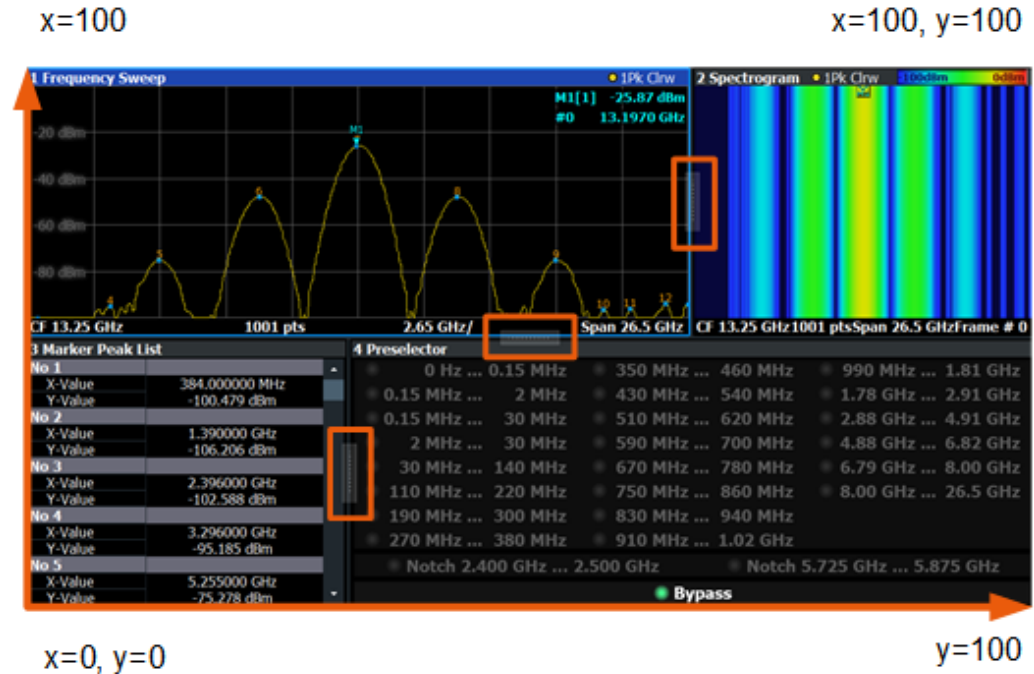


Figure 6-1: SmartGrid coordinates for remote control of the splitters

Setting parameters:

- <Index1> The index of one window the splitter controls.
- <Index2> The index of a window on the other side of the splitter.
- <Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin ($x = 0$, $y = 0$) is in the lower left corner of the screen. The end point ($x = 100$, $y = 100$) is in the upper right corner of the screen. (See [Figure 6-1](#).)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.
- Range: 0 to 100

Example:

```
LAY:SPL 1,3,50
```

Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
 Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen. The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
`LAY:SPL 3,2,70`
`LAY:SPL 4,1,70`
`LAY:SPL 2,1,70`

Usage: Setting only

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

Adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added. Unlike [LAYout:ADD\[:WINDow\]?](#), for which the existing window is defined by a parameter.

To replace an existing window, use the [LAYout:WINDow<n>:REPLace](#) command.

Is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:

<n> [Window](#)

Query parameters:

<Direction> LEFT | RIGHT | ABOVE | BELOW

<WindowType> Type of measurement window you want to add.
 See [LAYout:ADD\[:WINDow\]?](#) on page 384 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
 '2'
 Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENTify?

Queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel setup.

Note: to query the **index** of a particular window, use the [LAYout:IDENTify\[:WINDow\]?](#) command.

Suffix:	
<n>	Window
Return values:	
<WindowName>	String containing the name of a window. In the default state, the name of the window is its index.
Example:	LAY:WIND2:IDEN? Queries the name of the result display in window 2. Response: '2'
Usage:	Query only

LAYout:WINDow<n>:REMove

Removes the window specified by the suffix <n> from the display in the active channel setup.

The result of this command is identical to the [LAYout:REMove\[:WINDow\]](#) command.

Suffix:	
<n>	Window
Example:	LAY:WIND2:REM Removes the result display in window 2.
Usage:	Event

LAYout:WINDow<n>:REPLace <WindowType>

Changes the window type of an existing window (specified by the suffix <n>) in the active channel setup.

The effect of this command is identical to the [LAYout:REPLace\[:WINDow\]](#) command.

To add a new window, use the [LAYout:WINDow<n>:ADD?](#) command.

Suffix:	
<n>	Window
Setting parameters:	
<WindowType>	Type of measurement window you want to replace another one with. See LAYout:ADD[:WINDow]? on page 384 for a list of available window types.
Example:	LAY:WIND2:REPL MTAB Replaces the result display in window 2 with a marker table.
Usage:	Setting only

6.6 Preset

*RST.....	391
SYSTem:PRESet.....	391
SYSTem:PRESet:CHANnel[:EXEC].....	391

*RST

Reset

Sets the instrument to a defined default status. The default settings are indicated in the description of commands.

The command is equivalent to `SYSTem:PRESet`.

Usage: Setting only

SYSTem:PRESet

This command presets the R&S EPL1000. It is identical to `*RST`.

Example: `SYST:PRES`

Usage: Event

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default instrument settings in the current channel setup.

Use `INST:SEL` to select the channel setup.

Example: `INST:SEL 'Spectrum2'`
 Selects the channel setup for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
 Restores the factory default settings to the "Spectrum2" channel setup.

Usage: Event

Manual operation: See "[Preset Channel setup](#)" on page 185

6.7 Measurement configuration

6.7.1 Measurement control

Commands to control measurements described elsewhere.

- `INITiate<n>:ESpectrum` on page 426
- `INITiate<n>:SPURious` on page 453

INITiate<n>[:IMMediate].....	392
INITiate<n>:CONMeas.....	392
INITiate<n>:CONTinuous.....	393
[SENSe:]SWEep:COUNT:CURRent?.....	394

INITiate<n>[:IMMediate]

The command initiates a new sweep.

For a single sweep, the R&S EPL1000 stops measuring when it has reached the end frequency. When you start a continuous measurement, it stops only if you abort it deliberately.

If you are using trace modes MAXHold, MINHold and AVERage, previous results are reset when you restart the measurement.

- **Single measurements**

Synchronization to the end of the measurement is possible with *OPC, *OPC? or *WAI.

- **Continuous measurements**

Synchronization to the end of the measurement is not possible.

It is thus recommended to use a single measurement for remote controlled measurements, because results like trace data or markers are only valid after synchronization.

Suffix:

<mt> INITiate1 initiates a bargraph measurement.
 INITiate2 initiates a scan.

Example: //Start a single scan (with a scan count = 20), and wait until the measurement is done

```
INIT2:CONT OFF
SWE:COUN 20
INIT2;*WAI
```

Usage: Event

Manual operation: See "[Frequency Sweep](#)" on page 12

INITiate<n>:CONMeas

Restarts a (single) measurement that has been stopped (using `ABORT`) or finished in single sweep mode.

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

Suffix:

<n> irrelevant

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
DISP:WIND:TRAC:MODE AVER
Switches on trace averaging.
SWE:COUN 20
Setting the sweep counter to 20 sweeps.
INIT;*WAI
Starts the measurement and waits for the end of the 20 sweeps.
INIT:CONM;*WAI
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.
```

Usage: Asynchronous command

Manual operation: See "[Continue Single Sweep](#)" on page 238

INITiate<n>:CONTInuous <State>

Controls the sweep mode for an individual channel setup.

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

For details on synchronization see [Remote control via SCPI](#).

If the sweep mode is changed for a channel setup while the Sequencer is active, the mode is only considered the next time the measurement in that channel setup is activated by the Sequencer.

Suffix:

<n> irrelevant

Parameters:

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

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 12

[SENSe:]SWEep:COUNT:CURRent?

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

Return values:

<CurrentCount>

Example:

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

Usage: Query only

6.7.2 Power measurements

The following commands work for several power measurements.

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE	394
CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?	395
CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:SElect	396
CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>[:STATe]	397
[SENSe:]POWER:ACHannel:PRESet	397
[SENSe:]POWER:ACHannel:PRESet:RLEVel	397
[SENSe:]POWER:TRACe	398

CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:MODE <Mode>

Selects the trace display mode for power measurements.

Suffix:

<n> [Window](#)
 <m> [Marker](#)
 <sb> irrelevant

Parameters:

<Mode> WRITe | MAXHold

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 50

CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:RESult? <Measurement>

Queries the results of power measurements.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n>	irrelevant
<m>	irrelevant
<sb>	Multi-SEM: 1 to 2 for all other measurements: irrelevant

Parameters:

<Measurement>

ACPower | MCACpower

ACLR measurements (also known as adjacent channel power or multicarrier adjacent channel measurements).

Returns the power for every active transmission and adjacent channel. The order is:

- power of the transmission channels
- power of adjacent channel (lower,upper)
- power of alternate channels (lower,upper)

The unit of the return values depends on the scaling of the y-axis:

- logarithmic scaling returns the power in the current unit
- linear scaling returns the power in W

CN

Carrier-to-noise measurements.

Returns the C/N ratio in dB.

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.

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.

Note that this result is only available if the power reference type is set to peak power (see [SENSe:]ESpectrum<sb>:RTYPE on page 442).

OBANdwidth | OBWidth

Occupied bandwidth.

Returns the occupied bandwidth in Hz.

COBAndwidth | COBWidth

<Centroid frequency>,<Frequency offset>

See [Chapter 3.5.2, "OBW results"](#), on page 66

Manual operation: See "C/N" on page 62

CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:SElect <MeasType>

Selects a power measurement and turns the measurement on.

Suffix:

<n>	Window
<m>	Marker
<sb>	irrelevant

Parameters:

<MeasType>

ACPower | MCACpower

Adjacent channel leakage ratio (ACLR), also known as adjacent channel power or multicarrier adjacent channel.

The R&S EPL1000 performs the measurement on the trace selected with [SENSe:]POWer:TRACe.

CPOWer

Channel power measurement with a single carrier.

The R&S EPL1000 performs the measurement on the trace selected with [SENSe:]POWer:TRACe.

OBANdwidth | OBWidth

Occupied bandwidth measurement.

The R&S EPL1000 performs the measurement on the trace that marker 1 is positioned on.

CN

Carrier-to-noise ratio measurement.

CNO

Carrier-to-noise ratio measurement referenced to 1 Hz bandwidth

Manual operation: See "C/N" on page 62

CALCulate<n>:MARKer<m>:FUNction:POWer<sb>[:STATe] <State>

Turns a power measurement off. To switch on the power measurement again, use [CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:SElect](#) on page 396.

A standard frequency sweep is activated.

Suffix:

<n> irrelevant

<m> irrelevant

<sb> irrelevant

Parameters:

<State> OFF

Manual operation: See "C/N" on page 62

[SENSe:]POWer:ACHannel:PRESet <Measurement>

Determines the ideal span, bandwidths and detector for the current power measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Parameters:

<Measurement> **ACPower | MCACpower**
ACLR measurement

CPOWer
channel power measurement

OBANdwidth | OBWidth
Occupied bandwidth measurement

CN
Carrier to noise ratio

CNO
Carrier to noise ration referenced to a 1 Hz bandwidth

Manual operation: See "[Optimized Settings \(Adjust Settings\)](#)" on page 51

[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 EPL1000 or limit the dynamic range by too small a S/N ratio.

To determine the best reference level, the R&S EPL1000 aborts current measurements and performs a series of test sweeps. After it has finished the test, it continues with the actual measurement.

To get a valid result, you have to perform a complete sweep with synchronization to the sweep end. This is only possible in single sweep mode.

[SENSe:]POWer:TRACe <TraceNumber>

Selects the trace channel power measurements are performed on.

For the measurement to work, the corresponding trace has to be active.

Parameters:

<TraceNumber> Range: 1 to 6
 *RST: 1

Example:

POW:TRAC 2
 Assigns the measurement to trace 2.

Manual operation: See "[Selected Trace](#)" on page 50

6.7.3 Power sweep measurement

Useful commands for compression point measurements described elsewhere:

- [Chapter 6.8.1.6, "Generator configuration"](#), on page 524
- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RPOSITION`

6.7.3.1 Configuring the measurement

<code>CONFigure:CMEasurement:REFerence:VALue</code>	398
<code>CONFigure:CMEasurement:REFerence[:MODE]</code>	399
<code>CONFigure:CMEasurement:RESult:CVALue</code>	399
<code>CONFigure:CMEasurement:RESult:P1DB[:STAT]</code>	399
<code>CONFigure:CMEasurement:RESult:P3DB[:STAT]</code>	400
<code>CONFigure:CMEasurement:RESult:PNDB[:STAT]</code>	400
<code>CONFigure:CMEasurement[:STATe]</code>	401
<code>FETCh:CMEasurement:P1DB[:RESult]?</code>	401
<code>FETCh:CMEasurement:P3DB[:RESult]?</code>	401
<code>FETCh:CMEasurement:PNDB[:RESult]?</code>	401

CONFigure:CMEasurement:REFerence:VALue <ReferenceValue>

Defines the reference value used to calculate the compression point for `CONFigure:CMEasurement:REFerence[:MODE]MANuaL`.

Parameters:

<ReferenceValue> Default unit: DBM

Example: `CONF:CME:REF:MAN`
 `CONF:CME:REF:VAL -30`

Manual operation: See ["Reference"](#) on page 38

CONFigure:CMEasurement:REFerence[:MODE] <Mode>

Determines how the reference value for the compression point measurement is defined.

Parameters:

<Mode> `AUTO | MANual`

AUTO

The reference value is determined automatically.

MANual

The reference value is defined using [CONFigure:CMEasurement:REFerence:VALue](#) on page 398.

*RST: `AUTO`

Example: `CONF:CME:REF:MAN`
 `CONF:CME:REF:VAL -30`

Manual operation: See ["Reference"](#) on page 38

CONFigure:CMEasurement:RESult:CVALue <UserCompression>

Defines the compression value for the n dB compression point (see [CONFigure:CMEasurement:RESult:PNDB\[:STAT\]](#) on page 400).

To query the results of the n dB compression point measurement, use [FETCh:CMEasurement:PNDB\[:RESult\]?](#) on page 401.

Parameters:

<UserCompression> Distance from the linear trace to the reference trace
 Default unit: DB

Example: Enable calculation:
 `CONF:CME:REF:PNDB ON`
 Define compression value:
 `CONF:CME:RES:CVAL 5`
 Query results:
 `FETC:CME:PNDB?`

Manual operation: See ["Compression Points"](#) on page 38

CONFigure:CMEasurement:RESult:P1DB[:STAT] <State>

Enables or disables the calculation of the 1 dB compression point.

To query the results of the 1 dB compression point measurement, use `FETCh:CMMeasurement:P1DB[:RESult]?` on page 401.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on
 *RST: 1

Example:

Enable calculation:
`CONF:CM:REF:P1DB ON`
 Query results:
`FETC:CM:P1DB?`

Manual operation: See "[Compression Points](#)" on page 38

CONFigure:CMMeasurement:RESult:P3DB[:STAT] <State>

Enables or disables the calculation of the 3 dB compression point.

To query the results of the 3 dB compression point measurement, use `FETCh:CMMeasurement:P3DB[:RESult]?` on page 401.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on
 *RST: 1

Example:

Enable calculation:
`CONF:CM:REF:P3DB ON`
 Query results:
`FETC:CM:P3DB?`

Manual operation: See "[Compression Points](#)" on page 38

CONFigure:CMMeasurement:RESult:PNDB[:STAT] <State>

Enables or disables the calculation of the n dB compression point.

To define the compression value, use `CONFigure:CMMeasurement:RESult:CVALue` on page 399.

To query the results of the n dB compression point measurement, use `FETCh:CMMeasurement:PNDB[:RESult]?` on page 401.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

***RST:** 0**Example:**

Enable calculation:

CONF:CME:REF:PNDB ON

Define compression value:

CONF:CME:RES:CVAL 5

Query results:

FETC:CME:PNDB?

Manual operation: See "[Compression Points](#)" on page 38**CONFigure:CMEasurement[:STATe] <State>**

Enables or disables the compression point measurement.

For details see [Chapter 3.2, "Power sweep measurements"](#), on page 32.**Parameters:**

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

***RST:** 0**Example:**

CONF:CME ON

Manual operation: See "[Compression Measurement State](#)" on page 38**FETCh:CMEasurement:P1DB[:RESult]?****FETCh:CMEasurement:P3DB[:RESult]?****FETCh:CMEasurement:PNDB[:RESult]?**Queries the results of the n dB compression point measurement, see [CONFigure:CMEasurement:RESult:PNDB\[:STAT\]](#) on page 400.To query the compression value, use [CONFigure:CMEasurement:RESult:CVALue?](#).**Example:**

FETC:CME:PNDB?

//Result: -3 dBm, 3 dBm

Usage:

Query only

Manual operation: See "[Compression Points](#)" on page 38

6.7.3.2 Programming example: measuring compression points

This example demonstrates how to determine compression points for an amplifier in a remote environment.

```
//-----Configuring the measurement -----
//Reset the instrument
*RST
//Configure internal generator for power sweep from -30 dBm to -20 dBm
//with level offset of 2 dB
OUTP ON
SOUR:POW:MODE SWE
SOUR:POW:STAR -30
SOUR:POW:STOP -20
SOUR:POW:OFFS -2

//Activate compression point measurement for 3 dB and 5 dB compression.
CONF:CME ON
CONF:CME:RES:P3DB ON
CONF:CME:RES:CVAL 5
CONF:CME:RES:PNDB ON

//-----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 3 dB and 5 dB compression points.
FETC:CME:P3DB?
//Result: -25,-22
FETC:CME:PNDB?
//Result: -22,-20
```

6.7.4 Channel power and ACLR

6.7.4.1 Measurement configuration management

CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:PRESet.....	402
CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:STANdard:CATalog?.....	403
CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:STANdard:DELeTe.....	403
CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:STANdard:SAVE.....	404

CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:PRESet <Standard>

Loads a measurement configuration.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

Suffix:

<n> [Window](#)

<m> [Marker](#)

<sb> irrelevant

Parameters:

<Standard> For more information see [Chapter 3.3.8, "Reference: predefined CP/ACLR standards"](#), on page 60.

If you want to load a customized configuration, the parameter is a string containing the file name.

Manual operation: See "[Predefined Standards](#)" on page 48

CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:STANdard:CATalog?

Queries all xml files containing ACLR standards in the

C:\ProgramData\Rohde-Schwarz\ZNL-FPL\acp_std directory. Note that subdirectories are not searched.

Suffix:

<n> [Window](#)

<m> [Marker](#)

<sb> Multi-SEM: 1 to 2
for all other measurements: irrelevant

Return values:

<Standards> List of standard files.

Usage: Query only

Manual operation: See "[User Standards](#)" on page 48

**CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:STANdard:DELeTe
<Standard>**

Deletes a file containing an ACLR standard.

Suffix:

<n> [Window](#)

<m> [Marker](#)

<sb> irrelevant

Parameters:

<Standard> String containing the file name of the standard.

Manual operation: See "[User Standards](#)" on page 48

CALCulate<n>:MARKer<m>:FUNCTION:POWer<sb>:STANdard:SAVE <Standard>

Saves the current ACLR measurement configuration as a new ACLR standard.

The measurement configuration for power measurements consists of weighting filter, channel bandwidth and spacing, resolution and video bandwidth, detector and sweep time.

Suffix:

<n>	Window
<m>	Marker
<sb>	irrelevant

Parameters:

<Standard> String containing the file name. The file format is xml.

Manual operation: See "User Standards" on page 48

6.7.4.2 Channel configuration

[SENSe:]POWer:ACHannel:ACPairs.....	404
[SENSe:]POWer:ACHannel:BANDwidth:ACHannel.....	404
[SENSe:]POWer:ACHannel:BANDwidth:ALternate<ch>.....	405
[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>].....	405
[SENSe:]POWer:ACHannel:NAME:ACHannel.....	405
[SENSe:]POWer:ACHannel:NAME:ALternate<ch>.....	405
[SENSe:]POWer:ACHannel:NAME:CHANnel<ch>.....	406
[SENSe:]POWer:ACHannel:SPACing:ALternate<ch>.....	406
[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch>.....	406
[SENSe:]POWer:ACHannel:SPACing[:ACHannel].....	407
[SENSe:]POWer:ACHannel:TXCHannel:COUNt.....	407

[SENSe:]POWer:ACHannel:ACPairs <ChannelPairs>

Defines the number of pairs of adjacent and alternate channels.

Parameters:

<ChannelPairs>	Range:	0 to 12
	*RST:	1

Manual operation: See "Number of channels: Tx, Adj" on page 49

[SENSe:]POWer:ACHannel:BANDwidth:ACHannel <Bandwidth>

Defines the channel bandwidth of the adjacent channels.

Parameters:

<Bandwidth>	Range:	100 Hz to 1000 MHz
	*RST:	14 kHz
	Default unit:	Hz

Manual operation: See "Channel Bandwidth" on page 52

[SENSe:]POWer:ACHannel:BANDwidth:ALternate<ch> <Bandwidth>

Defines the channel bandwidth of the alternate channels.

If you set the channel bandwidth for the first alternate channel, the R&S EPL1000 sets the bandwidth of the other alternate channels to the same value, but not the other way round. The command works hierarchically: to set a bandwidth of the 3rd and 4th channel, you have to set the bandwidth of the 3rd channel first.

Suffix:

<ch> 1..n
Alternate channel number

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
 *RST: 14 kHz
 Default unit: Hz

Manual operation: See "[Channel Bandwidth](#)" on page 52

[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>] <Bandwidth>

Defines the channel bandwidth of the transmission channels.

Suffix:

<ch> 1..n
Tx channel number

Parameters:

<Bandwidth> Range: 100 Hz to 1000 MHz
 *RST: 14 kHz
 Default unit: Hz

Manual operation: See "[Channel Bandwidth](#)" on page 52

[SENSe:]POWer:ACHannel:NAME:ACHannel <Name>

Defines a name for the adjacent channel.

Parameters:

<Name> String containing the name of the channel
 *RST: ADJ

Manual operation: See "[Channel Names](#)" on page 54

[SENSe:]POWer:ACHannel:NAME:ALternate<ch> <Name>

Defines a name for an alternate channel.

Suffix:

<ch> 1..n
Alternate channel number

Parameters:

<Name> String containing the name of the channel
 *RST: ALT<1...11>

Manual operation: See "[Channel Names](#)" on page 54

[SENSe:]POWer:ACHannel:NAME:CHANnel<ch> <Name>

Defines a name for a transmission channel.

Suffix:

<ch> 1..n
 Tx channel number

Parameters:

<Name> String containing the name of the channel
 *RST: TX<1...12>

Manual operation: See "[Channel Names](#)" on page 54

[SENSe:]POWer:ACHannel:SPACing:ALternate<ch> <Spacing>

Defines the distance from transmission channel to alternate channels.

If you set the channel spacing for the first alternate channel, the R&S EPL1000 adjusts the spacing of alternate channels of a lower order, but not the other way round. The command works hierarchically: to set a distance from the transmission channel to the 2nd and 3rd alternate channel, you have to define a spacing for the 2nd alternate channel first.

Suffix:

<ch> 1..n
 Alternate channel number

Parameters:

<Spacing> Range: 100 Hz to 2000 MHz
 *RST: 40 kHz (ALT1), 60 kHz (ALT2), 80 kHz (ALT3), ...
 Default unit: Hz

Manual operation: See "[Channel Spacings](#)" on page 53

[SENSe:]POWer:ACHannel:SPACing:CHANnel<ch> <Spacing>

Defines the distance between transmission channels.

If you set the channel spacing for a transmission channel, the R&S EPL1000 sets the spacing of the lower transmission channels to the same value, but not the other way round. The command works hierarchically: to set a distance between the 2nd and 3rd and 3rd and 4th channel, you have to set the spacing between the 2nd and 3rd channel first.

Suffix:

<ch> 1..n
Tx channel number

Parameters:

<Spacing> Range: 14 kHz to 2000 MHz
*RST: 20 kHz
Default unit: Hz

Manual operation: See "Channel Spacings" on page 53

[SENSe:]POWer:ACHannel:SPACing[:ACHannel] <Spacing>

Defines the distance from transmission channel to adjacent channel.

Parameters:

<Spacing> Range: 100 Hz to 2000 MHz
*RST: 14 kHz
Default unit: Hz

Manual operation: See "Channel Spacings" on page 53

[SENSe:]POWer:ACHannel:TXCHannel:COUNT <Number>

Defines the number of transmission channels.

The command works for measurements in the frequency domain.

Parameters:

<Number> Range: 1 to 18
*RST: 1

Manual operation: See "Number of channels: Tx, Adj" on page 49

6.7.4.3 Weighting filters

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel.....	407
[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTErnate<ch>.....	408
[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch>.....	408
[SENSe:]POWer:ACHannel:FILTer:ALPHa[:ALL].....	408
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel.....	408
[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTErnate<ch>.....	409
[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch>.....	409
[SENSe:]POWer:ACHannel:FILTer[:STATe][:ALL].....	409

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ACHannel <Alpha>

Defines the roll-off factor for the adjacent channel weighting filter.

Parameters:

<Alpha> Roll-off factor
 Range: 0 to 1
 *RST: 0.22

Manual operation: See "[Weighting Filters](#)" on page 54

[SENSe:]POWer:ACHannel:FILTer:ALPHa:ALTErnate<ch> <Alpha>

Defines the roll-off factor for the alternate channel weighting filter.

Suffix:

<ch> 1..n
 Alternate channel number

Parameters:

<Alpha> Roll-off factor
 Range: 0 to 1
 *RST: 0.22

Manual operation: See "[Weighting Filters](#)" on page 54

[SENSe:]POWer:ACHannel:FILTer:ALPHa:CHANnel<ch> <Alpha>

Defines the roll-off factor for the transmission channel weighting filter.

Suffix:

<ch> 1..n
 Tx channel number

Parameters:

<Alpha> Roll-off factor
 Range: 0 to 1
 *RST: 0.22

Manual operation: See "[Weighting Filters](#)" on page 54

[SENSe:]POWer:ACHannel:FILTer:ALPHa:[ALL] <Value>

Defines the alpha value for the weighting filter for all channels.

Parameters:

<Value> *RST: 0.22

Example: POW:ACH:FILT:ALPH:ALL 0.35

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ACHannel <State>

Turns the weighting filter for the adjacent channel on and off.

Parameters:

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

Manual operation: See ["Weighting Filters"](#) on page 54

[SENSe:]POWer:ACHannel:FILTer[:STATe]:ALTerNate<ch> <State>

Turns the weighting filter for an alternate channel on and off.

Suffix:

<ch> 1..n
 Alternate channel number

Parameters:

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

Manual operation: See ["Weighting Filters"](#) on page 54

[SENSe:]POWer:ACHannel:FILTer[:STATe]:CHANnel<ch> <State>

Turns the weighting filter for a transmission channel on and off.

Suffix:

<ch> 1..n
 Tx channel number

Parameters:

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

Manual operation: See ["Weighting Filters"](#) on page 54

[SENSe:]POWer:ACHannel:FILTer[:STATe][:ALL] <State>

Turns the weighting filters for all channels on and off.

Parameters:

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

6.7.4.4 Reference channel

[SENSe:]POWer:ACHannel:REFerence:AUTO ONCE	410
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:AUTO	410
[SENSe:]POWer:ACHannel:REFerence:TXCHannel:MANual	410

[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 50

[SENSe:]POWer:ACHannel:REFerence:TXChannel:AUTO <RefChannel>

Selects the reference channel for relative measurements.

You need at least one channel for the command to work.

Parameters:

<RefChannel> MINimum | MAXimum | LHIGhest

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 49

[SENSe:]POWer:ACHannel:REFerence:TXChannel:MANual <ChannelNumber>

Defines a reference channel for relative ACLR measurements.

You need at least one channel for the command to work.

Parameters:

<ChannelNumber> Range: 1 to 18

*RST: 1

Manual operation: See "[Reference Channel](#)" on page 49

6.7.4.5 Limit check



The results of the limit checks are also indicated in the `STATUS:QUESTIONABLE:ACLR` status register.

For more information see the `STATUS:QUESTIONABLE:ACPLimit` Register in the R&S EPL1000 user manual.

<code>CALCulate<n>:LIMit:ACPowEr:ACHannel:ABSolute</code>	411
<code>CALCulate<n>:LIMit:ACPowEr:ACHannel:ABSolute:STATe</code>	411
<code>CALCulate<n>:LIMit:ACPowEr:ACHannel[:RELative]</code>	412
<code>CALCulate<n>:LIMit:ACPowEr:ACHannel[:RELative]:STATe</code>	412
<code>CALCulate<n>:LIMit:ACPowEr:ACHannel:RESult?</code>	413
<code>CALCulate<n>:LIMit:ACPowEr:ALTernate<ch>:ABSolute</code>	414
<code>CALCulate<n>:LIMit:ACPowEr:ALTernate<ch>:ABSolute:STATe</code>	414
<code>CALCulate<n>:LIMit:ACPowEr:ALTernate<ch>[:RELative]</code>	415
<code>CALCulate<n>:LIMit:ACPowEr:ALTernate<ch>[:RELative]:STATe</code>	415
<code>CALCulate<n>:LIMit:ACPowEr:ALTernate<ch>:RESult?</code>	416
<code>CALCulate<n>:LIMit:ACPowEr[:STATe]</code>	417

`CALCulate<n>:LIMit:ACPowEr:ACHannel:ABSolute` <LowerLimit>[, <UpperLimit>]

Defines the absolute limit of the adjacent channels.

If you have defined an absolute limit as well as a relative limit, the R&S EPL1000 uses the lower value for the limit check.

Suffix:

<n>	irrelevant
	irrelevant

Parameters:

<LowerLimit>	The limit of the lower adjacent channel. Range: -200 dBm to 200 dBm *RST: -200 dBm Default unit: dBm
<UpperLimit>	The limit of the upper adjacent channel. Range: -200 dBm to 200 dBm *RST: -200 dBm Default unit: dBm

Manual operation: See "[Limit Check](#)" on page 53

`CALCulate<n>:LIMit:ACPowEr:ACHannel:ABSolute:STATe` <State>[, <State>]

This command turns the absolute limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit:ACPower[:STATE]`.

Suffix:

<n> irrelevant

 irrelevant

Parameters:

<State> ON | OFF | 1 | 0
Absolute limit check for lower adjacent channel
*RST: 0

<State> ON | OFF | 1 | 0
Absolute limit check for upper adjacent channel
*RST: 0

Manual operation: See "[Limit Check](#)" on page 53

`CALCulate<n>:LIMit:ACPower:ACHannel[:RELative] <LowerLimit>[, <UpperLimit>]`

Defines the relative limit of the adjacent channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S EPL1000 uses the lower value for the limit check.

Suffix:

<n> irrelevant

 irrelevant

Parameters:

<LowerLimit> The limit of the lower adjacent channel.
Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

<UpperLimit> The limit of the upper adjacent channel.
Range: 0 dB to 100 dB
*RST: 0 dB
Default unit: dB

Manual operation: See "[Limit Check](#)" on page 53

`CALCulate<n>:LIMit:ACPower:ACHannel[:RELative]:STATE <State>[, <State>]`

This command turns the relative limit check for the adjacent channels on and off.

You have to activate the general ACLR limit check before using this command with `CALCulate<n>:LIMit:ACPower[:STATE]`.

Suffix:

<n> irrelevant

 irrelevant

Parameters:

<State> ON | OFF | 1 | 0
Relative limit check for lower adjacent channel

*RST: 0

<State> ON | OFF | 1 | 0
Relative limit check for upper adjacent channel

*RST: 0

Manual operation: See "[Limit Check](#)" on page 53

CALCulate<n>:LIMit:ACPpower:ACHannel:RESult?

Queries the state of the limit check for the adjacent channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> irrelevant

 irrelevant

Return values:

<LowerACH> text value
The state of the limit check for the lower adjacent channels.

PASSED

Limit check has passed.

FAIL

Limit check has failed.

<UpperACH> text value
The state of the limit check for the upper adjacent channels.

PASSED

Limit check has passed.

FAIL

Limit check has failed.

Example:

```
INIT:IMM;*WAI;  
CALC:LIM:ACP:ACH:RES?  
PASSED,PASSED
```

Usage: Query only

Manual operation: See "[Limit Check](#)" on page 53

CALCulate<n>:LIMit:ACPpower:ALternate<ch>:ABSolute <LowerLimit>[,
<UpperLimit>]

Defines the absolute limit of the alternate channels.

If you have defined an absolute limit as well as a relative limit, the R&S EPL1000 uses the lower value for the limit check.

Suffix:

<n>	irrelevant
	irrelevant
<ch>	1..n Alternate channel number

Parameters:

<LowerLimit>	The limit of the lower adjacent channel. Range: -200 dBm to 200 dBm *RST: -200 dBm Default unit: dBm
<UpperLimit>	The limit of the upper adjacent channel. Range: -200 dBm to 200 dBm *RST: -200 dBm Default unit: dBm

Manual operation: See "[Limit Check](#)" on page 53

CALCulate<n>:LIMit:ACPpower:ALternate<ch>:ABSolute:STATe <State>[,
<State>]

This command turns the absolute limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate](#)<n>:LIMit:ACPpower[:STATe].

Suffix:

<n>	irrelevant
	irrelevant
<ch>	1..n Alternate channel number

Parameters:

<State>	ON OFF 1 0 Absolute limit check for lower alternate channel *RST: 0
---------	---

<State> ON | OFF | 1 | 0
 Absolute limit check for upper alternate channel
 *RST: 0

Manual operation: See "[Limit Check](#)" on page 53

CALCulate<n>:LIMit:ACPowEr:ALternate<ch>[:RELative] <LowerLimit>[, <UpperLimit>]

Defines the relative limit of the alternate channels. The reference value for the relative limit is the measured channel power.

If you have defined an absolute limit as well as a relative limit, the R&S EPL1000 uses the lower value for the limit check.

Suffix:

<n> irrelevant
 irrelevant
 <ch> 1..n
 Alternate channel number

Parameters:

<LowerLimit> The limit of the lower alternate channel.
 Range: 0 dB to 100 dB
 *RST: 0 dB
 Default unit: dB

<UpperLimit> The limit of the upper alternate channel.
 Range: 0 dB to 100 dB
 *RST: 0 dB
 Default unit: dB

Manual operation: See "[Limit Check](#)" on page 53

CALCulate<n>:LIMit:ACPowEr:ALternate<ch>[:RELative]:STATe <State>[, <State>]

This command turns the relative limit check for the alternate channels on and off.

You have to activate the general ACLR limit check before using this command with [CALCulate<n>:LIMit:ACPowEr\[:STATe\]](#).

Suffix:

<n> irrelevant
 irrelevant
 <ch> 1..n
 Alternate channel number

Parameters:

<State>	ON OFF 1 0
	Relative limit check for lower alternate channel
	*RST: 0
<State>	ON OFF 1 0
	Relative limit check for upper alternate channel
	*RST: 0

Manual operation: See "[Limit Check](#)" on page 53

CALCulate<n>:LIMit:ACPower:ALternate<ch>:RESult?

Queries the state of the limit check for the adjacent or alternate channels in an ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n>	irrelevant
	irrelevant
<ch>	Alternate channel number

Return values:

<LowerChan>	text value
	The state of the limit check for the lower alternate or adjacent channels.
	PASSED
	Limit check has passed.
	FAIL
	Limit check has failed.
<UpperChan>	text value
	The state of the limit check for the upper alternate or adjacent channels.
	PASSED
	Limit check has passed.
	FAIL
	Limit check has failed.

Example:

```
INIT:IMM;*WAI;
CALC:LIM:ACP:ACH:RES?
PASSED,PASSED
```

Usage: Query only

CALCulate<n>:LIMIT:ACPower[:STATe] <State>

Turns the limit check for ACLR measurements on and off.

Suffix:

<n> irrelevant
 irrelevant

Parameters:

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

Manual operation: See "Limit Check" on page 53

6.7.4.6 Defining general ACLR characteristics

Commands to define general ACLR characteristics described elsewhere.

- CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:MODE
- [SENSe:]POWer:ACHannel:PRESet
- [SENSe:]POWer:ACHannel:PRESet:RLEVel
- [SENSe:]POWer:TRACe

[SENSe:]POWer:HSPeed..... 417

[SENSe:]POWer:HSPeed <State>

Turns high speed ACLR and channel power measurements on and off.

If on, the R&S EPL1000 performs a measurement on each channel in the time domain. It returns to the frequency domain when the measurement is done.

In some telecommunications standards, high speed measurements use weighting filters with characteristic or steep-edged channel filters for band limitation.

Parameters:

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

Example: POW:HSP ON

6.7.4.7 ACLR measurement control

Commands to perform ACLR measurements described elsewhere.

- CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:SElect
- CALCulate<n>:MARKer<m>:FUNction:POWer<sb>[:STATe]
- INITiate<n>[:IMMediate]

6.7.4.8 Measurement results

Commands to analyze ACLR results described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?`
- `TRACe<n>[:DATA]`
- `CALCulate<n>:LIMit:ACPoweR:ACHannel:RESult?`
- `CALCulate<n>:LIMit:ACPoweR:ALternate<ch>:RESult?`

<code>CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult:PHZ</code>	418
<code>CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult:UNIT</code>	418
<code>[SENSe:]POWer:ACHannel:MODE</code>	419

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult:PHZ` <State>

Selects the unit the R&S EPL1000 returns results for power measurements.

You can query results with `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?`.

Suffix:

<n>	Window
<m>	Marker
<sb>	irrelevant

Parameters:

<State>	ON OFF 1 0
	ON 1
	Channel power density in dBm/Hz
	OFF 0
	Channel power in dBm
	*RST: 0

Example:

`CALC:MARK:FUNC:POW:RES:PHZ ON`
Output of results referred to the channel bandwidth.

Manual operation: See "Channel power level and density (Power Unit)" on page 50

`CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult:UNIT` <Measurement>

LTE and 5G applications only.

Selects the unit the R&S EPL1000 returns results for power measurements.

You can query results with `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?`.

Suffix:

<n>	Window
<m>	irrelevant

<sb> irrelevant

Parameters:

<Measurement> **ABS**
Channel power in dBm

PHZ
Channel power density in dBm/Hz

MPHZ
Channel power density in dBm/MHz

*RST: ABS

Example: //Select unit for power measurements
CALC:MARK:FUNC:POW:RES:UNIT PHZ

Manual operation: See "[Channel power level and density \(Power Unit\)](#)" on page 50

[SENSe:]POWer:ACHannel:MODE <Mode>

Selects the way the R&S EPL1000 displays the power of adjacent channels.

You need at least one adjacent channel for the command to work.

Parameters:

<Mode> ABSolute | RELative

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 50

6.7.4.9 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](#).....419

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 EPL1000 performs the measurement optimally with the predefined settings, without further configuration.

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

```

//-----Preparing the measurement-----

//Activate adjacent-channel power measurement.
CALC:MARK:FUNC:POW:SEL ACP
//Select the user standard "GSM"
CALC:MARK:FUNC:POW:PRES GSM

//-----Setting Up Channels-----
//Create one transmission channel.
POW:ACH:TXCH:COUN 1
//Name the first transmission channel 'TX Channel'.
POW:ACH:NAME:CHAN1 'TX Channel'
//Create two adjacent channels - one adjacent channel and one alternate channel.
POW:ACH:ACP 2
//Name the adjacent channel 'ABC'
POW:ACH:NAME:ACH 'ABC'
//Name the first alternate channel 'XYZ'.
POW:ACH:NAME:ALT1 'XYZ'
//Define a bandwidth of 30 kHz for the transmission channel.
POW:ACH:BWID:CHAN1 30kHz
//Define a bandwidth of 30 kHz for the adjacent channel.
POW:ACH:BWID:ACH 30kHz
//Define a bandwidth of 30 kHz for the first alternate channel.
POW:ACH:BWID:ALT1 30kHz
//Define a distance of 33 kHz from the center of the transmission channel to the
//center of the adjacent channel.
//Also adjust the distance to the alternate channels (66 kHz).
POW:ACH:SPAC 33kHz
//Define a distance of 100 kHz from the center of the transmission channel to the
//center of the first alternate channel.
POW:ACH:SPAC:ALT1 100kHz

//-----Selecting a Reference Channel--
//Select relative display of the channel power.
POW:ACH:MODE REL
//Define transmission channel 1 as the reference channel.
POW:ACH:REF:TXCH:MAN 1

//-----Saving the settings as a user standard-----
//Save the user standard with the name "my_aclr_standard".
//Weighting filters can only be defined for user-defined standards.
CALC:MARK:FUNC:POW:STAN:SAVE 'my_aclr_standard'

//-----Defining Weighting Filters-----
//Define a roll-off factor of 0.35 for the weighting filter of the first
//transmission channel.
POW:ACH:FILT:ALPH:CHAN1 0.35
//Turn the weighting filter for the first transmission channel on.
POW:ACH:FILT:CHAN1 ON
//Define a roll-off factor of 0.35 for the weighting filter of the adjacent

```

```

//channel.
POW:ACH:FILT:ALPH:ACH 0.35
//Turn the weighting filter for the adjacent channel on.
POW:ACH:FILT:ACH ON
//Define a roll-off factor of 0.35 for the weighting filter of the first
//alternate channel.
POW:ACH:FILT:ALPH:ALT1 0.35
//Turn the weighting filter for the first alternate channel on.
POW:ACH:FILT:ALT1 ON

//-----Working with Limits-----
//Define a relative limit of 30 dB below the power of the reference channel
//for both adjacent channels.
CALC:LIM:ACP:ACH 30DB,30DB
//Define a relative limit of 25 dB below the power of the reference channel
//for the first alternate channels.
CALC:LIM:ACP:ALT1 25DB,25DB
//Define an absolute limit of -35 dBm for both adjacent channels.
CALC:LIM:ACP:ACH:ABS -35DBM,-35DBM
//Turn the ACLR limit check on.
CALC:LIM:ACP ON
//Turn the relative limit check for adjacent channels on.
CALC:LIM:ACP:ACH:STAT ON
//Turn the absolute limit check for adjacent channels on.
CALC:LIM:ACP:ACH:ABS:STAT ON
//Turn the absolute limit check for the first alternate channel on.
CALC:LIM:ACP:ALT1:ABS:STAT ON

//-----Performing the Measurement-----
//Determine the ideal ACLR measurement configuration.
POW:ACH:PRES ACP;*WAI
//Determine the ideal reference level for the measurement.
POW:ACH:PRES:RLEV;*WAI
//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//-----Limit Check-----
//Query the results of the limit check for the adjacent channels.
CALC:LIM:ACP:ACH:RES?
//Query the results of the limit check for the first alternate channels.
CALC:LIM:ACP:ALT1:RES?

//-----Retrieving Results-----
//Query the results for the ACLR measurement.
CALC:MARK:FUNC:POW:RES? ACP

```

6.7.5 Carrier-to-noise ratio

Commands to perform carrier-to-noise measurements described elsewhere.

- `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:RESult?`
- `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>:SElect`
- `CALCulate<n>:MARKer<m>:FUNction:POWer<sb>[:STATe]`
- `[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]`
- `[SENSe:]POWer:ACHannel:PRESet`

Programming example: Measuring the carrier-to-noise ratio

```
//-----Preparing the measurement-----
*RST
//Reset the instrument
FREQ:CENt 800MHz
//Sets the center frequency to the carrier frequency of 800 MHz.
CALC:MARK:FUNC:POW:SEL CN
//Activates carrier-to-noise ratio measurement.
POW:ACH:PREs CN
//Optimizes the instrument settings according to the channel bandwidth.
POW:ACH:PREs:RLEV
//Determines the ideal reference level for the measurement.

//-----Performing the Measurement-----
INIT:CONt OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
// Now turn off the carrier signal and repeat the measurement:
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:MARK:FUNC:POW:RES? CN
//Returns the carrier-to-noise ratio.
```

6.7.6 Occupied bandwidth

- [Configuring the measurement](#).....422
- [Programming example: OBW measurement](#)..... 423

6.7.6.1 Configuring the measurement

Commands to configure the channel described elsewhere.

- `[SENSe:]POWer:ACHannel:BANDwidth[:CHANnel<ch>]`
- `[SENSe:]POWer:ACHannel:PRESet`

- [SENSe:]POWer:ACHannel:PRESet:RLEVel

Commands to configure search limits described elsewhere.

- CALCulate<n>:MARKer<m>:X:SLIMits:LEFT
- CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT
- CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]

Commands to perform the measurement described elsewhere.

- CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>:SElect
- CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>[:STATe]

Commands to retrieve results described elsewhere.

- CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>:RESult?

[SENSe:]POWer:BWIDth.....	423
[SENSe:]POWer:BANDwidth.....	423

[SENSe:]POWer:BWIDth <Percentage>

[SENSe:]POWer:BANDwidth <Percentage>

Selects the percentage of the total power that defines the occupied bandwidth.

Parameters:

<Percentage> Range: 10 PCT to 99.9 PCT
 *RST: 99 PCT
 Default unit: PCT

Example: POW:BAND 95PCT

Manual operation: See "% Power Bandwidth" on page 67

6.7.6.2 Programming example: OBW measurement

This programming example demonstrates the measurement example described in [Chapter 3.5.5, "Measurement example"](#), on page 70 in a remote environment.

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

//-----Configuring the Measurement-----
//Set the center frequency to 800 MHz.
FREQ:CENT 800MHz
//Set the reference level to -10 dBm.
DISP:TRAC:Y:RLEV -10dBm
//Activate occupied bandwidth measurement.
CALC:MARK:FUNC:POW:SEL OBW
//Set the percentage of power to 99%.
POW:BWID 99PCT
//Set the channel bandwidth to 21 kHz.
POW:ACH:BAND 21kHz
//Optimize the instrument settings according to the channel bandwidth.
```

```

POW:ACH:PRES OBW
//Determine the ideal reference level for the measurement.
POW:ACH:PRES:RLEV
//Set the trace detector to positive peak.
DET APE

//-----Performing the Measurement-----
//Select single sweep mode.INIT:CONT OFF

//Initiate a new measurement and waits until the sweep has finished.
INIT;*WAI

//-----Retrieving Results-----
//Return the occupied bandwidth.
CALC:MARK:FUNC:POW:RES? OBW

```

6.7.7 Spectrum emission mask (SEM)

• Measurement configuration management	424
• Measurement control	426
• Multi SEM measurement configuration	426
• Sweep list configuration	428
• Reference range configuration	441
• Power class configuration	443
• List evaluation	448
• Measurement control	449
• Result retrieval	449
• Example: SEM measurement	450

6.7.7.1 Measurement configuration management

CALCulate<n>:LIMit:ESPectrum<sb>:RESTore	424
[SENSe:]ESPectrum<sb>:PRESet[:STANdard]	425
[SENSe:]ESPectrum<sb>:PRESet:RESTore	425
[SENSe:]ESPectrum<sb>:PRESet:STORE	425

CALCulate<n>:LIMit:ESPectrum<sb>:RESTore

Restores the predefined limit lines for the selected Spectrum Emission Mask standard.

All modifications made to the predefined limit lines are lost and the factory-set values are restored.

Suffix:

<n>	irrelevant
	irrelevant
<sb>	1 to 2 Subblock in a multi-SEM measurement

Example: `CALC:LIM:ESP:REST`
 Resets the limit lines for the current Spectrum Emission Mask standard to the default setting.

[SENSe:]ESpectrum<sb>:PRESet[:STANdard] <Standard>

Loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `C:\Users\Public\Documents\Rohde-Schwarz\Analyzer\sem_std`.

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

Parameters:

<Standard> String containing the file name.
 If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

Manual operation: See "[Standard](#)" on page 91

[SENSe:]ESpectrum<sb>:PRESet:RESTore

Restores the default configurations of predefined SEM standards.

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

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

Manual operation: See "[Restore Standard Files](#)" on page 96

[SENSe:]ESpectrum<sb>:PRESet:STORE <Standard>

Saves the current SEM measurement configuration.

Standard definitions are stored in an xml file. The default directory for SEM standards is `C:\Users\Public\Documents\Rohde-Schwarz\Analyzer\sem_std`.

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

Parameters:

<Standard> String containing the file name.
 You can save the file in a subdirectory of the directory mentioned above. In that case, you have to include the relative path to the file.

Manual operation: See "[Save Standard](#)" on page 96

6.7.7.2 Measurement control

<code>INITiate<n>:ESpectrum</code>	426
<code>[SENSe:]SWEep:MODE</code>	426

`INITiate<n>:ESpectrum`

Initiates a Spectrum Emission Mask measurement.

Suffix:

<n> irrelevant

Usage: Asynchronous command

`[SENSe:]SWEep:MODE <Mode>`

Selects the spurious emission and spectrum emission mask measurements.

You can select other measurements with

- `CALCulate<n>:MARKer<m>:FUNCTion:POWer<sb>[:STATe]`

Parameters:

<Mode> LIST | AUTO | ESpectrum

AUTO

Turns on basic spectrum measurements.

ESpectrum

Turns on spectrum emission mask measurements.

LIST

Turns on spurious emission measurements.

*RST: AUTO

Example: `SWE:MODE ESP`

6.7.7.3 Multi SEM measurement configuration

<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:MLCalc</code>	426
<code>[SENSe:]ESpectrum<sb>:SCENter</code>	427
<code>[SENSe:]ESpectrum<sb>:SCOunt</code>	427

`[SENSe:]ESpectrum<sb>:RANGe<ri>:MLCalc <Function>`

Defines the function used to calculate the limit line for the n-th power class for overlapping ranges in Multi-SEM measurements. For details see "[Limit calculation for individual ranges](#)" on page 82.

Suffix:

<sb> 1 to 2

Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

<Function> NONE | MAX | SUM

NONE
(reference ranges only:) the limit of the reference range is used;
Reference ranges always use the function "NONE".

SUM
sum of the two limit lines (calculated for linear powers) is used

MAX
maximum of the two limit lines is used

*RST: SUM (reference range: NONE)

Manual operation: See "[Multi-Limit Calc <n>](#)" on page 89

[SENSe:]ESpectrum<sb>:SCENter <Frequency>

Defines the center frequency of the selected sub block in a Multi-SEM measurement.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

Parameters:

<Frequency> Frequency within the currently defined global span (see
[\[SENSe:\]FREQUENCY:SPAN](#) on page 533 and [\[SENSe:\]FREQUENCY:CENTer](#) on page 531).

Range: 1 to 3
*RST: 1
Default unit: Hz

Example: ESP1:SCEN 1GHZ

Manual operation: See "[Sub Block / Center Freq](#)" on page 91

[SENSe:]ESpectrum<sb>:SCOut <Subblocks>

Defines the number of sub blocks in the SEM measurement.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

Parameters:

<Subblocks> Number of sub blocks in the SEM measurement.

Range: 1 to 2
*RST: 1

Example: ESP:SCO 2

Manual operation: See "[Sub Block Count](#)" on page 91

6.7.7.4 Sweep list configuration

Commands to configure sweep lists described elsewhere.

- `CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:LIMit[:STATe]`

<code>[SENSe:]ESpectrum<sb>:HSPeEd</code>	428
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:BANDwidth:RESolution</code>	429
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:BANDwidth:VIDeo</code>	429
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:COUNT?</code>	429
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:DELete</code>	430
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:FILTer:TYPE</code>	430
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:START</code>	431
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQuency]:STOP</code>	431
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation</code>	432
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO</code>	432
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATe</code>	433
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:INSert</code>	433
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:ABSolute:START</code>	433
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:ABSolute:STOP</code>	434
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:START</code>	434
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:START:ABS</code>	435
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:START:FUNCTION</code>	435
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP</code>	436
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:ABS</code>	437
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:FUNCTION</code>	437
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:STATe</code>	438
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:POINts:MINimum[:VALue]</code>	439
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:RLEVel</code>	439
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME</code>	439
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO</code>	440
<code>[SENSe:]ESpectrum<sb>:RANGe<ri>:TRANSDucer</code>	440
<code>[SENSe:]ESpectrum<sb>:SSETup</code>	441

`[SENSe:]ESpectrum<sb>:HSPeEd <State>`

Turns high speed mode for SEM measurements on and off.

For more information including restrictions see [Chapter 3.6.4.3, "Fast SEM measurements"](#), on page 79.

Suffix:

`<sb>` 1 to 2
 irrelevant

Parameters:

`<State>` ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on

Example: `ESP:HSP ON`

Manual operation: See "Fast SEM" on page 86

[SENSe:]ESpectrum<sb>:RANGe<ri>:BANDwidth:RESolution <RBW>

Defines the resolution bandwidth for a SEM range.

In case of high speed measurements, the resolution bandwidth has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
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 86

[SENSe:]ESpectrum<sb>:RANGe<ri>:BANDwidth:VIDeo <VBW>

Defines the video bandwidth for a SEM range.

In case of high speed measurements, the video bandwidth has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
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 87

[SENSe:]ESpectrum<sb>:RANGe<ri>:COUNT?

Queries the number of ranges in the sweep list.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> irrelevant

Return values:

<Ranges> Number of ranges in the sweep list.

Usage: Query only

[SENSe:]ESpectrum<sb>:RANGe<ri>:DELeTe

Removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> Selects the measurement range.

Manual operation: See "[Delete Range](#)" on page 90

[SENSe:]ESpectrum<sb>:RANGe<ri>:FILTer:TYPE <FilterType>

This command selects the filter type for an SEM range.

In case of high speed measurements, the filter has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 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.

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 86

[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQUENCY]:STARt <Frequency>

Defines the start frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S EPL1000 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 EPL1000 will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see [Chapter 3.6.4.1, "Ranges and range settings"](#), on page 75.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

<Frequency> Numeric value. Note that the minimum frequency range of a SEM range is 20 Hz.

*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)

Default unit: Hz

Manual operation: See ["Range Start / Range Stop"](#) on page 86

[SENSe:]ESpectrum<sb>:RANGe<ri>[:FREQUENCY]:STOP <Frequency>

Defines the stop frequency of a SEM range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the SEM sweep list covers, the R&S EPL1000 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 EPL1000 will adjust the start frequency of the first SEM range and the stop frequency of the last SEM range to the span

For more information see [Chapter 3.6.4.1, "Ranges and range settings"](#), on page 75.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
 *RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
 Default unit: Hz

Manual operation: See "[Range Start / Range Stop](#)" on page 86

[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation <Attenuation>

Defines the input attenuation for a SEM range.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

<ri> 1..n
 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 Attenuation](#)" on page 87

[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:ATTenuation:AUTO <State>

Turns automatic selection of the input attenuation for a SEM range on and off.

In case of high speed measurements, the input attenuation has to be identical for all ranges.

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

<ri> 1..n
 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 87

[SENSe:]ESpectrum<sb>:RANGe<ri>:INPut:GAIN:STATe <State>

Turns the preamplifier for a SEM range on and off.

In case of high speed measurements, the state of the preamplifier has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

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

Manual operation: See "[Preamp](#)" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:INSert <Mode>

Inserts a new SEM range and updates the range numbers accordingly.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the SEM range.

Parameters:

<Mode> AFTer | BEFore
AFTer
Inserts a range after the selected range.
BEFore
Inserts a range before the selected range.

Manual operation: See "[Insert before Range / Insert after Range](#)" on page 90

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:ABSolute:STARt <Level>

Defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

 1..n
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.
Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESpectrum:RANGe:LIMit:ABSolute:START -10`
For a detailed example see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See "[Abs Limit Start / Stop <n>](#)" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:ABSolute:STOP <Level>

Defines an absolute limit for a SEM range.

Unlike manual operation, you can define an absolute limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

 1..n
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.
Range: -400 to 400
*RST: -13
Default unit: dBm

Example: `SENSe:ESpectrum:RANGe:LIMit:ABSolute:STOP -15`
For a detailed example see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See "[Abs Limit Start / Stop <n>](#)" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STARt <Level>

Defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit regardless of the limit check mode.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the SEM range.

<lj> 1..n
Power class for which the limit is defined.

Parameters:

<Level> Relative limit at the start frequency of a SEM range.
Range: -400 to 400
*RST: -50
Default unit: dBc

Example: SENS:ESP:RANG:LIM:REL:STAR -10

Manual operation: See "[Rel Limit Start / Stop <n>](#)" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STARt:ABS <Level>

Defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see "[Relative limit line functions](#)" on page 78.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the SEM range.

<lj> 1..n
Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see [\[SENSe:\]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STARt:FUNCTION](#) on page 435).
Range: -400 to 400
*RST: -13
Default unit: dBm

Example: SENSe:ESpectrum:RANGe:LIMit:RELative:STARt:ABSolute -10

For a detailed example see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See "[Rel Limit Start / Stop <n>](#)" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STARt:FUNCTION <Function>

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the SEM range.

 1..n
Power class for which the limit is defined.

Parameters:

<Function> OFF | MAX
Defines the function to be used to determine the relative limit line 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<ri>:LIMit:RELative:START and [SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit: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<ri>:LIMit:RELative:START command to define this value.

*RST: OFF

Example:

```
SENSe:ESpectrum:RANGe:LIMit:RELative:START:
FUNction MAX
```

For a detailed example see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See "[Rel Limit Start / Stop <n>](#)" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP <Level>

Defines a relative limit for a SEM range.

Unlike manual operation, you can define a relative limit anytime and regardless of the limit check mode.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the SEM range.

 1..n
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 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See ["Rel Limit Start / Stop <n>"](#) on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:ABS <Level>

Defines an absolute limit for the MAX function of the relative limit for a SEM range.

For more information see ["Relative limit line functions"](#) on page 78.

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

<ri> 1..n
 Selects the SEM range.

 1..n
 Power class for which the limit is defined.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range to be used in addition to the relative limit if the MAX function is enabled (see [\[SENSe:\]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:FUNCTION](#) on page 437).

Range: -400 to 400
 *RST: -13
 Default unit: dBm

Example: `SENSe:ESpectrum:RANGe:LIMit:RELative:STOP:ABSolute -15`
 For a detailed example see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See ["Rel Limit Start / Stop <n>"](#) on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:FUNCTION <Function>

Enables the use of a function when defining the relative limit for a SEM range.

Suffix:

<sb> 1 to 2
 Subblock in a multi-SEM measurement

<ri> 1..n
 Selects the SEM range.

 1..n
 Power class for which the limit is defined.

Parameters:

<Function> OFF | MAX

Defines the function to be used to determine the relative limit line stop value

MAX

The maximum of the relative *and* the absolute level is used as the limit stop value. Use the `[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP` and `[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP:ABS` commands to define these values.

OFF

No function is used, the relative limit line is defined by a fixed relative stop value. Use the `[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:RELative:STOP` command to define this value.

*RST: OFF

Example:

```
SENSe:ESpectrum:RANGe:LIMit:RELative:STOP:
FUNction MAX
```

For a detailed example see [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.

Manual operation: See "Rel Limit Start / Stop <n>" on page 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:LIMit:STATe <State>

Selects the limit check mode for *all* SEM ranges (<range> is irrelevant).

Suffix:

<sb>	1 to 2 Subblock in a multi-SEM measurement
<ri>	1..n Selects the SEM range.
	1..n 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 88

[SENSe:]ESpectrum<sb>:RANGe<ri>:POINTs:MINimum[:VALue] <SweepPoint>

Defines the minimum number of sweep points for the range.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> Selects the measurement range.

Parameters:

<SweepPoint> Minimum number of sweep points per range

Range: 1 to 32001

*RST: 1

Example: SENSe1:ESpectrum:RANGe3:POINTs:MIN:VALue 400

Manual operation: See "[Min Sweep Points](#)" on page 89

[SENSe:]ESpectrum<sb>:RANGe<ri>:RLEVel <RefLevel>

Defines the reference level for a SEM range.

In case of high speed measurements, the reference level has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.

*RST: 0 dBm
Default unit: dBm

Manual operation: See "[Ref Level](#)" on page 87

[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME <SweepTime>

Defines the sweep time for a SEM range.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.
Default unit: s

Manual operation: See " [Sweep Time](#) " on page 87

[SENSe:]ESpectrum<sb>:RANGe<ri>:SWEep:TIME:AUTO <State>

Turns automatic selection of the sweep time for a SEM range on and off.

In case of high speed measurements, the sweep time has to be identical for all ranges.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

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

Example: ESP:RANG3:SWE:TIME:AUTO OFF
Deactivates the sweep time auto mode for range 3.

Manual operation: See " [Sweep Time Mode](#) " on page 87

[SENSe:]ESpectrum<sb>:RANGe<ri>:TRANsducer <Transducer>

Selects a transducer factor for a SEM range.

Note that

- the transducer must cover at least the span of the range
- the x-axis has to be linear
- the unit has to be dB

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

<ri> 1..n
Selects the measurement range.

Parameters:

<Transducer> String containing the transducer file name, including the path information.

Manual operation: See "Transducer Factor" on page 88

[SENSe:]ESpectrum<sb>:SSETup <State>

Enables or disables symmetrical configuration of the range settings.

See Chapter 3.6.4.1, "Ranges and range settings", on page 75.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on
*RST: 0

Manual operation: See "Symmetrical Setup" on page 90

6.7.7.5 Reference range configuration

[SENSe:]ESpectrum<sb>:BWID.....	441
[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHa.....	441
[SENSe:]ESpectrum<sb>:FILTer[:RRC][:STATe].....	442
[SENSe:]ESpectrum<sb>:RRANge?.....	442
[SENSe:]ESpectrum<sb>:RTYPE.....	442

[SENSe:]ESpectrum<sb>:BWID <Bandwidth>

Defines the channel bandwidth of the reference range.

The bandwidth is available if the power reference is the channel power.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

Parameters:

<Bandwidth> minimum span ≤ value ≤ span of reference range
*RST: 3.84 MHz
Default unit: Hz

Manual operation: See "Tx Bandwidth" on page 92

[SENSe:]ESpectrum<sb>:FILTer[:RRC]:ALPHa <Alpha>

Defines the roll-off factor for the RRC filter.

The RRC filter is available if the power reference is the channel power.

Suffix:

<sb> 1 to 2
irrelevant

Parameters:

<Alpha> Range: 0 to 1
*RST: 0.22

Manual operation: See "[Alpha](#):" on page 93

[SENSe:]ESpectrum<sb>:FILTer[:RRC][:STATe] <State>

Turns the RRC filter in the reference range on and off.

The RRC filter is available if the power reference is the channel power.

Suffix:

<sb> 1 to 2
irrelevant

Parameters:

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

Manual operation: See "[RRC Filter State](#)" on page 93

[SENSe:]ESpectrum<sb>:RRANGe?

Queries the reference range.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

Return values:

<RefRange> Number of the current reference range.
Range: 1 to 30

Usage: Query only

[SENSe:]ESpectrum<sb>:RTYPE <Type>

Defines the type of the power reference.

Suffix:

<sb> 1 to 2
Subblock in a multi-SEM measurement

Parameters:

<Type> PEAK | CPOWER

PEAK

Measures the highest peak within the reference range.

CPOWer

Measures the channel power within the reference range (integral bandwidth method).

*RST: CPOWer

Manual operation: See "Power Reference Type" on page 92

6.7.7.6 Power class configuration

CALCulate<n>:LIMit:ESPectrum<sb>:LIMits.....	443
CALCulate<n>:LIMit:ESPectrum<sb>:MODE.....	444
CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:COUNT.....	444
CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:LIMit[:STATE].....	445
CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:MAXimum.....	446
CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:MINimum.....	446
CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>[:EXCLUSIVE].....	447
CALCulate<n>:LIMit:ESPectrum<sb>:VALue.....	447

CALCulate<n>:LIMit: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:ESPectrum<sb>:PCLass<pc>:COUNT` on page 444.

Suffix:

<n>	irrelevant
	irrelevant
<sb>	1 to 2 Subblock in a multi-SEM measurement

Setting parameters:

<Max1>	<p>Defines the value range for power class 1 as -200 to <Max1>.</p> <p>Only available for <code>CALC:LIM:ESP:PCL:COUNT >=2</code></p> <p>If only 2 power classes are defined, the value range for power class 2 is defined as <Max1> to 200.</p> <p>Range: -199 to + 199</p> <p>Default unit: DBM</p>
<Max2>	<p>Defines the value range for power class 2 as <Max1> to <Max2>.</p> <p>Only available for <code>CALC:LIM:ESP:PCL:COUNT >=3</code></p> <p>If only 3 power classes are defined, the value range for power class 3 is defined as <Max2> to 200.</p> <p>Range: -199 to + 199, <Max2> must be higher than <Max1></p>

<Max3> Defines the value range for power class 3 as <Max2> to <Max3>.
 The value range for power class 4 is defined as <Max3> to 200.
 Only available for `CALC:LIM:ESP:PCL:COUNT = 4`
 Range: -199 to + 199, <Max3> must be higher than <Max2>

Example: `CALC:LIM:ESP:LIM -50,50,70`
 Defines the following power classes:
 <-200, -50>
 <-50, 50>
 <50, 70>
 <70, 200>
 Query:
`CALC:LIM:ESP:LIM?`
 Response:
 -200,-50,50,70,200

CALCulate<n>:LIMit:ESPectrum<sb>:MODE <Mode>

Which limit line is to be used for an SEM measurement depends on the power class the input signal power belongs to. This command defines whether the power class is determined automatically or manually.

Suffix:

<n> irrelevant
 irrelevant
 <sb> 1 to 2
 Subblock in a multi-SEM measurement

Parameters:

<Mode>

AUTO

The power class (and thus the limit line) is assigned dynamically according to the currently measured channel power.

MANUAL

One of the specified power classes is selected manually for the entire measurement. The selection is made with the `CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>[:EXCLUSIVE]` command.

*RST: AUTO

Example: `CALC:LIM:ESP:MODE AUTO`
 Activates automatic selection of the limit line.

CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:COUNT <NoPowerClasses>

Sets the number of power classes to be defined.

Must be executed before any new power class values can be defined using `CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:MAXimum` and `CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:MINimum`.

Suffix:

<n>	irrelevant
	irrelevant
<sb>	1 to 2 Subblock in a multi-SEM measurement
<pc>	irrelevant

Parameters:

<NoPowerClasses>	1 to 4
*RST:	1

Example:

`CALC:LIM:ESP:PCL:COUN 2`
Two power classes can be defined.

Manual operation: See ["Adding or Removing a Power Class"](#) on page 94

CALCulate<n>:LIMit:ESpectrum<sb>:PCLass<pc>:LIMit[:STATE] <State>

Selects the limit check mode for each power class.

Suffix:

<n>	irrelevant
	irrelevant
<sb>	1 to 2 Subblock in a multi-SEM measurement
<pc>	1..n power class

Parameters:

<State> ABSolute | RELative | AND | OR

ABSolute

Evaluates only limit lines with absolute power values

RELative

Evaluates only limit lines with relative power values

AND

Evaluates limit lines with relative and absolute power values. A negative result is returned if both limits fail.

OR

Evaluates limit lines with relative and absolute power values. A negative result is returned if at least one limit failed.

*RST: REL

Example:

`CALC:LIM:ESP:PCL:LIM ABS`

Manual operation: See ["Used Power Classes:"](#) on page 93

CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:MAXimum <Level>

Defines the upper limit of a particular power class.

Note:

- The last power class always has an upper limit of 200 dBm.
- The upper limit of a power class must always be the same as the lower limit of the subsequent power class.
- The power class must already exist (see [CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:COUNT](#) on page 444).

Suffix:

<n>	irrelevant
	irrelevant
<sb>	1 to 2 Subblock in a multi-SEM measurement
<pc>	1..n power class

Parameters:

<Level>	Range: -199.9 dBm to 200 dBm Default unit: dBm
---------	---

Example:

```
CALC:LIM:ESP:PCL1:MAX -40 dBm
```

Sets the maximum power value of the first power class to -40 dBm.

Manual operation: See "[PMin/ PMax](#)" on page 94

CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:MINimum <Level>

Defines the lower limit of a particular power class.

Note:

- The first power class always has a lower limit of -200 dBm.
- The lower limit of a power class must always be the same as the upper limit of the previous power class.
- The power class must already exist (see [CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>:COUNT](#) on page 444).

Suffix:

<n>	irrelevant
	irrelevant
<sb>	1 to 2 Subblock in a multi-SEM measurement
<pc>	1..n power class

Parameters:

<Level> Range: -200 dBm to 199.9 dBm
Default unit: dBm

Example:

CALC:LIM:ESP:PCL2:MIN -40 dBm

Sets the minimum power value of the second power class to -40 dBm.

Manual operation: See "PMin/ PMax" on page 94

CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>[:EXCLusive] <State>

Selects the power class used by the measurement if `CALCulate<n>:LIMit:ESPectrum<sb>:MODE` is set to manual.

Note that:

- You can only use power classes for which limits are defined.

Suffix:

<n> irrelevant
 irrelevant
<sb> 1 to 2
Subblock in a multi-SEM measurement
<pc> 1..n
power class

Parameters:

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

Example:

CALC:LIM:ESP:PCL1 ON

Activates the first defined power class.

Manual operation: See "Used Power Classes:" on page 93

CALCulate<n>:LIMit:ESPectrum<sb>:VALue <Power>

Activates the manual limit line selection as and specifies the expected power as a value. Depending on the entered value, the associated predefined limit lines is selected.

Has the same effect as a combination of the `CALC:LIM:ESP:MODE MAN` and the `CALCulate<n>:LIMit:ESPectrum<sb>:PCLass<pc>[:EXCLusive]` commands; however, the power class to be used is not defined directly, but via the expected power. As opposed to `CALC:LIM:ESP:MODE AUTO`, the power class is not re-assigned to the input signal power dynamically, but only once when the command is executed.

Suffix:

<n> irrelevant

<lj> irrelevant
 <sb> 1 to 2
 Subblock in a multi-SEM measurement

Parameters:

<Power> integer
 Range: -200 to 199
 *RST: 0

Example:

CALC:LIM:ESP:VAL 33
 Activates manual selection of the limit line and selects the limit line for P = 33.

6.7.7.7 List evaluation

Commands to configure the list evaluation described elsewhere.

- [MMEMory:STORe<n>:LIST](#)

CALCulate<n>:ESpectrum:PSEarch:AUTO	448
CALCulate<n>:ESpectrum:PEAKsearch:AUTO	448
CALCulate<n>:ESpectrum:PSEarch[:IMMEDIATE]	448
CALCulate<n>:ESpectrum:PEAKsearch[:IMMEDIATE]	448
CALCulate<n>:ESpectrum:PSEarch:MARGIN	449
CALCulate<n>:ESpectrum:PEAKsearch:MARGIN	449
CALCulate<n>:ESpectrum:PSEarch:PSHOW	449
CALCulate<n>:ESpectrum:PEAKsearch:PSHOW	449

CALCulate<n>:ESpectrum:PSEarch:AUTO <State>
CALCulate<n>:ESpectrum:PEAKsearch:AUTO <State>

Turns the list evaluation on and off.

Suffix:

<n> [Window](#)

Parameters:

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

Example:

CALC:ESP:PSE:AUTO OFF
 Deactivates the list evaluation.

Manual operation: See "[List Evaluation State \(result summary\)](#)" on page 97

CALCulate<n>:ESpectrum:PSEarch[:IMMEDIATE]
CALCulate<n>:ESpectrum:PEAKsearch[:IMMEDIATE]

Initiates a list evaluation.

Suffix:

<n> [Window](#)

CALCulate<n>:ESpectrum:PSEarch:MARGin <Threshold>
CALCulate<n>:ESpectrum:PEAKsearch:MARGin <Margin>

Defines the threshold of the list evaluation.

Suffix:

<n> [Window](#)

Parameters:

<Margin> Range: -200 to 200
 *RST: 200
 Default unit: dB

Example: `CALC:ESP:PSE:MARG 100`
 Sets the margin to 100 dB.

Manual operation: See "[Margin](#)" on page 97

CALCulate<n>:ESpectrum:PSEarch:PSHow <State>
CALCulate<n>:ESpectrum:PEAKsearch:PSHow <State>

Turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Suffix:

<n> [Window](#)

Parameters:

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

Example: `CALC:ESP:PSE:PSH ON`
 Marks all peaks with blue squares.

Manual operation: See "[Show Peaks](#)" on page 97

6.7.7.8 Measurement control

Commands to perform SEM measurements described elsewhere.

- `INITiate<n>:ESpectrum`
- `INITiate<n>[:IMMEDIATE]`
- `[SENSe:]SWEep:MODE`

6.7.7.9 Result retrieval

Commands to retrieve results described elsewhere.

- `CALCulate<n>:LIMit:FAIL?`
- `CALCulate<n>:MARKer<m>:FUNCTION:POWER<sb>:RESult?`
- `TRACe<n>[:DATA]`
- `TRACe<n>[:DATA]:MEMory?`

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

6.7.7.10 Example: SEM measurement

In this example we will configure and perform an SEM measurement. Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task. For most common measurement standards, the R&S EPL1000 performs the measurement optimally with the predefined settings, without further configuration.

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

//----- Preparing the measurement-----
//Activate SEM Measurement
SWE:MODE ESP

//Selects single sweep mode.
//SEM has to be in single sweep mode to be configured and no sweep operation
//may be running!
// If required, a sweep stop can be ensured by INIT:IMM;*WAI
INIT:CONT OFF

//----- Managing Measurement Configurations-----
//Load the 3GPP configuration stored in the file '3GPP_UL.xml'
ESP:PRES 'WCDMA\3GPP\UL\3GPP_UL.xml'

//----- Defining the Reference Range-----
//Query the current reference range.
ESP:RRAN?
//Select the channel power as the power reference.
ESP:RTYP CPOW
//Define a channel bandwidth of 4 MHz for the power reference.
ESP:BWID 4 MHZ
//Use an RRC filter with a roll-off factor of 0.5 when measuring
//the reference power.
ESP:FILT:RRC ON
ESP:FILT:ALPH 0.5

//----- Configuring Power Classes-----
//Define 3 power classes.
CALC:LIM:ESP:PCL:COUN 3
//Define the value ranges of the three power classes as [dBm]:
//power class 1: -200 to -100
//power class 2: -100 to 0
//power class 3: 0 to 200
CALC:LIM:ESP:LIM -100,0
//Define an absolute limit check for class 1.
```

```

CALC:LIM:ESP:PCL1:LIM ABS
//Define a relative limit check for class 2.
CALC:LIM:ESP:PCL2:LIM REL
//Define a manual selection of the power class.
CALC:LIM:ESP:MODE MAN
//Activate the use of the second power class for the entire measurement.
CALC:LIM:ESP:PCL2 ON

//----- Configuring a Sweep List-----
//Insert a range after range 2.
ESP:RANG2:INS AFT
//Insert a range before range 1.
ESP:RANG1:INS BEF
//Query the number of measurement ranges in the sweep list (currently 11).
ESP:RANG:COUNT?
//Delete the 11th range.
ESP:RANG5:DEL

//Define a stop frequency of -9 MHz for range 1.
ESP:RANG1:STOP -10000000

//Define a start frequency of -10 MHz for range 2.
ESP:RANG2:STAR -9000000

//Switch off Fast SEM mode so the ranges can be configured individually.
ESP:HSP OFF

//Define a resolution bandwidth of 1 MHz for range 2.
ESP:RANG2:BAND:RES 1000000

//Define a video bandwidth of 5 MHz for range 2.
ESP:RANG2:BAND:VID 5000000
//Define a sweep time of 1 second for range 2.
ESP:RANG2:SWE:TIME 1
//Define a reference level of 0 dBm for range 2.
ESP:RANG2:RLEV 0
//Define an input attenuation of 10 dB for range 2.
ESP:RANG2:INP:ATT 10

// Create a transducer that can be used.
// It has to cover the corresponding frequency range

SENSE1:CORREction:TRANSDUCER:SElect 'Transducer'
SENSE1:CORREction:TRANSDUCER:UNIT 'DB'
SENSE1:CORREction:TRANSDUCER:COMment 'Test Transducer'
// Frequency Span 0 MHz bis 20 Ghz
SENSE1:CORREction:TRANSDUCER:DATA 0e6,5, 20e9,3

```

```

//Include a transducer called 'transducer' for range 2.
ESP:RANG2:TRAN 'Transducer'

//----- Configuring the limit check-----

//Check the absolute and relative limits for all ranges in power class 1 and
//fails if both limits are violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant. They are
//defined here to demonstrate the use of the MAX function for relative limits.
ESP:RANG:LIM1:STAT AND
//Enable the use of maximum function for relative limit start. If the value
//exceeds the larger of the absolute (-13 dBm) and relative (-10 dBc) start
//values, the check fails.
ESP:RANG2:LIM1:REL:STAR:FUNC MAX
ESP:RANG2:LIM1:REL:STAR -10
ESP:RANG2:LIM1:REL:STAR:ABS -13
ESP:RANG2:LIM1:REL:STOP:FUNC MAX
ESP:RANG2:LIM1:REL:STOP -10
ESP:RANG2:LIM1:REL:STOP:ABS -13

//Check the absolute and relative limits for all ranges in power class 2 and
//fails if either limit is violated. Since power class 2 is set to be used for
//the entire measurement, values for Limit Check 1 are irrelevant.
ESP:RANG:LIM2:STAT OR
//Define an absolute limit of 10 dBm for the entire range 2 for power class 2.
ESP:RANG2:LIM2:ABS:STAR 10
ESP:RANG2:LIM2:ABS:STOP 10
//Define a relative limit of -20 dBc for the entire range 2 for power class 2.
ESP:RANG2:LIM2:REL:STAR -20
ESP:RANG2:LIM2:REL:STOP -20

//----- Configuring List Evaluation-----
//Activate list evaluation, i.e. the peak is determined for each range
//after each sweep.
CALC:ESP:PSE:AUTO ON
//Define a peak threshold of 10 dB.
CALC:ESP:PSE:MARG 10dB

//----- Managing Measurement Configurations-----

//Save the current configuration in a new file named '3GPP_UL_User'
//in the same directory so the standard is not overwritten.
ESP:PRES:STOR 'WCDMA\3GPP\UL\3GPP_UL_User.xml'

//----- Performing the measurement-----
//One sweep
INIT:ESP

//----- Checking the Results-----
//Query the result of the limit check for all ranges.

```

```
CALC:LIM:FAIL?
//Query the peak for each range of the SEM measurement as a list.
TRAC:DATA? LIST
```

6.7.8 Spurious emissions

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6.7.8.1 Measurement initialization

Note that you have to initialize the measurement before you can configure the sweep list or the list evaluation.

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INITiate<n>:SPURious

Initiates a Spurious Emission measurement.

Suffix:

<n>

Usage: Asynchronous command

6.7.8.2 Sweep list configuration



In remote operation, it is not possible to configure the sweep list while a sweep is running.

Commands to configure sweep lists described elsewhere.

- [\[SENSe:\] SWEep:MODE](#)

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[\[SENSe:\]LIST:RANGe<ri>:DELete](#)..... 455

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[\[SENSe:\]LIST:RANGe<ri>\[:FREQUENCY\]:STOP](#).....457

[\[SENSe:\]LIST:RANGe<ri>:INPut:ATTenuation](#)..... 457

[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO.....	458
[SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATe.....	458
[SENSe:]LIST:RANGe<ri>:LIMit:STARt.....	458
[SENSe:]LIST:RANGe<ri>:LIMit:STATe.....	459
[SENSe:]LIST:RANGe<ri>:LIMit:STOP.....	459
[SENSe:]LIST:RANGe<ri>:POINts[:VALue].....	459
[SENSe:]LIST:RANGe<ri>:RLEVel.....	460
[SENSe:]LIST:RANGe<ri>:SWEep:TIME.....	460
[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO.....	460
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[SENSe:]LIST:RANGe<ri>:BANDwidth:RESolution <RBW>

Defines the resolution bandwidth for a spurious emission measurement range.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<RBW> Resolution bandwidth.
Refer to the data sheet for available resolution bandwidths.
Default unit: Hz

Example: LIST:RANG2:BAND:RES 3KHZ

Manual operation: See "RBW" on page 117

[SENSe:]LIST:RANGe<ri>:BANDwidth:VIDeo <VBW>

Defines the video bandwidth for a spurious emission measurement range.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<VBW> Video bandwidth.
Refer to the data sheet for available video bandwidths.
Default unit: Hz

Example: LIST:RANG2:BAND:VID 3KHZ

Manual operation: See "VBW" on page 117

[SENSe:]LIST:RANGe<ri>:BREak <State>

Controls the sweep for all ranges.

Suffix:

<ri> irrelevant

Parameters:

<State>

ON | 1

The R&S EPL1000 stops after measuring one range, and the status bit number 10 in the `STAT:OPER` register is set.

To continue with the next range, use `INITiate<n>:CONMeas`.

OFF | 0

The R&S EPL1000 sweeps all ranges in one go.

*RST: 0

Example:

`LIST:RANG2:BRE ON`

[SENSe:]LIST:RANGe<ri>:COUNT?

Queries the number of ranges in the sweep list.

Suffix:

<ri> irrelevant

Return values:

<Ranges> Number of ranges in the sweep list.

Example:

`LIST:RANG:COUN?`

Usage:

Query only

[SENSe:]LIST:RANGe<ri>:DELEte

Removes a range from the sweep list.

Note that

- you cannot delete the reference range
- a minimum of three ranges is mandatory.

Suffix:

<ri> 1..n
Selects the measurement range.

Example:

`LIST:RANG2:DEL`

[SENSe:]LIST:RANGe<ri>:DETEctor <Detector>

This command selects the detector for a spurious emission measurement range.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<Detector> **APEak**
Autopeak

NEGative

minimum peak detector

POSitive

peak detector

SAMPIe

sample detector

RMS

RMS detector

AVERage

average detector

*RST: RMS

Example: LIST:RANG2:DET AVER**Manual operation:** See "[Detector](#)" on page 117**[SENSe:]LIST:RANGe<ri>:FILTer:TYPE <FilterType>**

This command selects the filter type for a spurious emission measurement range.

Suffix:

<ri> 1..30
 Selects the measurement range.

Parameters:

<FilterType>

CFILter

Channel filters

Available in the Spectrum application.

NORMal

3 dB Gaussian filters

Available in the Spectrum application.

CISPr | PULSe

6 dB CISPR filter

Return value for query is always PULS.

MIL

6 dB MIL standard filter

*RST: Depends on application

Example: LIST:RANG2:FILT:TYPE NORM**Manual operation:** See "[Filter Type](#)" on page 117**[SENSe:]LIST:RANGe<ri>[:FREQuency]:STARt <Frequency>**

Defines the start frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S EPL1000 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 EPL1000 will adjust the start frequency of the first range and the stop frequency of the last range to the span

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
*RST: -12.75 MHz (range 1), -2.515 MHz (range 2), 2.515 MHz (range 3)
Default unit: Hz

Example: LIST:RANG2:STAR 2MHZ

Manual operation: See "[Range Start / Range Stop](#)" on page 116

[SENSe:]LIST:RANGe<ri>[:FREQuency]:STOP <Frequency>

Defines the stop frequency of a spurious emission measurement range.

Make sure to set an appropriate span. If you set a span that is

- smaller than the span the sweep list covers, the R&S EPL1000 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 EPL1000 will adjust the start frequency of the first range and the stop frequency of the last range to the span

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<Frequency> Numeric value.
*RST: -2.52 MHz (range 1), 2.52 MHz (range 2), 250.0 MHz (range 3)
Default unit: Hz

Example: LIST:RANG2:STOP 5MHZ

Manual operation: See "[Range Start / Range Stop](#)" on page 116

[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation <Attenuation>

Defines the input attenuation for a spurious emission measurement range.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<Attenuation> Numeric value.
 Refer to the data sheet for the attenuation range.
 *RST: 10 dB
 Default unit: dB

Example: LIST:RANG2:INP:ATT 5

Manual operation: See "[RF Attenuation](#)" on page 118

[SENSe:]LIST:RANGe<ri>:INPut:ATTenuation:AUTO <State>

Turns automatic selection of the input attenuation for a spurious emission measurement range on and off.

Suffix:

<ri> 1..n
 Selects the measurement range.

Parameters:

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

Example: LIST:RANG2:INP:ATT:AUTO ON

Manual operation: See "[RF Attenuation Mode](#)" on page 118

[SENSe:]LIST:RANGe<ri>:INPut:GAIN:STATe <State>

Turns the preamplifier for a spurious emission measurement range on and off.

Suffix:

<ri> 1..n
 Selects the measurement range.

Parameters:

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

Example: LIST:RANG2:INP:GAIN:STAT ON

[SENSe:]LIST:RANGe<ri>:LIMit:STARt <Level>

Defines an absolute limit for a spurious emission measurement range.

Suffix:

<ri> 1..n
 Selects the measurement range.

Parameters:

<Level> Absolute limit at the start frequency of a SEM range.
 Range: -400 to 400
 *RST: 13
 Default unit: dBm

Example: LIST:RANG2:LIM:STAR 200

Manual operation: See "[Abs Limit Start/ Abs Limit Stop](#)" on page 119

[SENSe:]LIST:RANGe<ri>:LIMit:STATe <State>

Turns the limit check for all spurious emission measurement ranges on and off.

Suffix:

<ri> irrelevant

Parameters:

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

Example: LIST:RANG2:LIM:STAT ON

Manual operation: See "[Limit Check](#)" on page 118

[SENSe:]LIST:RANGe<ri>:LIMit:STOP <Level>

Defines an absolute limit for a spurious emission measurement range.

Suffix:

<ri> 1..n
 Selects the measurement range.

Parameters:

<Level> Absolute limit at the stop frequency of a SEM range.
 Range: -400 to 400
 *RST: 13
 Default unit: dBm

Example: LIST:RANG2:LIM:STOP 200

Manual operation: See "[Abs Limit Start/ Abs Limit Stop](#)" on page 119

[SENSe:]LIST:RANGe<ri>:POINts[:VALue] <Points>

Defines the number of sweep points in a spurious emission measurement range.

Suffix:

<ri> 1..n
 Selects the measurement range.

Parameters:

<Points> For more information on sweep points see [Chapter 4.5.1.8, "How much data is measured: sweep points and sweep count"](#), on page 230.

*RST: 1001

Example:

LIST:RANG2:POIN 1000

Manual operation: See "[Sweep Points](#)" on page 118

[SENSe:]LIST:RANGe<ri>:RLEVel <RefLevel>

Defines the reference level for a spurious emission measurement range.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<RefLevel> Reference level.
Refer to the data sheet for the reference level range.

*RST: 0 dBm

Default unit: dBm

Example:

LIST:RANG2:RLEV 1DBM

Manual operation: See "[Reference Level](#)" on page 117

[SENSe:]LIST:RANGe<ri>:SWEep:TIME <SweepTime>

Defines the sweep time for a spurious emission measurement range.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<SweepTime> Sweep time.
The range depends on the ratios of the span to the RBW and the RBW to the VBW. Refer to the data sheet for more information.

Example:

LIST:RANG2:SWE:TIME 2MS

Manual operation: See "[Sweep Time](#)" on page 117

[SENSe:]LIST:RANGe<ri>:SWEep:TIME:AUTO <State>

Turns automatic selection of the sweep time for a spurious emission measurement range on and off.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

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

Example: LIST:RANG2:SWE:TIME:AUTO ON

Manual operation: See " [Sweep Time Mode](#) " on page 117

[SENSe:]LIST:RANGe<ri>:TRANsducer <Transducer>

Selects a transducer factor for a spurious emission measurement range.

Note the following prerequisites for the selected transducer:

- The transducer must cover at least the span of the range.
- The x-axis has to be linear.
- The unit has to be dB.

Suffix:

<ri> 1..n
Selects the measurement range.

Parameters:

<Transducer> String containing the transducer file name. Do not include a file extension or the file path.
The file must be located in the
C:\Users\Public\Documents\Rohde-Schwarz\Analyzer\trd directory.

Example: LIST:RANG2:TRAN 'MYTRANS'

Manual operation: See "[Transducer](#)" on page 118

6.7.8.3 List evaluation

Commands to configure the list evaluation described elsewhere.

- `MMEMoRY:STORe<n>:LIST`

<code>CALCulate<n>:ESpectrum:PEAKsearch:DEtails</code>	462
<code>CALCulate<n>:PSEArch:AUTO</code>	462
<code>CALCulate<n>:PEAKsearch:AUTO</code>	462
<code>CALCulate<n>:PSEArch:MARGIn</code>	462
<code>CALCulate<n>:PEAKsearch:MARGIn</code>	462
<code>CALCulate<n>:PSEArch:PSHow</code>	463
<code>CALCulate<n>:PEAKsearch:PSHow</code>	463
<code>CALCulate<n>:PSEArch:SUBRanges</code>	463
<code>CALCulate<n>:PEAKsearch:SUBRanges</code>	463

CALCulate<n>:ESPectrum:PEAKsearch:DEtails <State>

Configures how detailed the list in the Result Summary is.

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF | 1 | 0

ON | 1

Includes all detected peaks (up to a maximum defined by [CALCulate<n>:PEAKsearch:SUBRanges](#) on page 463).

OFF | 0

Includes only one peak per range.

*RST: 0

Example:

CALC:ESP:PSE:DET ON

CALC:PSE:SUBR 10

Includes up to 10 peaks per range in the list.

Manual operation: See "[Details](#)" on page 121

CALCulate<n>:PSEarch:AUTO <State>**CALCulate<n>:PEAKsearch:AUTO <State>**

Turns the list evaluation

on and off.

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example:

CALC:PSE:AUTO OFF

Deactivates the list evaluation.

Manual operation: See "[List Evaluation State](#)" on page 120

CALCulate<n>:PSEarch:MARGin <Threshold>**CALCulate<n>:PEAKsearch:MARGin <Margin>**

Defines the threshold of the list evaluation.

Suffix:

<n> [Window](#)

Parameters:

<Margin> Range: -200 to 200
Default unit: dB

Example: `CALC:PSE:MARG 100`
Sets the threshold to 100 dB.

Manual operation: See "[Margin](#)" on page 120

CALCulate<n>:PSEarch:PSHow <State>
CALCulate<n>:PEAKsearch:PSHow <State>

Turns the peak labels in the diagram on and off.

Peak labels are blue squares.

Suffix:
<n> [Window](#)

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

Example: `CALC:PSE:PSH ON`
Marks all peaks with blue squares.

Manual operation: See "[Show Peaks](#)" on page 120

CALCulate<n>:PSEarch:SUBRanges <NumberPeaks>
CALCulate<n>:PEAKsearch:SUBRanges <NumberPeaks>

Defines the number of peaks included in the peak list.

After this number of peaks has been found, the R&S EPL1000 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 121

6.7.8.4 Adjustment of x-axis to the range definitions

[\[SENSe:\]LIST:XADJust.....](#) 463

[SENSe:]LIST:XADJust

Sets the x-axis range for the spurious emission measurement from the start frequency of the first sweep range to the stop frequency of the last sweep range.

Example: `SENS:LIST:XADJ`

Usage: Event

6.7.8.5 Spurious emission measurements

Commands to perform the measurement described elsewhere.

- `[SENSe:]SWEep:MODE`
- `INITiate<n>[:IMMediate]`

6.7.8.6 Result retrieval

Commands to retrieve results described elsewhere.

- `CALCulate<n>:LIMit:FAIL?`
- `TRACe<n>[:DATA]`
- `TRACe<n>[:DATA]:MEMory?`
- `TRACe<n>[:DATA]:X?`

6.7.8.7 Programming example: spurious emissions measurement

In the following example, the Spurious Emissions measurement is configured by defining ranges and parameters to create the following sweep list.

Note that this example is primarily meant to demonstrate the remote control commands, it does not necessarily reflect a useful measurement task.

```
//-----Preparing the measurement-----
*RST
//Resets the instrument

SWE:MODE LIST
//Activates spurious emissions measurement

INIT:CONT OFF
//Selects single sweep mode.

//Spurious measurement has to be in single sweep mode to be configured
//and no sweep operation may be running!

// If required, a sweep stop can be ensured by INIT:IMM;*WAI

//-----Configuring a Sweep List-----

LIST:RANG:COUNT?
//Returns the number of measurement ranges in the sweep list.
LIST:RANG4:DEL
//Deletes the fourth range.
LIST:RANG1:STAR 10000000
//Defines a start frequency of 10 MHz for range 1.
```



```

LIST:RANG1:STOP 100000000
//Defines a stop frequency of 100 MHz for range 1.
LIST:RANG1:BAND 500000
//Defines a resolution bandwidth of 500 kHz in range 1.
LIST:RANG1:BAND:VID 5000000
//Defines a video bandwidth of 5 MHz for range 1.
LIST:RANG1:INP:ATT:AUTO OFF
//Turns automatic selection of the input attenuation in range 1 off.

LIST:RANG1:INP:ATT 10
//Defines a input attenuation of 10 dBm for range 1.

LIST:RANG1:FILT:TYPE CFILter
//Selects an Channel filter for range 1.
LIST:RANG1:DET SAMP
//Selects a sample detector for range 1.
LIST:RANG1:POIN 601
//Defines 601 sweep points for range 1.
LIST:RANG1:RLEV -20
//Defines a reference level of -20 dBm for range 1.
LIST:RANG1:SWE:TIME 5
//Defines a manual sweep time of 5 second for range 1.

// Create a transducer that can be used.
// It has to cover the corresponding frequency range
//
SENSE1:CORREction:TRANsdUCer:SElect 'Test'
SENSE1:CORREction:TRANsdUCer:UNIT 'DB'
SENSE1:CORREction:TRANsdUCer:COMment 'Test Transducer'
// Frequency Span 0 MHz to 20 Ghz
SENSE1:CORREction:TRANsdUCer:DATA 0e6,5, 20e9,3

SENS:LIST:RANG1:TRAN 'Test'
//Includes a transducer called 'Test' for range 1.

LIST:RANG1:LIM:STAR 10
LIST:RANG1:LIM:STOP 10
//Defines an absolute limit of 10 dBm at the start and stop frequencies of range 1.
LIST:RANG:LIM:STAT ON
//Turns the limit check for all ranges on.

//-----Configuring the List Evaluation-----
CALC:PSE:MARG 100
//Sets the threshold to 100 dB.
CALC:PSE:PSH ON
//Marks all peaks in the diagram with blue squares.
CALC:PSE:SUBR 10
//Sets 10 peaks per range to be stored in the list.

```

```
//-----Performing the Measurement-----

INIT:SPUR; *WAI
//Performs a spurious emission measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:LIM1:FAIL?
//Queries the result of the check for limit line 1.
TRAC? SPUR
//Queries the peak list of the spurious emission measurement.
```

6.7.9 Statistics

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- [Measurement configuration](#).....467
- [Gate ranges](#).....468
- [Diagram scale](#).....470
- [Measurement control](#).....473
- [Result retrieval](#).....473
- [Programming example: measuring statistics](#).....474

6.7.9.1 Measurement selection

- [CALCulate<n>:STATistics:APD\[:STATe\]](#).....466
- [CALCulate<n>:STATistics:CCDF\[:STATe\]](#).....466

CALCulate<n>:STATistics:APD[:STATe] <State>

Turns the APD measurement on and off.

Suffix:

<n> [Window](#)

Parameters:

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

Example:

CALC:STAT:APD ON
 Switches on the APD measurement.

CALCulate<n>:STATistics:CCDF[:STATe] <State>

Turns the "CCDF" on and off.

Suffix:

<n> irrelevant

Parameters:

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

Example: `CALC:STAT:CCDF ON`
Switches on the "CCDF" measurement.

6.7.9.2 Measurement configuration

Commands to configure statistical measurements described elsewhere.

- `[SENSe:]BANDwidth[:RESolution][:VALue]`

<code>CALCulate<n>:MARKer<m>:Y:PERCent</code>	467
<code>CALCulate<n>:STATistics:NSAMples</code>	467
<code>DISPlay[:WINDow<n>]:STATistics:CCDF:GAUSS</code>	468

`CALCulate<n>:MARKer<m>:Y:PERCent <Probability>`

Sets a marker to a particular probability value. You can query the corresponding level with `CALCulate<n>:MARKer<m>:X`.

Using the command turns delta markers into normal markers.

Is available for CCDF measurements.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Probability> Range: 0 % to 100 %
Default unit: %

Example: `CALC1:MARK:Y:PERC 95PCT`
Positions marker 1 to a probability of 95 %.

Manual operation: See "[Percent Marker \(CCDF only\)](#)" on page 129

`CALCulate<n>:STATistics:NSAMples <Samples>`

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 130

DISPlay[:WINDow<n>]:STATistics:CCDF:GAUSs <State>

Enables or disables the red trace in the CCDF display indicating the normal distribution.

Suffix:

<n> 1..n
Window

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on
*RST: 1

Example: DISP:WIND:STAT:CCDF:GAUS OFF

Manual operation: See "Normal Distribution" on page 130

6.7.9.3 Gate ranges

[SENSe:]SWEep:EGATe:TRACe<t>:COMMeNt.....	468
[SENSe:]SWEep:EGATe:TRACe<t>:PERiod.....	468
[SENSe:]SWEep:EGATe:TRACe<t>:STARt<gr>.....	469
[SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr>.....	469
[SENSe:]SWEep:EGATe:TRACe<t>[:STATe<gr>].....	470

[SENSe:]SWEep:EGATe:TRACe<t>:COMMeNt <Comment>

Defines a comment for the gate of a particular trace.

Suffix:

<t> Trace

Parameters:

<Comment> String containing the comment.

Example:

SWE:EGAT:TRAC1:COMM 'MyComment'
Defines a comment for the gate in trace 1.

Manual operation: See "Comment" on page 131

[SENSe:]SWEep:EGATe:TRACe<t>:PERiod <Length>

Defines the length of the gate for all traces.

The gate length applies to all traces.

Suffix:

<t> irrelevant

Parameters:

<Length> Range: 100 ns to 1000 s
 *RST: 2 ms
 Default unit: s

Example:

SWE:EGAT:TRAC:PER 5ms
 Defines the period for gated triggering to 5 ms.

Manual operation: See "[Period](#)" on page 131

[SENSe:]SWEep:EGATe:TRACe<t>:START<gr> <Time>

Defines the start time for a gate range.

Suffix:

<t> [Trace](#)
 <gr> 1..n
 gate range

Parameters:

<Time> The value range depends on the gate period you have set for the selected trace with [\[SENSe:\]SWEep:EGATe:TRACe<t>:PERiod](#). The following rules apply:

- the start time may not be higher than the length of the gate
- the start time may not be lower than the stop time of the gate range of a lower order

The reset values depend on the gate range.

- for gate range 1, the start time is 0 ms
- for gate range 3, the start time is 2 ms
- for gate range 5, the start time is 4 ms

Default unit: s

Example:

SWE:EGAT:TRAC1:STAR1 3ms
 Sets the Starting point for range 1 on trace 1 at 3 ms.

Manual operation: See "[Range <x> Start/Stop](#)" on page 132

[SENSe:]SWEep:EGATe:TRACe<t>:STOP<gr> <Time>

Defines the stop time for a gate range.

Suffix:

<t> [Trace](#)
 <gr> 1..n
 gate range

Parameters:

<Time> The value range depends on the gate period you have set for the selected trace with [\[SENSe:\]SWEep:EGATe:TRACe<t>:PERiod](#). The following rules apply:

- the stop time may not be higher than the length of the gate

- the stop time may not be lower than the start time

The reset values depend on the gate range.

- for gate range 1, the stop time is 1 ms
- for gate range 3, the stop time is 3 ms
- for gate range 5, the stop time is 5 ms

Default unit: s

Example: `SWE:EGAT:TRAC1:STOP1 5ms`
Sets the stopping point for range 1 on trace 1 at 5 ms.

Manual operation: See "[Range <x> Start/Stop](#)" on page 132

[SENSe:]SWEp:EGATe:TRACe<t>[:STATe<gr>] <State>

Includes or excludes a gate range for a particular trace.

Suffix:

<t> [Trace](#)

<gr> gate range

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example: `SWE:EGAT:TRAC1:STAT1 ON`
Activates gate range 1 for trace 1.

Manual operation: See "[Range <x> Use](#)" on page 132

6.7.9.4 Diagram scale

CALCulate<n>:STATistics:PRESet	470
CALCulate<n>:STATistics:SCALE:AUTO ONCE	471
CALCulate<n>:STATistics:SCALE:X:RANGe	471
CALCulate<n>:STATistics:SCALE:X:RLEVel	471
CALCulate<n>:STATistics:SCALE:Y:LOWer	472
CALCulate<n>:STATistics:SCALE:Y:UNIT	472
CALCulate<n>:STATistics:SCALE:Y:UPPer	472

CALCulate<n>:STATistics:PRESet

Resets the scale of the diagram (x- and y-axis).

- Reference level (x-axis)
0.0 dBm
- Display range (x-axis) for APD measurements
100 dB
- Display range (x-axis) for CCDF measurements

20 dB

- Upper limit of the y-axis
1.0
- Lower limit of the y-axis
1E-6

Suffix:

<n> [Window](#)

Example:

CALC:STAT:PRES

Resets the scaling for statistical functions

Manual operation: See ["Default Settings"](#) on page 134

CALCulate<n>:STATistics:SCALE:AUTO ONCE

Initiates an automatic scaling of the diagram (x- and y-axis).

To obtain maximum resolution, the level range is set as a function of the measured spacing between peak power and the minimum power for the APD measurement and of the spacing between peak power and mean power for the CCDF measurement. In addition, the probability scale for the number of test points is adapted.

To get valid results, you have to perform a complete sweep with synchronization to the end of the auto range process. This is only possible in single sweep mode.

Suffix:

<n> [Window](#)

Manual operation: See ["Adjust Settings"](#) on page 130

CALCulate<n>:STATistics:SCALE:X:RANGE <Range>

Defines the display range of the x-axis for statistical measurements.

The effects are identical to `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]`.

Suffix:

<n> [Window](#)

Parameters:

<Range> Range: 1 dB to 200 dB
 *RST: 100 dB
 Default unit: dB

Example:

CALC:STAT:SCAL:X:RANG 20dB

Manual operation: See ["Range"](#) on page 133

CALCulate<n>:STATistics:SCALE:X:RLEVEL <RefLevel>

Sets the reference level for statistical measurements. The effects are identical to `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALE]:RLEVEL`.

Note that in case of statistical measurements the reference level applies to the x-axis.

Suffix:

<n> [Window](#)

Parameters:

<RefLevel> The unit is variable.
If a reference level offset is included, the range is adjusted by that offset.

Range: -130 dBm to 30 dBm

*RST: 0 dBm

Default unit: dBm

Example:

CALC:STAT:SCAL:X:RLEV -60dBm

Manual operation: See "[Ref Level](#)" on page 133

CALCulate<n>:STATistics:SCALE:Y:LOWer <Magnitude>

Defines the lower vertical limit of the diagram.

Suffix:

<n> [Window](#)

Parameters:

<Magnitude> The number is a statistical value and therefore dimensionless.

Range: 1E-9 to 0.1

*RST: 1E-6

Example:

CALC:STAT:SCAL:Y:LOW 0.001

Manual operation: See "[Y-Max/ Y-Min](#)" on page 133

CALCulate<n>:STATistics:SCALE:Y:UNIT <Unit>

Selects the unit of the y-axis.

Suffix:

<n> [Window](#)

Parameters:

<Unit> PCT | ABS

*RST: ABS

Example:

CALC:STAT:SCAL:Y:UNIT PCT

Sets the percentage scale.

Manual operation: See "[Y-Unit](#)" on page 133

CALCulate<n>:STATistics:SCALE:Y:UPPer <Magnitude>

Defines the upper vertical limit of the diagram.

Suffix:	
<n>	Window
Parameters:	
<Magnitude>	The number is a statistical value and therefore dimensionless.
	Range: 1E-5 to 1.0
	*RST: 1.0
Example:	CALC:STAT:SCAL:Y:UPP 0.01
Manual operation:	See "Y-Max/ Y-Min" on page 133

6.7.9.5 Measurement control

Commands to perform statistical measurements described elsewhere.

- `INITiate<n>[:IMMEDIATE]`

6.7.9.6 Result retrieval

Commands to retrieve results described elsewhere.

- `CALCulate<n>:MARKer<m>:X`

<code>CALCulate<n>:STATistics:CCDF:X<t>?</code>	473
<code>CALCulate<n>:STATistics:RESult<res>?</code>	474

`CALCulate<n>:STATistics:CCDF:X<t>? <Probability>`

Queries the results of the CCDF.

Suffix:	
<n>	Window
<t>	Trace
Query parameters:	
<Probability>	P0_01 Level value for 0.01 % probability
	P0_1 Level value for 0.1 % probability
	P1 P1: Level value for 1 % probability
	P10 Level value for 10 % probability

Return values:
<CCDF Result>

Example: `CALC:STAT:CCDF:X1? P10`
Returns the level values that are over 10 % above the mean value.

Usage: Query only

CALCulate<n>:STATistics:RESult<res>? <ResultType>

Queries the results of a measurement for a specific trace.

Suffix:

<n> [Window](#)

<res> [Trace](#)

Query parameters:

<ResultType> **MEAN**
Average (=RMS) power in dBm measured during the measurement time.

PEAK

Peak power in dBm measured during the measurement time.

CFACTOR

Determined crest factor (= ratio of peak power to average power) in dB.

ALL

Results of all three measurements mentioned before, separated by commas: <mean power>,<peak power>,<crest factor>

Example:

```
CALC:STAT:RES2? ALL
```

Reads out the three measurement results of trace 2. Example of answer string: 5.56,19.25,13.69 i.e. mean power: 5.56 dBm, peak power 19.25 dBm, crest factor 13.69 dB

Usage:

Query only

6.7.9.7 Programming example: measuring statistics

This example demonstrates how to determine statistical values for a measurement in a remote environment using the gated statistics example described in [Chapter 3.8.4, "APD and CCDF basics - gated triggering"](#), on page 127.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
TRIG:SOUR EXT
//Defines the use of an external trigger.
TRIG:HOLD 25us
//Defines a trigger offset of 25 µs.
CALC:STAT:APD ON
//Activates APD measurement.
CALC:STAT:NSAM 1000
//Sets the number of samples to be included in the statistical evaluation to 1000.

//-----Defining Gate ranges -----

SWE:EGAT:TRAC1:COMM 'GSM - useful part'
//Defines a comment for the gate
SWE:EGAT:TRAC1:PER 4.61536ms
```

```

//Sets the gate period to 4.61536ms.
SWE:EGAT:TRAC1:STAR1 15us
//Sets the start of range 1 to 15 µs.
SWE:EGAT:TRAC1:STOP1 557.8us
//Sets the end of range 1 to 15 µs (start time) + 542.77 µs (useful part) = 557.8 µs.
SWE:EGAT:TRAC1:STAT1 ON
//Activates the use of range 1.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//-----Retrieving Results-----
CALC:STAT:RES1? MEAN
//Returns the mean average power for the useful part of the GSM signal.

//----- Determining the CCDF values-----

CALC:STAT:CCDF ON
//Activates CCDF measurement.
CALC:MARK2:Y:PERC 95PCT
//Sets marker 2 to the 95% probability value.
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.
CALC:STAT:CCDF:X? P1
//Returns the level value for 10% probability for the CCDF.
CALC:MARK2:X?
//Returns the level for a probability of 95%.

//----- Scaling the diagram -----
CALC:STAT:SCAL:X:RLEV -70dBm
//Sets the reference level to -70 dBm (x-axis!)
CALC:STAT:SCAL:X:RANG 20dB
//Defines a power level range of 20 dB for the x-axis
CALC:STAT:SCAL:Y:LOW 0.0001
//Sets the minimum of the y-axis to 0.01% probability
CALC:STAT:SCAL:Y:UPP 1.0
//Sets the maximum of the y-axis to 100% probability
CALC:STAT:SCAL:Y:UNIT PCT
//Displays percentage values on y-axis scale

```

6.7.10 Time domain power

- [Measurement configuration](#).....476
- [Measurement control](#)..... 479
- [Result retrieval](#)..... 479

6.7.10.1 Measurement configuration

Commands to configure time domain power measurements described elsewhere.

- `CALCulate<n>:MARKer<m>:X:SLIMits:LEFT`
- `CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT`
- `CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]`

<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AOFF</code>	476
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERAge</code>	476
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:MEAN[:STATe]</code>	477
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PHOLd</code>	477
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:PPEak[:STATe]</code>	477
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:RMS[:STATe]</code>	478
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:SDEViation[:STATe]</code>	478
<code>CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY[:STATe]</code>	478

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AOFF

Turns all time domain power evaluation modes off.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:FUNCTION:SUMMARY:AVERAge <State>

Switches on or off averaging for the active power measurement in zero span in the window specified by the suffix <n>. If activated, a time domain value is calculated from the trace after each sweep; in the end, all values are averaged to calculate the final result.

The number of results required for the calculation of average is defined with `[SENSe:]AVERAge<n>:COUNT`.

Averaging is reset by switching it off and on again.

Synchronization to the end of averaging is only possible in single sweep mode.

Suffix:

<n> Window

<m> Marker

Parameters:

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

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:SUMM:AVER ON
Switches on the calculation of average.
AVER:COUN 200
Sets the measurement counter to 200.
INIT;*WAI
Starts a sweep and waits for the end.
```

CALCulate<n>:MARKer<m>:FUNction:SUMMary:MEAN[:STATe] <State>

Turns the evaluation to determine the mean time domain power on and off.

The R&S EPL1000 performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

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

Manual operation: See ["Results"](#) on page 141

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd <State>

Switches on or off the peak-hold function for the active power measurement in zero span in the window specified by the suffix <n>. If activated, the peak for each sweep is compared to the previously stored peak; the maximum of the two is stored as the current peak.

The peak-hold function is reset by switching it off and on again.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

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

CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak[:STATe] <State>

Turns the evaluation to determine the positive peak time domain power on and off.

The R&S EPL1000 performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

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

Manual operation: See ["Results"](#) on page 141

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS[:STATe] <State>

Turns the evaluation to determine the RMS time domain power on and off.

The R&S EPL1000 performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

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

Manual operation: See ["Results"](#) on page 141

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEviation[:STATe] <State>

Turns the evaluation to determine the standard deviation of the time domain power on and off.

The R&S EPL1000 performs the measurement on the trace marker 1 is positioned on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

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

CALCulate<n>:MARKer<m>:FUNction:SUMMary[:STATe] <State>

Turns time domain power measurements on and off. This measurement is only available in zero span.

When you turn the measurement on, the R&S EPL1000 activates a marker and positions it on the peak power level in the marker search range.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

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

6.7.10.2 Measurement control

Commands to perform time domain power measurements described elsewhere.

- [INITiate<n>\[:IMMEDIATE\]](#)

6.7.10.3 Result retrieval

- [Mean power](#)..... 479
- [Peak power](#)..... 480
- [RMS power](#)..... 482
- [Standard deviation](#)..... 483

Mean power

- [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:AVERAge:RESult?](#)..... 479
- [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:PHOLd:RESult?](#)..... 479
- [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:RESult?](#)..... 480

CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:AVERAge:RESult?

Queries the average mean time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:AVERAge](#) on page 476.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:MEAN:PHOLd:RESult?

Queries the maximum mean time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNCTION:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<MeanPower> Mean power of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNctIon:SUMMary:MEAN:RESult?

Queries the mean time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

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 141

Peak power

CALCulate<n>:MARKer<m>:FUNctIon:SUMMary:PPEak:AVERage:RESult?	480
CALCulate<n>:MARKer<m>:FUNctIon:SUMMary:PPEak:PHOLd:RESult?	481
CALCulate<n>:MARKer<m>:FUNctIon:SUMMary:PPEak:RESult?	481

CALCulate<n>:MARKer<m>:FUNctIon:SUMMary:PPEak:AVERage:RESult?

Queries the average positive peak time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNctIon:SUMMary:AVERage](#) on page 476.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

Suffix:<n> [Window](#)<m> [Marker](#)**Return values:**

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only**CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:PHOLd:RESult?**

Queries the maximum positive peak time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

Suffix:<n> [Window](#)<m> [Marker](#)**Return values:**

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only**CALCulate<n>:MARKer<m>:FUNction:SUMMary:PPEak:RESult?**

Queries the positive peak time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

Suffix:<n> [Window](#)<m> [Marker](#)**Return values:**

<PeakPower> Peak power of the signal during the measurement time.

Usage: Query only**Manual operation:** See "[Results](#)" on page 141

RMS power

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:AVERage:RESult?	482
CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:PHOLd:RESult?	482
CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:RESult?	482

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:AVERage:RESult?

Queries the average RMS of the time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:AVERage](#) on page 476.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n>	Window
<m>	Marker

Return values:

<RMSPower>	RMS power of the signal during the measurement time.
------------	--

Usage:	Query only
---------------	------------

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:PHOLd:RESult?

Queries the maximum RMS of the time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n>	Window
<m>	Marker

Return values:

<RMSPower>	RMS power of the signal during the measurement time.
------------	--

Usage:	Query only
---------------	------------

CALCulate<n>:MARKer<m>:FUNction:SUMMary:RMS:RESult?

Queries the RMS of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

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 141

Standard deviation

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:AVERage:RESult?	483
CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:PHOLd:RESult?	483
CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:RESult?	484

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:AVERage:RESult?

Queries the average standard deviation of the time domain power. The query is only possible if averaging has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:AVERage](#) on page 476.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNction:SUMMary:SDEViation:PHOLd:RESult?

Queries the maximum standard deviation of the time domain power. The query is only possible if the peak hold function has been activated previously using [CALCulate<n>:MARKer<m>:FUNction:SUMMary:PHOLd](#).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNctioN:SUMMary:SDEViation:RESult?

Queries the standard deviation of the time domain power.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<StandardDeviation> Standard deviation of the signal during the measurement time.

Usage: Query only

6.7.11 Harmonic distortion

- [Measurement selection](#)..... 484
- [Measurement configuration](#)..... 485
- [Measurement control](#)..... 486
- [Result retrieval](#)..... 486
- [Example: measuring the harmonic distortion](#)..... 487

6.7.11.1 Measurement selection

[CALCulate<n>:MARKer<m>:FUNctioN:HARMonics\[:STATe\]](#)..... 484

CALCulate<n>:MARKer<m>:FUNctioN:HARMonics[:STATe] <State>

Turns the harmonic distortion measurement on and off.

Note the following:

- If you perform the measurement in the frequency domain, the search range for the frequency of the first harmonic, whose power is determined, is defined by the last span.

- If you perform the measurement in the time domain, the current center frequency is used as the frequency of the first harmonic. Thus, the frequency search is bypassed. The first harmonic frequency is set by a specific center frequency in zero span before the harmonic measurement is started.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

Example:

CALC:MARK:FUNC:HARM ON

Activates the harmonic distortion measurement.

6.7.11.2 Measurement configuration

Commands to configure the measurement described elsewhere.

- CALCulate<n>:MARKer<m>:FUNCtion:CENTer
- [SENSe:] SWEep:TIME:AUTO

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO.....485

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics.....485

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:PRESet.....486

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:BANDwidth:AUTO <State>

Selects the resolution bandwidth of the harmonic in respect to the bandwidth of the first harmonic.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

identical

ON | 1

a multiple

*RST: 1

Manual operation: See "Harmonic RBW Auto" on page 147

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:NHARmonics <NoHarmonics>

Selects the number of harmonics that the R&S EPL1000 looks for.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<NoHarmonics> Range: 1 to 26

*RST: 10

Manual operation: See "[Number of Harmonics](#)" on page 147**CALCulate<n>:MARKer<m>:FUNctioN:HARMonics:PRESet**

Initiates a measurement to determine the ideal configuration for the harmonic distortion measurement.

The method depends on the span.

- Frequency domain (span > 0)
Frequency and level of the first harmonic are determined and used for the measurement list.
- Time domain (span = 0)
The level of the first harmonic is determined. The frequency remains unchanged.

Suffix:<n> [Window](#)<m> [Marker](#)**Manual operation:** See "[Adjust Settings](#)" on page 148**6.7.11.3 Measurement control**

Commands to perform the measurement described elsewhere.

- [INITiate<n>\[:IMMEDIATE\]](#)

6.7.11.4 Result retrieval

[CALCulate<n>:MARKer<m>:FUNctioN:HARMonics:DISToRTion?](#)..... 486

[CALCulate<n>:MARKer<m>:FUNctioN:HARMonics:LIST](#).....487

CALCulate<n>:MARKer<m>:FUNctioN:HARMonics:DISToRTion?

Queries the total harmonic distortion of the signal.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:<n> [Window](#)

<m> [Marker](#)

Query parameters:

<Result> TOTAL

Return values:

<DistortionPct>

<DistortionDb>

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:HARMonics:LIST

Queries the position of the harmonics.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<Harmonics> Returns one value for every harmonic.
 The first value is the absolute power of the first harmonic. The unit is variable.
 The other values are power levels relative to the first harmonic. The unit for these is dB.

6.7.11.5 Example: measuring the harmonic distortion

```
//-----Configuring the Measurement-----
*RST
//Resets the instrument.

INIT:CONT OFF
//Turns on single sweep mode.

CALC:MARK:FUNC:HARM ON
//Turns on the harmonic distortion measurement.
CALC:MARK:FUNC:HARM:NHAR 3
//Defines three harmonics to be found.

CALC:MARK:FUNC:HARM:BAND:AUTO OFF
//Turns off automatic bandwidth selection.
CALC:MARK:FUNC:HARM:PRES
//Determines the ideal configuration.
```

```
//-----Performing the Measurement-----

INIT;*WAI
//Initiates the measurement and finishes the sweep.

//-----Retrieving the Results-----
CALC:MARK:FUNC:HARM:LIST?
//Queries the position of the harmonics.
CALC:MARK:FUNC:HARM:DIST? TOT
//Queries the total harmonic distortion.
```

6.7.12 Third order intercept point (TOI)

- [Measurement configuration](#).....488
- [Programming example: measuring the TOI](#)..... 491

6.7.12.1 Measurement configuration

Commands to configure TOI measurements described elsewhere.

- [CALCulate<n>:DELTamarker<m>:X](#)
- [CALCulate<n>:DELTamarker<m>:X:RELative?](#)
- [CALCulate<n>:DELTamarker<m>:Y?](#)
- [CALCulate<n>:MARKer<m>:X](#)
- [CALCulate<n>:MARKer<m>:Y?](#)

CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?	488
CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MAXimum?	489
CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult:MINimum?	489
CALCulate<n>:MARKer<m>:FUNCTION:TOI:SEARChsignal ONCE	490
CALCulate<n>:MARKer<m>:FUNCTION:TOI[:STATE]	490

CALCulate<n>:MARKer<m>:FUNCTION:TOI:RESult?

Queries the results for the third order intercept point measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<TOI> Third order intercept point.

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:TOI ON
Switches the intercept measurement.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:TOI:RES?
Outputs the measured value.
```

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MAXimum?

Queries the results for the maximum third order intercept point measurement (see [Chapter 3.11.3, "TOI results"](#), on page 153).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<TOI> Maximum third order intercept point.

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:TOI ON
Switches the intercept measurement.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:TOI:RES:MAX?
Returns the maximum TOI.
```

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:TOI:RESult:MINimum?

Queries the results for the minimum third order intercept point measurement (see [Chapter 3.11.3, "TOI results"](#), on page 153).

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m>	Marker
Return values:	
<TOI>	Minimum third order intercept point.
Example:	<pre>INIT:CONT OFF Switches to single sweep mode. CALC:MARK:FUNC:TOI ON Switches the intercept measurement. INIT;*WAI Starts a sweep and waits for the end. CALC:MARK:FUNC:TOI:RES:MIN? Returns the minimum TOI.</pre>
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNction:TOI:SEARChsignal ONCE

This command initiates a search for signals in the current trace to determine the third intercept point.

Suffix:

<n>	irrelevant
<m>	irrelevant

Manual operation: See "[Search Signals](#)" on page 155

CALCulate<n>:MARKer<m>:FUNction:TOI[:STATe] <State>

Initiates a measurement to determine the third intercept point.

A two-tone signal with equal carrier levels is expected at the RF input of the instrument. Marker 1 and marker 2 (both normal markers) are set to the maximum of the two signals. Delta marker 3 and delta marker 4 are positioned to the intermodulation products. The delta markers can be modified separately afterwards with the [CALCulate<n>:DELTAmarker<m>:X](#) command.

The third-order intercept is calculated from the level spacing between the normal markers and the delta markers.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State>	ON OFF 1 0
*RST:	0

Example:

```
CALC:MARK:FUNC:TOI ON
Switches on the measurement of the third-order intercept.
```

6.7.12.2 Programming example: measuring the TOI

This example demonstrates how to determine the TOI in a remote environment.

```
//-----Configuring the measurement -----
*RST
//Reset the instrument
CALC:MARK:FUNC:TOI ON
//Activate TOI measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.

CALC:MARK:FUNC:TOI:SEAR ONCE
//Initiates a search for signals in the current trace.

//-----Retrieving Results-----
CALC:MARK:FUNC:TOI:RES?
//Returns the TOI.
```

6.7.13 AM modulation depth

- [Measurement configuration](#).....491
- [Example: measuring the AM modulation depth](#)..... 492

6.7.13.1 Measurement configuration

Commands to configure the measurement described elsewhere.

- [CALCulate<n>:DELTamarker<m>:X](#)
- [CALCulate<n>:DELTamarker<m>:X:RELative?](#)
- [CALCulate<n>:MARKer<m>:X](#)

CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult<t>?	491
CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:SEARchsignal ONCE	492
CALCulate<n>:MARKer<m>:FUNCTION:MDEPth[:STATE]	492

CALCulate<n>:MARKer<m>:FUNCTION:MDEPth:RESult<t>?

Queries the results of the AM modulation depth measurement..

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> Marker

<t> Trace

Return values:

<ModulationDepth> Modulation depth in %.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth:SEARChsignal ONCE

This command initiates a search for the signals required for the AM depth measurement.

Note that the command does not perform a new measurement, but looks for the signals on the current trace.

Suffix:

<n> Window

<m> Marker

Example:

CALC:MARK:FUNC:MDEP:SEAR ONCE

Executes the search of an AM modulated signal at the currently available trace.

Manual operation: See "[Search Signals](#)" on page 158

CALCulate<n>:MARKer<m>:FUNCtion:MDEPth[:STATe] <State>

Turns the AM Modulation Depth measurement on and off.

To work correctly, the measurement requires an AM modulated signal.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 1 | 0

*RST: 0

6.7.13.2 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:CEN 100MHz
//Set center frequency
FREQ:SPAN 10KHz
```

```

// Set span
CALC:MARK:FUNC:MDEP ON
//Activate AM modulation depth measurement.

//-----Performing the Measurement-----
INIT:CONT OFF
//Selects single sweep mode.
INIT:IMM
// Perform a single measurement
CALC:MARK:FUNC:MDEP:SEAR ONCE
//Initiates a search for signals in the current trace.

//-----Retrieving Results-----
CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results.

//If the results are not accurate, change the position of the
//the temporary markers manually.

//----Changing the position of the temp markers----
CALC:MARK:X 100MHZ
//Positions the reference marker on 100 MHz.
CALC:DELT2:X 5KHZ
//Positions delta marker 2 and 3 at a distance of 5 kHz to the reference marker.
CALC:DELT3:X 1KHZ
//Corrects the position of delta marker 3 by 1 kHz.

CALC:MARK:FUNC:MDEP:RES?
//Queries the measurement results for the repositioned markers.

```

6.7.14 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 EPL1000 aborts the list evaluation.

List evaluations allow for a different instrument setup for each frequency you want to measure. You can define most of the settings with the commands described here. Settings not covered by the commands listed below can be controlled with the common configuration commands (see [Chapter 6.8, "Configuration"](#), on page 515). Note that these commands have to be sent prior to the commands that control the list evaluation.

In case of a triggered measurement, a separate trigger event is required for each frequency to initiate that measurement. Note that you have to make changes to the trigger level in the time domain in order for it to take effect for the List Evaluation commands.



The list evaluation is incompatible to other measurement functions (e.g. marker functionality or statistics). If you use a command that controls those functions, the R&S EPL1000 aborts the list evaluation.

The R&S EPL1000 also aborts the list evaluation if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. This method causes the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

6.7.14.1 Performing list evaluations

All remote control commands specific to list evaluations (which are available via remote control only) are described here.

Remote commands exclusive to list evaluation

[SENSe:]LIST:POWer:RESult?.....	494
[SENSe:]LIST:POWer[:SEQuence].....	494
[SENSe:]LIST:POWer:SET.....	495
[SENSe:]LIST:POWer:STATe.....	496

[SENSe:]LIST:POWer:RESult?

Queries the results of the list evaluation.

May be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PowerLevel> Power level for each frequency included in the measurement.
 The command returns up to 3 power levels for each frequency, depending on the number of evaluation modes you have turned on with [SENSe:]LIST:POWer:SET.
 The result is a list of floating point values separated by commas.
 The unit depends on CALCulate<n>:UNIT:POWer.

Usage: Query only

[SENSe:]LIST:POWer[:SEQuence]

Configures and initiates the List Evaluation measurement.

The list can contain up to 200 entries (frequencies). You can define a different instrument setup for each frequency that is in the list.

If you synchronize the measurement with *OPC, the R&S EPL1000 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 measurement time for a list entry.
<MeasTime>	Defines the measurement time for a list entry. Range: 1 μ s to 16000 s Default unit: s
<TriggerLevel>	Reserved for future use; currently: must be 0.
<PowerLevel>	Default unit: PCT
Usage:	Asynchronous command

[SENSe:]LIST:POWer:SET <State>, <State>, <State>, <TriggerSource>, <TriggerSlope>, <TriggerOffset>, <GateLength>

Defines global List Evaluation parameters.

These parameters are valid for every frequency you want to measure.

The state of the first three parameters (<PeakPower>, <RMSPower> and <AVG-Power>) define the number of results for each frequency in the list.

Note that you have to set the trigger level *after* sending this command.

Parameters:

<State>	ON OFF 0 1 Turns peak power evaluation on and off. *RST: 1
<State>	ON OFF 0 1 Turns RMS power evaluation on and off. *RST: 0
<State>	ON OFF 0 1 Turns average power evaluation on and off. *RST: 0
<TriggerSource>	IMMEDIATE LINE EXTERNAL VIDEO IFPOWER RFPower EXT2 EXT3 EXT4 LXI EXTERNAL IMMEDIATE IFPOWER TIME Selects a trigger source.
<TriggerSlope>	POSITIVE NEGATIVE Selects the trigger slope.
<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 Default unit: s

[SENSe:]LIST:POWer:STATe <State>

Turns the List Evaluation off.

Parameters:

<State>	OFF 0 *RST: 0
---------	--------------------

6.7.14.2 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).
```

```
-----Initiliating the measurement and querying results simultaneously-----
```

```
LIST:POW?
```

```
935.2MHZ,0,10,OFF,NORM,1MHZ,3MHZ,440us,0,
```

```
935.4MHZ,0,10,10,CFIL,30KHZ,100KHZ,440us,0,
```

```
935.6MHZ,0,10,20,CFIL,30KHZ,100KHZ,440us,0
```

```
//Defines a list with 3 entries, initiates the measurement and queries the results.
```

```
//Result example:
```

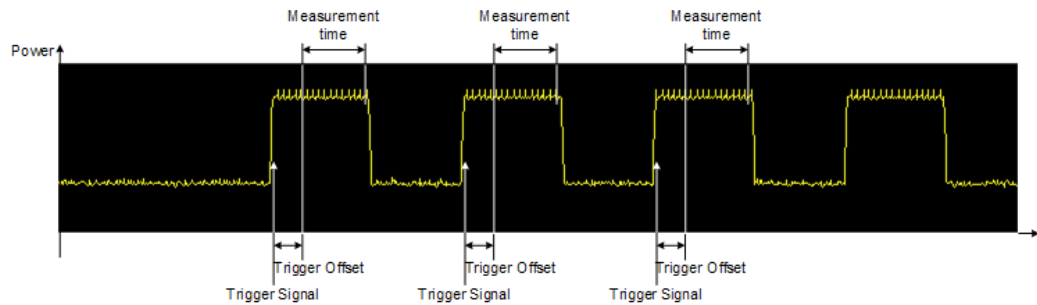
```
-28.3,-30.6,-38.1
```

6.7.15 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 EPL1000 aborts the Pulse Power measurement.

The R&S EPL1000 also aborts the Pulse Power measurement if you end the remote session.

The commands can be used in two different ways.

- Instrument setup, measurement and querying of the results in a single command line. With this method, there is the least delay between the measurement and the result output. However, it requires the control computer to wait for the response from the instrument.
- Instrument setup and querying of the result list at the end of the measurement: With this method, the control computer may be used for other activities while the measurement is being performed. However, more time is needed for synchronization via service request.

6.7.15.1 Performing pulse power measurements

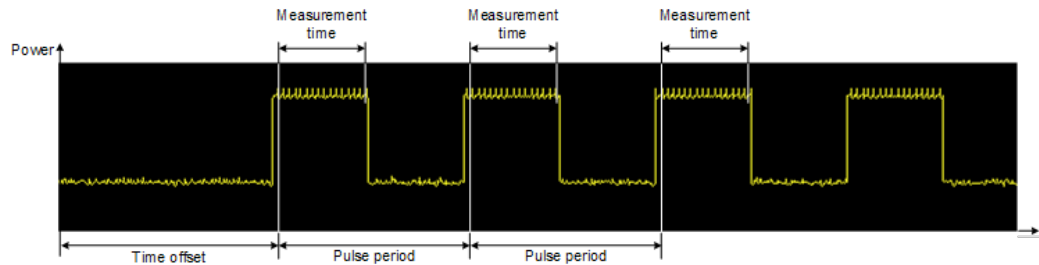
The following commands control pulse power measurements.

CALCulate<n>:MARKer<m>:FUNCTION:MSUMmary	498
[SENSe:]MPOWER:FTYPE	499
[SENSe:]MPOWER:RESult[:LIST]?	500
[SENSe:]MPOWER[:SEQUence]	500
[SENSe:]MPOWER:RESult:MIN?	501

CALCulate<n>:MARKer<m>:FUNCTION:MSUMmary <TimeOffset>, <MeasTime>, <PulsePeriod>, <OfPulses>

Configures power measurements on pulses in the time domain.

To evaluate the pulse power, the R&S EPL1000 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.

See also [INITiate<n>:CONTinuous](#) on page 393.

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.

Default unit: s

<OfPulses> Defines the number of pulses to measure.

Example:

CALC:MARK:FUNC:MSUM 50US,450US,576.9US,8

Evaluates data that contains 8 pulses during a measurement time of 450 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> **CFILter**
Channel filters
Available in the Spectrum application.

NORMAL

3 dB Gaussian filters

Available in the Spectrum application.

CISPr | PULSe

6 dB CISPR filter

Return value for query is always *PULS*.**MIL**

6 dB MIL standard filter

*RST: Depends on application

[SENSe:]MPOWer:RESult[:LIST]?

Queries the results of the pulse power measurement.

May be used to obtain measurement results in an asynchronous way, using the service request mechanism for synchronization to the end of the measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> List of pulse powers.
 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>, <NoPulses>

Configures and initiates the pulse power measurement.

The R&S EPL1000 caches all measurement parameters that you can set with this command. If you use the command repeatedly, the R&S EPL1000 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 EPL1000 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.
 Default unit: HZ

<MeasTime>	Defines the measurement time. Range: 1 μ s to 30 s Default unit: 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 EPL1000 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.
Usage:	Asynchronous command

[SENSe:]MPOWer:RESult:MIN?

Queries the lowest pulse power that has been measured during a pulse power measurement.

If there are no results, the command returns an error.

Return values:

<PulsePower> Lowest power level of the pulse power measurement.
The unit is dBm.

Usage: Query only

6.7.15.2 Example: performing a pulse power measurement

The following example shows a pulse power measurement.

```

-----Measurement with synchronization via service request-----
*ESE 1
*SRE 32
// Configures the status reporting system to produce a service request.
MPOW:FTYP NORM
//Selects a Gaussian filter for the measurement.
MPOW 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20;
*OPC
//Configures and initiates a measurement on 20 pulses with synchronization to the end.
//Analyzer produces a service request
//On service request:
MPOW:RES?
//Returns the results of the measurements (20 power levels).
MPOW:RES:MIN?
//Returns the lowest of the 20 power level that have been measured.

-----Initiliazing the measurement and querying results simultaneously-----
MPOW? 935.2MHZ,1MHZ,434us,VID,50,5us,MEAN,20
//Configures, initiates and queries the results of the measurement.
//Result example:
-105.225059509,-105.656074524,-105.423065186,-104.374649048,-103.059822083,-101.29511261,
-99.96534729,-99.7452468872,-99.6610794067,-100.327224731,-100.96686554,-101.450386047,
-102.150642395,-103.240142822,-105.95476532,-110.583129883,-115.7760849,-126.279388428,
-124.620399475,-116.97366333

```

6.7.16 EMI measurements

- [Measurement selection](#).....502
- [EMI marker configuration](#).....503
- [Final test configuration](#).....504
- [Limit line configuration](#).....505
- [LISN control](#).....505
- [Result retrieval](#).....507
- [Evaluating the results](#).....510

6.7.16.1 Measurement selection

[CALCulate<n>:MARKer<m>:FUNcTion:FMEasurement\[:STATe\]](#)..... 502

CALCulate<n>:MARKer<m>:FUNcTion:FMEasurement[:STATe] <State>

This command turns the EMI measurement marker functionality on and off.

Suffix:

<n>, <m> irrelevant

Parameters:

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

6.7.16.2 EMI marker configuration

Commands to configure EMI markers described elsewhere.

- `CALCulate<n>:MARKer<m>[:STATe]`
`CALCulate<n>:DELTamarker<m>[:STATe]`
- `CALCulate<n>:MARKer<m>[:STATe]`
`CALCulate<n>:DELTamarker<m>[:STATe]`
- `CALCulate<n>:DELTamarker<m>:MREference`
- `CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>`
`CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>`
`CALCulate<n>:DELTamarker<m>:LINK`
- `CALCulate<n>:MARKer<m>:TRACe`

<code>CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:DETECTOR</code>	503
<code>CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DETECTOR</code>	503

CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:DETECTOR <Detector>

Selects the detector for a specific deltamarker during the final evaluation.

If the deltamarker is not yet active, the command also turns the deltamarker on.

Suffix:

<n>	irrelevant
<m>	Marker

Parameters:

<Detector>	OFF no final measurement is performed
	AVER average detector
	CAV CISPR Average detector
	CRMS RMS Average detector
	POS maximum peak detector
	QPE quasipeak detector
	*RST: OFF

Manual operation: See "[Final Test Detector](#)" on page 171

CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:DETECTOR <Detector>

Selects the detector for a specific marker during the final measurement.

If the marker is not yet active, the command also turns the marker on.

Suffix:

<n> Window

<m> Marker

Parameters:

<Detector> **OFF**
no final measurement is performed

AVER
average detector

CAV
CISPR Average detector

CRMS
RMS Average detector

POS
maximum peak detector

QPE
quasipeak detector

*RST: OFF

Manual operation: See "Final Test Detector" on page 171

6.7.16.3 Final test configuration

Commands to configure final tests described elsewhere.

- [SENSe:]BANDwidth[:RESolution]:TYPE
- [SENSe:]BANDwidth[:RESolution]
- DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing

CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:PEAKsearch:AUTO..... 504
 CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:PSEArch:AUTO..... 504
 CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:DWELI..... 504

CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:PEAKsearch:AUTO
 <State>

CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:PSEArch:AUTO <State>

Suffix:

<n> 1..n

<m> 1..n

Parameters:

<State>

CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:DWELI <Time>

Defines the dwell time during the final measurement.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<Time> Range: 100 us to 100 s
 *RST: 1 s
 Default unit: s

Manual operation: See "Dwell Time" on page 174

6.7.16.4 Limit line configuration

The remote commands required to configure limit lines for EMI measurements are described in [Chapter 6.9.4, "Lines"](#), on page 643.

6.7.16.5 LISN control

INPut:LISN:FILTer:HPASs[:STATe].....	505
INPut:LISN:PHASe.....	505
INPut:LISN[:TYPE].....	506

INPut:LISN:FILTer:HPASs[:STATe] <State>

Turns the 150 kHz highpass filter for the ENV216 network on and off.

Prerequisites for this command

- Select ENV216 network (`INPut:LISN[:TYPE]`).

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on
 *RST: 0

Example: //Turn on high pass filter
 INP:LISN:TYPE ENV216
 INP:LISN:FILT:HPAS ON

Manual operation: See "150 kHz Highpass" on page 177

INPut:LISN:PHASe <Phase>

Selects one LISN phase to be measured.

The command is available in all applications (spectrum, receiver, I/Q analyzer and analog demodulator).

Parameters:

<Phase> L1

L2

Available for networks with four phases (R&S ESH2Z5, R&S ENV4200 and R&S ENV432)

L3

Available for networks with four phases (R&S ESH2Z5, R&S ENV4200 and R&S ENV432)

N

*RST: L1

Example: //Select phase L1
INP:LISN:PHAS L1

Manual operation: See "Phase" on page 177

INPut:LISN[:TYPE] <Type>

Turns automatic control of a LISN on and off. It also selects the type of network.

Parameters:

<Type>

ENV216

R&S ENV 216 / AMN6500: two phases and highpass are controllable.

ENV432

R&S ENV 432: four phases are controllable.

ENV4200

R&S ENV 4200: four phases are controllable.

ESH2Z5

R&S ESH2-Z5: four phases (incl. protective earth) are controllable.

ESH3Z5

R&S ESH3-Z5: two phases (incl. protective earth) are controllable.

FOURphase

R&S ESH2-Z5: four phases (incl. protective earth) are controllable.

OFF

Turns off remote control of the LISN.

TWOPhase

R&S ESH3-Z5: two phases (incl. protective earth) are controllable.

*RST: OFF

Example: //Select LISN
INP:LISN:TYPE TWOP

Manual operation: See "LISN Type" on page 177

6.7.16.6 Result retrieval

Commands to retrieve results described elsewhere.

- `CALCulate<n>:MARKer<m>:X`
`CALCulate<n>:DELTamarker<m>:X`
- `CALCulate<n>:MARKer<m>:Y?`
`CALCulate<n>:DELTamarker<m>:Y?`

<code>CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:RESult?</code>	507
<code>CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:RESult?</code>	507
<code>CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:LIMit:CONDition?</code>	508
<code>CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:LIMit:CONDition?</code>	508
<code>CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:LIMit:DELTA?</code>	509
<code>CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:LIMit:DELTA?</code>	509

`CALCulate<n>:DELTamarker<m>:FUNCTION:FMEasurement:RESult?` <Result>

Queries the result of the EMI measurement at the deltamarker position.

Suffix:

<n>	irrelevant
<m>	Marker

Return values:

<Result> Absolute power level measured during final EMI measurement.

Example:

`CALC:DELT3:FUNC:FME:RES?`
Queries the result of delta marker 3.

Usage:

Query only

`CALCulate<n>:MARKer<m>:FUNCTION:FMEasurement:RESult?` <Result>

Queries the result of the EMI measurement at the marker position.

Suffix:

<n>	Window
<m>	Marker

Return values:

<Result> Power level. The unit depends on the one you have currently set.

Example:

`CALC:MARK1:FUNC:FME:RES?`
Queries the result of marker 1.

Usage:

Query only

CALCulate<n>:DELTaMarker<m>:FUNcTion:FMEasurement:LIMit:CONDition?
 <Condition>

Queries the condition of a deltamarker position in relation to all active limit lines. The results are provided as a comma-separated list, with one value per marker for each active limit line.

Suffix:

<n> irrelevant

<m> [Marker](#)

 irrelevant

Return values:

<Condition> **0**
 The deltamarker has passed the limit check.

1
 The deltamarker is inside the margins of a limit line.

2
 The deltamarker has failed the limit check.

Example:

```
CALC:DELT2:FUNC:FME:LIM:COND?
```

Queries the condition of deltamarker 2 in relation to all active limit lines.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNcTion:FMEasurement:LIMit:CONDition?
 <Condition>

Queries the condition of a marker position in relation to all active limit lines. The results are provided as a comma-separated list, with one value per marker for each active limit line.

Suffix:<n> [Window](#)<m> [Marker](#)

 irrelevant

Return values:

<Condition> **0**
 The marker has passed the limit check.

1
 The marker is inside the margins of a limit line.

2
 The marker has failed the limit check.

Example:

```
CALC:MARK1:FUNC:FME:LIM:COND?
```

Queries the condition of marker 1 in relation to all active limit lines.

Usage: Query only

CALCulate<n>:DELTamarker<m>:FUNcTion:FMEasurement:LIMit:DELTA?

Queries the vertical distance from the deltamarker position to all active limit lines. The unit is dB.

The results are provided as a comma-separated list, with one value per marker for each active limit line.

If the deltamarker has been assigned to a different trace than the limit lines, or if no limit line is defined for the marker position, the command returns -200.

Suffix:

<n> irrelevant

<m> [Marker](#)

 irrelevant

Return values:

<Amplitude> Vertical distance to the limit line in dB.

Example:

CALC:DELT3:FUNC:FME:LIM:DELTA?

Queries the distance of deltamarker 3 to all active limit lines.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNcTion:FMEasurement:LIMit:DELTA? <Amplitude>

Queries the vertical distance from the marker position to the limit line. The unit is dB.

The results are provided as a comma-separated list, with one value per marker for each active limit line.

If the marker has been assigned to a different trace than the limit lines, or if no limit line is defined for the marker position, the command returns -200.

Suffix:

<n> [Window](#)

<m> [Marker](#)

 irrelevant

Return values:

<Amplitude> Vertical distance to the limit line in dB.

Example:

CALC:MARK3:FUNC:FME:LIM:DELTA?

Queries the distance of marker 3 to all active limit lines.

Usage: Query only

6.7.16.7 Evaluating the results

The commands required to control the demodulation of signals at the marker position are described in "[Marker demodulation](#)" on page 627.

6.7.17 Programming example: EMI measurement

This example demonstrates how to detect electromagnetic interferences (EMI) in a remote environment.

```
//----- Preparing the measurement -----
//Reset the instrument
*RST
//Define the span to be analyzed
FREQ:STAR 150kHz
FREQ:STOP 1GHz
//Configure two traces, one with peak detector, one with average detector
DISP:TRAC1 ON
DISP:TRAC2 ON
DET1 POS
DET2 AVER

//----- Configuring the measurement -----
//Select EMI measurement
CALC:MARK:FUNC:FME:STAT ON
//Configure CISPR filter and RBW
BAND:TYPE CISP
BAND:RES 1MHz
//Define the dwell time
CALC:MARK:FUNC:FME:DWEL 1ms
//Configure an auto peak search
CALC:MARK:FUNC:FME:PEAK:AUTO ON
//Configure a logarithmic frequency scaling
DISP:TRAC:X:SPAC LOG
//Configure marker demodulation for marker 1
CALC:MARK:FUNC:DEM ON
//Increase the number of sweep points
SWE:POIN 200000
//Set the unit to V
CALC:UNIT:POW V

//----- Configuring EMI markers -----
//Activate 6 normal EMI markers
CALC:MARK1 ON
CALC:MARK2 ON
CALC:MARK3 ON
CALC:MARK4 ON
CALC:MARK5 ON
```

```

CALC:MARK6 ON
//Set markers 1 to 3 on trace 1. Set markers 4 to 6 on trace 2.
CALC:MARK1:TRAC 1
CALC:MARK2:TRAC 1
CALC:MARK3:TRAC 1
CALC:MARK4:TRAC 2
CALC:MARK5:TRAC 2
CALC:MARK6:TRAC 2
//Use CISPR average detector for all markers during final test
CALC:MARK1:FUNC:FME:DET CAV
CALC:MARK2:FUNC:FME:DET CAV
CALC:MARK3:FUNC:FME:DET CAV
CALC:MARK4:FUNC:FME:DET CAV
CALC:MARK5:FUNC:FME:DET CAV
CALC:MARK6:FUNC:FME:DET CAV

//----- Configuring a limit check -----
//Select EN55011A.LIN as limit line 1
CALC:LIM1:NAME "EN55011A.LIN"
//Configure trace 1 to be checked against limit line 1
CALC:LIM1:TRAC1:CHEC ON
//Clear the results of all previous limit checks
CALC:LIM:CLE

//----- Performing the Measurement -----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//----- Retrieving Results -----
//Query the results for the EMI measurement
//First marker frequency, then final test level
CALC:MARK1:X?
CALC:MARK1:FUNC:FME:RES?
CALC:MARK2:X?
CALC:MARK2:FUNC:FME:RES?
CALC:MARK3:X?
CALC:MARK3:FUNC:FME:RES?
CALC:MARK4:X?
CALC:MARK4:FUNC:FME:RES?
CALC:MARK5:X?
CALC:MARK5:FUNC:FME:RES?
CALC:MARK6:X?
CALC:MARK6:FUNC:FME:RES?

//Query the result of the limit check for trace 1
CALC:LIM1:FAIL?
//Query the result of the limit check and the distance from the limit lines

```

```

//for each marker
CALC:MARK1:FUNC:FME:LIM:COND?
CALC:MARK1:FUNC:FME:LIM:DELT?
CALC:MARK2:FUNC:FME:LIM:COND?
CALC:MARK2:FUNC:FME:LIM:DELT?
CALC:MARK3:FUNC:FME:LIM:COND?
CALC:MARK3:FUNC:FME:LIM:DELT?
CALC:MARK4:FUNC:FME:LIM:COND?
CALC:MARK4:FUNC:FME:LIM:DELT?
CALC:MARK5:FUNC:FME:LIM:COND?
CALC:MARK5:FUNC:FME:LIM:DELT?
CALC:MARK6:FUNC:FME:LIM:COND?
CALC:MARK6:FUNC:FME:LIM:DELT?

```

6.7.18 Programming example: carrier-to-noise ratio

This programming example demonstrates how to perform a Carrier-to-noise measurement in a remote environment.

```

//-----Preparing the measurement-----
*RST
//Reset the instrument
FREQ: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.

```


6.7.19 Programming example: performing a basic frequency sweep

This example demonstrates how to configure and perform a basic frequency sweep measurement in a remote environment.

This example assumes a signal is measured at 100 MHz, with a maximum power level of -3 dBm.



Some commands in the following examples may not be necessary as they reflect the default settings; however, they are included to demonstrate the command usage.

```
//-----Preparing the measurement -----
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.

//-----Configuring the Frequency and Span-----
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 100MHz
//Sets the span to 50 MHz on either side of the center frequency.

//-----Configuring the Bandwidth-----
BAND:AUTO OFF
BAND 1MHz
//Defines the RBW as 1 MHz

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 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 5dB
//Sets the electronic attenuation to 5 dB.
//INP:ATT 0dB
//Sets the mechanical attenuation to 0 dB - makes a total of 5 dB attenuation
//otherwise:
INP:ATT 5 dB
```

```

//Sets the mechanical attenuation to 40 dB and couples the reference level
//to the attenuation instead of vice versa.

//-----Configuring the Amplitude and Scaling-----
DISP:TRAC1:Y:RLEV:OFFS 10dB
//Shifts the trace display in the diagram up by 10 dB.
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.

//-----Configuring the Trace-----
DISP:TRAC2:MODE AVER
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 75
//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 value per sweep point for each trace.
TRAC:DATA:X?
//Returns one frequency value per sweep point for each trace.

```

6.8 Configuration

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6.8.1 Inputs and output configuration

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6.8.1.1 Input source selection

`INPut<ip>:SElect`.....516

`INPut<ip>:SElect` <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S EPL1000.

Suffix:

<ip> 1 | 2
 irrelevant

Parameters:

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

6.8.1.2 RF input configuration

`INPut<ip>:ATTenuation:LIMiter[:STATe]`..... 516

`INPut:ATTenuation:PROTection:RESet`..... 516

`INPut<ip>:IMPedance`.....517

`INPut:UPORt:STATe`.....517

`INPut:UPORt[:VALue]`.....517

`INPut<ip>:ATTenuation:LIMiter[:STATe]` <State>

This command turns the pulse limiter on and off.

The pulse limiter is an additional protection mechanism for the second RF input that attenuates high level pulses.

Suffix:

<ip> irrelevant

Parameters:

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

Example:

```
//Turn on pulse limiter
INP:ATT:LIM ON
```

`INPut:ATTenuation:PROTection:RESet`

Resets the attenuator and reconnects the RF input with the input mixer for the R&S EPL1000 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 EPL1000 manual.

The command works only if the overload condition has been eliminated first.

For more information, see [Chapter 4.4.1.1, "Increasing measurement sensitivity \(or avoiding an input mixer overload\)"](#), on page 216.

Example: `INP:ATT:PROT:RES`

INPut<ip>:IMPedance <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

Suffix:

<ip> 1 | 2
 irrelevant

Parameters:

<Impedance> 50 | 75
 *RST: 50 Ω
 Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See "[Impedance](#)" on page 186

INPut:UPORt:STATe <State>

Toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S EPL1000.

See the R&S EPL1000 Getting Started manual for details.

Parameters:

<State> **ON | 1**
 User port is switched to INPut
 OFF | 0
 User port is switched to OUTPut
 *RST: 1

INPut:UPORt[:VALue]

Queries the control lines of the user ports.

For details see [OUTPut:UPORt\[:VALue\]](#) on page 521.

Return values:

<Level> bit values in hexadecimal format
 TTL type voltage levels (max. 5V)
 Range: #B00000000 to #B00111111

Example: `INP:UPOR?`
 //Result: #B00100100
 Pins 5 and 7 are active.

6.8.1.3 Preselector configuration

<code>INPut<ip>:PRESelection[:STATe]</code>	518
<code>INPut<ip>:PRESelection:BYPass</code>	518

`INPut<ip>:PRESelection[:STATe] <State>`

This command turns the preselector on and off.

The preselector is always on in the receiver application.

Suffix:

<ip> irrelevant

Parameters:

<State> ON | OFF | 1 | 0

*RST: Depends on application.

Example:

```
//Turn on preselector
INP:PREs ON
```

`INPut<ip>:PRESelection:BYPass <State>`

This command turns the preselector on and off.

It basically has the same effect as `INPut<ip>:PRESelection[:STATe]`.

Suffix:

<ip> irrelevant

Parameters:

<State> ON | 1

Turns off (bypasses) the preselector.

Unavailable in the receiver application.

OFF | 0

Turns on the preselector.

*RST: OFF

Example:

```
//Bypass preselector
INP:PREs:BYp ON
```

Manual operation: See "[Preselection filter](#)" on page 188

6.8.1.4 Output configuration (analog demodulation)

<code>OUTPut<ou>:IF:LPASs:FREQuency:MANual</code>	519
<code>OUTPut<ou>:IF:LPASs[:STATe]</code>	519
<code>OUTPut<ou>:IF:SCALEf:VALue</code>	520
<code>OUTPut<ou>:IF[:SOURce]</code>	520
<code>OUTPut:UPORt[:VALue]</code>	521
<code>OUTPut<up>:UPORt:STATe</code>	521
<code>[SENSe:]DEMod:SQUelch:LEVel</code>	521
<code>[SENSe:]DEMod:SQUelch:LEVel:ABSolute</code>	522

[SENSe:]DEMod:SQUelch[:STATe].....	522
SYSTem:SPEaker:MAXVolume.....	523
SYSTem:SPEaker:MUTE.....	523
SYSTem:SPEaker:VOLume.....	523

OUTPut<ou>:IF:LPASs:FREQuency:MANual <Frequency>

This command defines the cutoff frequency of the low pass filter available for signal output.

Available for the following output types:

- Video
- AM
- FM
- PM

This command is available after you have turned on the low pass filter with [OUTPut<ou>:IF:LPASs\[:STATe\]](#).

Suffix:

<ou> [Output](#)

Parameters:

<Frequency> Default unit: Hz

Example:

```
//Turn on low pass filter with a cutoff frequency of 100 kHz
OUTP:IF:LPAS ON
OUTP:IF:LPAS:FREQ:MAN 100KHZ
```

Manual operation: See "[Low Pass](#)" on page 190

OUTPut<ou>:IF:LPASs[:STATe] <State>

This command turns a low pass filter to control the output on and off.

Available for the following output types:

- Video
- AM
- FM
- PM

Suffix:

<ou> [Output](#)

Parameters:

<State> ON | OFF | 1 | 0

Example:

```
//Turn on low pass filter with a cutoff frequency of 100 kHz
OUTP:IF:LPAS ON
OUTP:IF:LPAS:FREQ:MAN 100KHZ
```

Manual operation: See "[Low Pass](#)" on page 190

OUTPut<ou>:IF:SCALe[:VALue] <Scale>

This command defines the scale of the transferred signal.

Available for the following output types:

- AM
- FM

Suffix:

<ou> [Output](#)

Parameters:

<Scale> Numeric value whose unit depends on the output type:

- % for AM output
- Hz for FM output

Example: //Select a scale of 100 kHz for FM output on output 1
 OUTP:IF:FM
 OUTP:IF:SCAL 100KHZ

Manual operation: See "[Scale](#)" on page 191

OUTPut<ou>:IF[:SOURce] <Type>

This command selects the type of signal data that is output.

Suffix:

<ou> [Output](#)

Parameters:

<Type>

AM
Outputs the AM signal.

FM
Outputs the FM signal.

FOCUS
Outputs the data of the currently selected measurement window.
Available for Analog Modulation Analysis.

IF
Outputs the IF signal.
Unavailable for audio output.

OFF
Turns off the output.

VIDeo
Outputs the video signal.
Unavailable for audio output.

Example: //Select output of AM signal data
 OUTP:IF:SOUR AM

Manual operation: See "[Selecting the output type](#)" on page 189

OUTPut:UPORt[:VALue] <Value>

Sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern.

If the user port is programmed to input instead of output (see [INPut:UPORt:STATe](#) on page 517), the output value is temporarily stored.

Parameters:

<Value> bit values in hexadecimal format
 TTL type voltage levels (max. 5V)
 Range: #B00000000 to #B00111111

Example:

OUTP:UPOR #B00100100
 Sets pins 5 and 7 to 5 V.

OUTPut<up>:UPORt:STATe <State>

Toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S EPL1000.

Suffix:

<up> irrelevant

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 User port is switched to INPut
ON | 1
 User port is switched to OUTPut

Example:

OUTP:UPOR:STAT ON

[SENSe:]DEMod:SQUelch:LEVel <Level>

This command defines the relative squelch level for audio output, below which the output is not demodulated.

To define an absolute squelch level, use [\[SENSe:\]DEMod:SQUelch:LEVel:ABSolute](#).

If you are using the "Marker Demodulation" marker function in the spectrum application, the command instead selects the level below which the signal at the marker position is not demodulated.

Parameters:

<Level> <numeric value>
 Default unit: PCT

Example:

```
//Configure squelch for audio output
DEM:SQU ON
DEM:SQU:LEV 10
```

Manual operation: See "Squelch" on page 190

[SENSe:]DEMod:SQUelch:LEVel:ABSolute <Level>

This command defines the absolute squelch level for audio output, below which the output is not demodulated.

To define a relative squelch level, use [SENSe:]DEMod:SQUelch:LEVel.

Parameters:

<Level> <numeric value>
 The unit depends on CALCulate<n>:UNIT:POWer.

Example:

```
//Configure squelch in dBmV for audio output
CALC:UNIT:POW DBMV
DEM:SQU ON
DEM:SQU:LEV:ABS 10
```

Manual operation: See "Squelch" on page 190

[SENSe:]DEMod:SQUelch[:STATe] <State>

This command turns a squelch for the audio output on and off.

The squelch is available for the following outputs.

- AM
- FM

If you are using the "Marker Demodulation" marker function in the spectrum application, the command instead turns selective demodulation at the marker position on and off. For selective demodulation, the R&S EPL1000 turns on a video trigger whose level corresponds to the squelch level. Therefore it turns off other triggers or gates.

In both cases, you can define the squelch level with [SENSe:]DEMod:SQUelch:LEVel.

Parameters:

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

Example:

```
//Configure squelch for audio output
DEM:SQU ON
DEM:SQU:LEV 10
```

Manual operation: See "Squelch" on page 190

SYSTem:SPEaker:MAXVolume <Volume>

This command defines the maximum volume level for audio output (for example over headphones).

Parameters:

<Volume> Numeric value between 0 and 1, with 1 being the loudest.

Example: //Define a maximum volume of 60 %
 SYST:SPE:MAXV 0.6

Manual operation: See "[Controlling the volume](#)" on page 191

SYSTem:SPEaker:MUTE

This command turns off audio output.

To turn the volume back on again, use [SYSTem:SPEaker:VOLume](#).

Example: //Turn off audio output
 SYST:SPE:MUTE
 //Turn audio output back on
 SYST:SPE:VOL 25

Usage: Event

Manual operation: See "[Controlling the volume](#)" on page 191

SYSTem:SPEaker:VOLume <Volume>

This command defines the volume with which audio signals are output.

Parameters:

<Volume> Numeric value between 0 and 1, with 1 being the loudest.
 Note that if you have defined a maximum volume level with
 [SYSTem:SPEaker:MAXVolume](#), the value range is limited by
 the maximum volume.

Example: //Define a volume of 25 %.
 SYST:SPE:VOL 0.25

Manual operation: See "[Controlling the volume](#)" on page 191

6.8.1.5 Additional output

Commands to configure additional output described elsewhere.

- [OUTPut<ou>:IF\[:SOURce\]](#)

[DIAGnostic:SERVice:NSource](#).....524

DIAGnostic:SERVice:NSOource <State>

Turns the 28 V supply of the BNC connector labeled [noise source control] on the R&S EPL1000 on and off.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on

Example: DIAG:SERV:NSO ON

Manual operation: See "Noise Source Control" on page 192

6.8.1.6 Generator configuration

[SENSe:]CORRection[:STATe].....	524
[SENSe:]CORRection:COLLect[:ACQuire].....	525
[SENSe:]CORRection:METhod.....	525
[SENSe:]CORRection:RECall.....	526
[SENSe:]CORRection:TRANsducer:GENERate.....	526
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue.....	526
OUTPut[:STATe].....	526
SOURce<si>:INTErnal:FREQUency.....	527
SOURce<si>:POWer[:LEVel][:IMMEdiate][:AMPLitude].....	527
SOURce<si>:POWer[:LEVel][:IMMEdiate]:OFFSet.....	527
SOURce<si>:FREQUency:COUPLing[:STATe].....	527
SOURce<si>:INTErnal:FREQUency:OFFSet.....	528
SOURce<si>:POWer:MODE.....	528
SOURce<si>:POWer:START.....	529
SOURce<si>:POWer:STOP.....	529

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

Turns correction of measurement results (normalization) on and off.

The command is available after you have created a reference trace for the selected measurement type with [SENSe:]CORRection:COLLect[:ACQuire] on page 525.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on
 *RST: 1

Example: CORR ON
 Activates normalization.

Manual operation: See "[Normalization state](#)" on page 203

[SENSe:]CORRection:COLLEct[:ACQuire] <MeasType>

Initiates a reference measurement (calibration). The reference measurement is the basis for the measurement normalization. The result depends on whether a reflection measurement or transmission measurement is performed (see [\[SENSe:\]CORRection:METhod](#) on page 525).

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.

Setting parameters:

<MeasType> THRough | OPEN

THRough

"TRANsmission" mode: calibration with direct connection between generator and device input

"REFLection" mode: calibration with short circuit at the input

OPEN

only allowed in "REFLection" mode: calibration with open input

Example: INIT:CONT OFF
 Selects single sweep operation
 CORR:METh TRAN
 Selects a transmission measurement.
 CORR:COLL THR;*WAI
 Starts the measurement of reference data using direct connection between generator and device input and waits for the sweep end.

Usage: Setting only

Manual operation: See "[Calibrate Reflection Short](#)" on page 203

[SENSe:]CORRection:METhod <Type>

Selects the type of measurement to be performed with the generator.

Parameters:

<Type>

REFLection

Selects reflection measurements.

TRANsmission

Selects transmission measurements.

*RST: TRANsmission

Example: CORR:METh TRAN
 Sets the type of measurement to "transmission".

Manual operation: See ["Calibrate Transmission"](#) on page 202

[SENSe:]CORRection:RECall

Restores the measurement configuration used for calibration.

Example: CORR:REC

Manual operation: See ["Recall Cal. Settings"](#) on page 204

[SENSe:]CORRection:TRANsducer:GENerate <Name>

Uses the normalized measurement data to generate a transducer factor with up to 1001 points. The trace data is converted to a transducer with unit dB and stored in a file with the specified name and the suffix .trd under

C:\ProgramData\Rohde-Schwarz\ZNL-FPL\trd. The frequency points are allocated in equidistant steps between start and stop frequency.

Parameters:

<Name> '<name>'

Example: CORR:TRAN:GEN 'MyGenerator'
Creates the transducer file
C:\r_s\instr\trd\MyGenerator.trd.

Manual operation: See ["Save as Trd Factor"](#) on page 204

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

Defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

Suffix:

<n> [Window](#)

<w> subwindow

<t> irrelevant

Parameters:

<Value> Default unit: DB

Example: DISP:TRAC:Y:RVAL 0
Sets the value assigned to the reference position to 0 Hz

Manual operation: See ["Reference Value"](#) on page 204

OUTPut[:STATe] <State>

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

*RST: 0

Example: OUP ON**Manual operation:** See "[Generator](#)" on page 188**SOURce<si>:INTernal:FREQUENCY** <Frequency>**Suffix:**

<si> irrelevant

Parameters:

<Frequency> Range: 5 kHz to 3 GHz
 Increment: 0.1 Hz
 *RST: 1 GHz
 Default unit: HZ

Example: SOUR:INT:FREQ 2 GHz**Manual operation:** See "[CW Frequency](#)" on page 201**SOURce<si>:POWer[:LEVel][:IMMEDIATE][:AMPLitude]** <Amplitude>**Suffix:**

<si> irrelevant

Example: SOUR:POW -30dBm**Manual operation:** See "[Level](#)" on page 201**SOURce<si>:POWer[:LEVel][:IMMEDIATE]:OFFSet** <Offset>**Suffix:**

<si> irrelevant

Parameters:

<Offset> Range: -200 dB to +200 dB
 *RST: 0dB
 Default unit: DB

Example: SOUR:POW:OFFS -10dB**Manual operation:** See "[Level Offset](#)" on page 201**SOURce<si>:FREQUENCY:COUPLing[:STATE]** <State>

Enables or disables the usage of the internal generator as a tracking generator. The tracking generator is only available for frequency sweeps in the Spectrum application.

Suffix:
<si> 1..n

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the tracking generator off
ON | 1
Switches the tracking generator on
*RST: 0

Example: SOUR:FREQ:COUP:STAT ON

SOURce<si>:INTernal:FREQuency:OFFSet <FreqOffset>

Defines an offset of the tracking generator signal to the analyzer frequency.

Suffix:
<si> 1..n

Parameters:
<FreqOffset> Default unit: HZ

Example: SOUR:INT:FREQ:OFFS 10kHz

Manual operation: See "[Frequency Offset](#)" on page 202

SOURce<si>:POWer:MODE <Mode>

Enables or disables a power sweep.

Suffix:
<si> irrelevant

Parameters:
<Mode> FIXed | SWEEp
FIXed
Fixed power level. Required for tracking generator.
SWEEp
Increasing power level. Required for power sweep.
*RST: FIXed

Example:
SOUR:POW:MODE:SWE
SOUR:POW:STAR -50
SOUR:POW:STOP -10

Manual operation: See "[Power Sweep](#)" on page 13

SOURce<si>:POWer:STARt <StartLevel>

Defines the start power level of the internal generator signal for power sweeps. This value must be lower than the stop level (see [SOURce<si>:POWer:STOP](#) on page 529).

Suffix:

<si> irrelevant

Parameters:

<StartLevel> Range: -60 to +10
*RST: -30
Default unit: DBM

Example:

```
SOUR:POW:MODE:SWE
SOUR:POW:STAR -50
SOUR:POW:STOP -10
```

Manual operation: See "[Level Start / Level Stop](#)" on page 205

SOURce<si>:POWer:STOP <StopLevel>

Defines the end power level of the internal generator signal for power sweeps. This value must be higher than the start level (see [SOURce<si>:POWer:STARt](#) on page 529).

Suffix:

<si> irrelevant

Parameters:

<StopLevel> Range: -60 to +10
*RST: -20
Default unit: DBM

Example:

```
SOUR:POW:MODE:SWE
SOUR:POW:STAR -50
SOUR:POW:STOP -10
```

Manual operation: See "[Level Start / Level Stop](#)" on page 205

6.8.1.7 Programming example for a tracking generator

The following example demonstrates how to work with a tracking generator in a remote environment. It requires the Tracking Generator option (R&S EPL1-B9) to be installed on the R&S EPL1000.

```
//-----Preparing the instrument -----

//Reset the instrument
*RST

//Set the frequency span.
SENS:FREQ:STAR 10HZ
```

```

SENS:FREQ:STOP 1MHZ

//-----Configuring the use of the internal generator -----
OUTP ON
SOUR:FREQ:COUP ON
//Set the generator output level to -10 dBm.
SOUR:POW -10DBM
//Define a frequency offset of 100kHz
SOUR:INT:FREQ:OFFS 100KHZ

//-----Performing the calibration measurement -----

//Perform a transmission measurement with direct connection between the generator
//and the analyzer and wait till the end
SENS:CORR:METH TRAN
SENS:CORR:COLL:ACQ THR; *WAI

//-----Retrieving the calibration trace results -----

//Retrieve the measured frequencies (10 Hz - 10 MHz)
TRAC:DATA:X? TRACE1

//Retrieve the measured power levels;
TRAC:DATA? TRACE1

//-----Normalizing the calibration trace results -----

//Retrieve the normalized power levels (= power offsets from calibration results)
//Should be 0 for all sweep points directly after calibration
SENS:CORR:STAT ON
TRAC:DATA? TRACE1

//-----Changing the display of the calibration results -----
//Shift the reference line so the -5 dB level is displayed in the center
DISP:TRAC:Y:SCAL:RVAL -5DB
DISP:TRAC:Y:SCAL:RPOS 50PCT

```

6.8.2 Frequency configuration

[SENSe:]FREQuency:CENTer.....	531
[SENSe:]FREQuency:CENTer:STEP.....	531
[SENSe:]FREQuency:CENTer:STEP:AUTO.....	532
[SENSe:]FREQuency:CENTer:STEP:LINK.....	532
[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor.....	532
[SENSe:]FREQuency:OFFSet.....	533
[SENSe:]FREQuency:SPAN.....	533
[SENSe:]FREQuency:SPAN:FULL.....	533
[SENSe:]FREQuency:START.....	533

[SENSe:]FREQUency:STOP.....	534
CALCulate<n>:MARKer<m>:FUNcTION:CENTer.....	534
CALCulate<n>:MARKer<m>:FUNcTION:CSTep.....	534
CALCulate<n>:MARKer<m>:FUNcTION:STRack[:STATe].....	534
CALCulate<n>:MARKer<m>:FUNcTION:STRack:BANDwidth.....	535
CALCulate<n>:MARKer<m>:FUNcTION:STRack:THReshold.....	535
CALCulate<n>:MARKer<m>:FUNcTION:STRack:TRACe.....	536
DEVIce:INFO:HWBand?.....	536

[SENSe:]FREQUency:CENTer <Frequency>

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.
```

Manual operation: See "PS Frequency" on page 205

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

Defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the SENS:FREQ UP AND SENS:FREQ DOWN commands, see [SENSe:]FREQUency:CENTer on page 531.

Parameters:

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

Range: 1 to f_{\max}

*RST: 0.1 x span

Default unit: Hz

Example:

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

Manual operation: See "Center Frequency Stepsize" on page 212

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

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

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Parameters:

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

Example:

```
FREQ:CENT:STEP:AUTO ON
Activates the coupling of the step size to the span.
```

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

Couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType> SPAN | RBW | OFF

SPAN

Couples the step size to the span. Available for measurements in the frequency domain.

RBW

Couples the step size to the resolution bandwidth. Available for measurements in the time domain.

OFF

Decouples the step size.

*RST: SPAN

Example:

```
//Couple step size to span
FREQ:CENT:STEP:LINK SPAN
```

Manual operation: See "[Center Frequency Stepsize](#)" on page 212

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

Defines a step size factor if the center frequency step size is coupled to the span or the resolution bandwidth.

Parameters:

<Factor> 1 to 100 PCT
*RST: 10
Default unit: PCT

Example:

```
//Couple frequency step size to span and define a step size factor
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 20PCT
```

Manual operation: See "[Center Frequency Stepsize](#)" on page 212

[SENSe:]FREQuency:OFFSet <Offset>

Defines a frequency offset.

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

See also "[Frequency Offset](#)" on page 213.

Parameters:

<Offset> Range: -1 THz to 1 THz
 *RST: 0 Hz
 Default unit: HZ

Example: `FREQ:OFFS 1GHZ`

Manual operation: See "[Frequency Offset](#)" on page 213

**[SENSe:]FREQuency:SPAN **

Defines the frequency span.

If you set a span of 0 Hz in the Spectrum application, the R&S EPL1000 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
 Default unit: HZ

Manual operation: See "[Zero Span](#)" on page 12

[SENSe:]FREQuency:SPAN:FULL

Restores the full span.

Manual operation: See "[Full Span](#)" on page 212

[SENSe:]FREQuency:STARt <Frequency>

Defines a start frequency for measurements in the frequency domain.

Parameters:

<Frequency> 0 to (fmax - min span)
 *RST: 0
 Default unit: HZ

Example: `FREQ:STAR 20MHz`

Manual operation: See ["Frequency Sweep"](#) on page 12

[SENSe:]FREQuency:STOP <Frequency>

Defines a stop frequency for measurements in the frequency domain.

Parameters:

<Frequency> min span to fmax
 *RST: fmax
 Default unit: HZ

Example: `FREQ:STOP 2000 MHz`

Manual operation: See ["Frequency Sweep"](#) on page 12

CALCulate<n>:MARKer<m>:FUNCTion:CENTer

Matches the center frequency to the frequency of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:

<n> [Window](#)
 <m> [Marker](#)

Example: `CALC:MARK2:FUNC:CENT`
 Sets the center frequency to the frequency of marker 2.

Manual operation: See ["Center Frequency = Marker Frequency"](#) on page 331

CALCulate<n>:MARKer<m>:FUNCTion:CSTep

Matches the center frequency step size to the current marker frequency.

The command turns delta markers into normal markers.

Suffix:

<n> [Window](#)
 <m> [Marker](#)

CALCulate<n>:MARKer<m>:FUNCTion:STRack[:STATe] <State>

Turns signal tracking on and off.

Suffix:

<n> irrelevant
 <m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

```
//Activate signal tracking to keep the center frequency on the signal peak
//After each sweep the maximum on trace 1 is searched within a range of 20MHz
//around the center frequency. It must have a minimum power of -90dBm.
CALC:MARK:FUNC:STR ON
CALC:MARK:FUNC:STR:BAND 20MHz
CALC:MARK:FUNC:STR:THR -90dBm
CALC:MARK:FUNC:STR:TRAC 1
```

Manual operation: See "[Signal Tracking](#)" on page 214**CALCulate<n>:MARKer<m>:FUNCtion:STRack:BANDwidth <Bandwidth>**

Defines the bandwidth around the center frequency that is included in the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<Bandwidth> Range: 10 Hz to Max span
 *RST: (= span/10 on activating the function)
 Default unit: Hz

Manual operation: See "[Signal Tracking](#)" on page 214**CALCulate<n>:MARKer<m>:FUNCtion:STRack:THReshold <Level>**

Defines the threshold level for the signal tracking process.

Note that you have to turn on signal tracking before you can use the command.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<Level> The unit depends on [CALCulate<n>:UNIT:POWER](#).
 Range: -130 dBm to 30 dBm
 *RST: -120 dBm
 Default unit: DBM

Manual operation: See "[Signal Tracking](#)" on page 214

CALCulate<n>:MARKer<m>:FUNCTION:STRack:TRACe <TraceNumber>

Selects the trace on which the largest signal is searched for.

Suffix:

<n> irrelevant
 <m> irrelevant

Parameters:

<TraceNumber> 1 to 6
 Range: 1 to 6
 *RST: 1

Manual operation: See "[Signal Tracking](#)" on page 214

DEVice:INFO:HWBand?

Queries the frequency bands used for measurement by the R&S EPL1000 hardware. The start frequency of each band is provided.

The bands are instrument-specific and depend on the currently defined RBW, VBW and YIG preselector state. The precise frequency bands are required to define correction data for the correct bands, in particular for frequency-drifting DUTs.

This query is only available in zero span mode.

Return values:

<StartFreq>

Example:

```
//Set to zero span mode
FREQ:SPAN 0
//Set RBW
BAND:RES 1000000
//Set VBW
BAND:VID 10000
//Activate YIG filter
INP:FILT:YIG ON
//Query used hardware bands
DEV:INFO:HWB?
//Result:
//0,500000000,450000000,1000000000,3000000000,4000000000,5200000000,...
```

The used bands for this instrument and measurement setup are:

0 Hz to 49999999 Hz
 50000000 Hz to 44999999
 450000000 Hz to 999999999
 1000000000 Hz to 2999999999
 3000000000 Hz to 3999999999
 4000000000 Hz to 5199999999
 5200000000 Hz to ...

Usage: Query only

6.8.3 Amplitude configuration

CALCulate<n>:MARKer<m>:FUNCtion:REFerence.....	537
CALCulate<n>:UNIT:POWER.....	537
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel.....	537
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet.....	538
INPut<ip>:ATTenuation[:VALue].....	538
INPut<ip>:ATTenuation:AUTO.....	539
INPut<ip>:ATTenuation:PROTection[:STATe].....	539
INPut<ip>:GAIN:STATe.....	539

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

Matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Example:

`CALC:MARK2:FUNC:REF`

Sets the reference level to the level of marker 2.

Manual operation: See "[Reference Level = Marker Level](#)" on page 331

CALCulate<n>:UNIT:POWER <Unit>

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 | DBM_mhz | DBM_hz | DBUa_mhz |
 DBUV_mhz | DBmV_mhz | DBpW_mhz

*RST: dBm

Example:

`CALC:UNIT:POW DBM`

Sets the power unit to dBm.

Manual operation: See "[Unit](#)" on page 221

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

Defines the reference level (for all traces in all windows).

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

Suffix:

<n>	irrelevant
<w>	subwindow Not supported by all applications
<t>	irrelevant

Parameters:

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

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

Manual operation: See "[Reference Level](#)" on page 221

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet
<Offset>

Defines a reference level offset (for all traces in all windows).

Suffix:

<n>	irrelevant
<w>	subwindow Not supported by all applications
<t>	irrelevant

Parameters:

<Offset>	Range: -200 dB to 200 dB *RST: 0dB Default unit: DB
----------	---

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "[Shifting the Display \(Offset\)](#)" on page 133

INPut<ip>:ATTenuation[:VALue] <Attenuation>

This command defines the attenuation at the RF input.

To protect the input mixer, attenuation levels of 10 dB or less are possible only if you have turned off the input protection with `INPut<ip>:ATTenuation:PROTection[:STATe]` on page 539.

Suffix:

<ip>	irrelevant
------	------------

Parameters:

<Attenuation> Range: 0 dB to 55 dB
 *RST: 10 dB
 Default unit: dB

Example:

```
//Define attenuation
INP:ATT 40dB
```

Manual operation: See "[Attenuation](#)" on page 223

INPut<ip>:ATTenuation:AUTO <State>

This command turns automatic determination of the attenuation level on and off.

When you turn it on, the R&S EPL1000 selects an attenuation that results in a good signal-to-noise ratio without overloading the RF input.

Suffix:

<ip> irrelevant

Parameters:

<State> ON | OFF
ON
 Selects automatic attenuation mode.
OFF
 Selects manual attenuation mode.
 *RST: ON

Example:

```
//Turn on auto ranging
INP:ATT:AUTO ON
```

Manual operation: See "[Attenuation](#)" on page 223

INPut<ip>:ATTenuation:PROTection[:STATe] <State>

This command turns the availability of attenuation levels of 10 dB or less on and off.

Suffix:

<ip> irrelevant

Parameters:

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

Example:

```
//Turn on input protection
INP:ATT:PROT ON
```

Manual operation: See "[10 dB Minimum Attenuation](#)" on page 222

INPut<ip>:GAIN:STATe <State>

This command turns the preamplifier on and off.

Suffix:	
<ip>	irrelevant
Parameters:	
<State>	ON OFF 1 0
	*RST: OFF
Example:	//Turn on preamplifier INP:GAIN:STAT ON
Manual operation:	See "Preamplifier" on page 223

6.8.4 Y-axis scaling

Commands to scale the y-axis described elsewhere.

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue`

<code>DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]</code>	540
<code>DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE</code>	540
<code>DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE</code>	541
<code>DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition</code>	541
<code>DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing</code>	542

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe] <Range>`

Defines the display range of the y-axis (for all traces).

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing`.

Suffix:	
<n>	Window
<w>	subwindow Not supported by all applications
<t>	irrelevant
Parameters:	
<Range>	Range: 1 dB to 200 dB *RST: 100 dB Default unit: HZ
Example:	<code>DISP:TRAC:Y 110dB</code>
Manual operation:	See "Range" on page 224

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE`

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

Suffix:	
<n>	Window

<t> irrelevant

Manual operation: See ["Auto Scale Once"](#) on page 224

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

Selects the type of scaling of the y-axis (for all traces).

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

Suffix:

<n> [Window](#)

<w> subwindow

<t> irrelevant

Parameters:

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

Example: DISP:TRAC:Y:MODE REL

Manual operation: See ["Scaling"](#) on page 224

**DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition
<Position>**

Defines the vertical position of the reference level on the display grid (for all traces).

The R&S EPL1000 adjusts the scaling of the y-axis accordingly.

Suffix:

<n> [Window](#)

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

<Position> 0 PCT corresponds to the lower display border, 100 percent corresponds to the upper display border.
*RST: frequency display: 90 PCT; time display: 50 PCT;
AF spectrum display (K7): 100 PCT;
Default unit: PCT

Example: DISP:TRAC:Y:RPOS 50PCT

Manual operation: See ["Reference Position"](#) on page 203

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

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

Suffix:

<n> [Window](#)
 <w> subwindow
 <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 %.

Manual operation: See "[Scaling](#)" on page 224

6.8.5 Bandwidth configuration

[SENSe:]BANDwidth[:RESolution]:AUTO	542
[SENSe:]BANDwidth[:RESolution]	543
[SENSe:]BANDwidth[:RESolution]:RATio	543
[SENSe:]BANDwidth[:RESolution]:TYPE	543
[SENSe:]BANDwidth[:RESolution][:VALue]	544
[SENSe:]BANDwidth:VIDeo	544
[SENSe:]BANDwidth:VIDeo:AUTO	544
[SENSe:]BANDwidth:VIDeo:RATio	544
[SENSe:]BANDwidth:VIDeo:TYPE	545

[SENSe:]BANDwidth[:RESolution]:AUTO <State>

Couples and decouples the resolution bandwidth to the span.

Parameters:

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

Example: BAND:AUTO OFF
 Switches off the coupling of the resolution bandwidth to the span.

Manual operation: See "[RBW](#)" on page 174

[SENSe:]BANDwidth[:RESolution] <Bandwidth>

Defines the resolution bandwidth and decouples the resolution bandwidth from the span.

For statistics measurements, this command defines the **demodulation** bandwidth.

Parameters:

<Bandwidth> refer to data sheet
 *RST: RBW: AUTO is set to ON; DBW: 3MHz
 Default unit: Hz

Example:

BAND 1 MHz
 Sets the resolution bandwidth to 1 MHz

Manual operation: See "[Analysis Bandwidth](#)" on page 129

[SENSe:]BANDwidth[:RESolution]:RATio <Ratio>

Defines the ratio between the resolution bandwidth (Hz) and the span (Hz).

Note that the ratio defined with this remote command (RBW/span) is reciprocal to that of the coupling ratio (span/RBW).

Parameters:

<Ratio> Range: 0.0001 to 1
 *RST: 0.01

Example:

BAND:RAT 0.1

Manual operation: See "[Span/RBW](#)" on page 234

[SENSe:]BANDwidth[:RESolution]:TYPE <FilterType>

This command selects the resolution filter type.

When you change the filter type, the command selects the next larger filter bandwidth if the same bandwidth is unavailable for that filter.

Parameters:

<FilterType> **CFILter**
 Channel filters
 Available in the spectrum application.
NORMal
 Gaussian filters
CISPr | PULSe
 CISPR (6 dB)
 Return value for query is always PULS.
MIL
 MIL Std (6 dB)
 *RST: NORMal

Example:

BAND:TYPE NORM

Example: See [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513.

Manual operation: See ["Filter Type"](#) on page 173

[SENSe:]BANDwidth[:RESolution][:VALue] <Bandwidth>

This command defines the measurement (or resolution) bandwidth.

The available bandwidths depend on the selected filter type.

A change of the resolution bandwidth automatically turns the coupling to the frequency off.

Parameters:

<Bandwidth> <numeric value>
 Refer to the datasheet for available bandwidths.
 Default unit: Hz

Example: //Select measurement bandwidth
 BAND 3MHZ

[SENSe:]BANDwidth:VIDeo <Bandwidth>

Defines the video bandwidth.

The command decouples the video bandwidth from the resolution bandwidths.

Parameters:

<Bandwidth> refer to data sheet
 *RST: AUTO is set to ON
 Default unit: HZ

Example: BAND:VID 10 kHz

Manual operation: See ["VBW"](#) on page 233

[SENSe:]BANDwidth:VIDeo:AUTO <State>

Couples and decouples the video bandwidth to the resolution bandwidth.

Parameters:

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

Example: BAND:VID:AUTO OFF

Manual operation: See ["VBW"](#) on page 233

[SENSe:]BANDwidth:VIDeo:RATio <Ratio>

Defines the coupling ratio of the video bandwidth to the resolution bandwidth (VBW/RBW).

Parameters:

<Ratio> Range: 0,001 to 1000
 *RST: 1

Example:

BAND:VID:RAT 3
 Sets the video bandwidth to 3*resolution bandwidth.

Manual operation: See "RBW/VBW" on page 234

[SENSe:]BANDwidth:VIDeo:TYPE <Mode>

Enables or disables the logarithmic amplifier in front of the video filter in the signal path.

Parameters:

<Mode> **LINEar**
 The logarithmic amplifier in front of the video filter is bypassed to process linear detector samples.

LOGarithmic
 The logarithmic amplifier in front of the video filter is enabled to process logarithmic detector samples.

 *RST: LOGarithmic

Example:

BAND:VID:TYPE LIN
 Logarithmic amplifier in front of the video filter is disabled.

Manual operation: See "VBW" on page 233

6.8.6 Sweep configuration

[SENSe:]AVERage<n>:COUNT.....	545
[SENSe:]AVERage<n>[:STATe<t>].....	546
[SENSe:]AVERage<n>:TYPE.....	546
[SENSe:]BANDwidth[:RESolution]:FFT.....	547
[SENSe:]SWEep:COUNT.....	547
[SENSe:]SWEep:DURation?.....	548
[SENSe:]SWEep:FFTSubspan?.....	548
[SENSe:]SWEep:OPTimize.....	548
[SENSe:]SWEep[:WINDow<n>]:POINTs.....	549
[SENSe:]SWEep:TIME.....	549
[SENSe:]SWEep:TIME:AUTO.....	550
[SENSe:]SWEep:TYPE.....	550
[SENSe:]SWEep:TYPE:USED.....	550

[SENSe:]AVERage<n>:COUNT <AverageCount>

Defines the number of sweeps that the application uses to average traces.

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

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

Suffix:

<n> irrelevant

Parameters:

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

Range: 0 to 200000

*RST: 0

Manual operation: See "Average Count" on page 293

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

Turns averaging for a particular trace in a particular window on and off.

Suffix:

<n> [Window](#)

<t> [Trace](#)

Parameters:

<State> ON | OFF | 1 | 0

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

Selects the trace averaging mode.

Suffix:

<n> 1..n
[Window](#)

Parameters:

<Mode>

LOGarithmic

The logarithmic power values are averaged.

LINear

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

POWER

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

Example:

AVER:TYPE LIN

Switches to linear average calculation.

Manual operation: See "Average Mode" on page 293

[SENSe:]BANDwidth[:RESolution]:FFT <FilterMode>

Defines the filter mode to be used for FFT filters by defining the subspan size. The subspan is the span which is covered by one FFT analysis.

Is only available when using the sweep type "FFT".

Parameters:

<FilterMode>

WIDE | AUTO | NARRow

AUTO

Automatically applies the sweep optimization mode that is best for the current measurement.

NARRow

Optimizes the sweep mode for a large dynamic range.

WIDE

Optimizes the sweep mode for high performance.

*RST: AUTO

Example:

BAND:TYPE FFT

Select FFT filter.

Example:

BAND:FFT NARR

Select narrow subspan for FFT filter.

[SENSe:]SWEep:COUNT <SweepCount>

Defines the number of sweeps that the application uses to average traces.

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

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

Parameters:

<SweepCount>

When you set a sweep count of 0 or 1, the R&S EPL1000 performs one single sweep in single sweep mode.

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

Range: 0 to 200000

*RST: 0

Example:

SWE:COUN 64

Sets the number of sweeps to 64.

INIT:CONT OFF

Switches to single sweep mode.

INIT;*WAI

Starts a sweep and waits for its end.

Manual operation: See "[Sweep/Average Count](#)" on page 235

[SENSe:]SWEep:DURation? <Time>

Provides an estimation of the total time required to capture the data and process it. This time span may be considerably longer than the actual sweep time (see [SENSe:]SWEep:TIME on page 549).

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

Manual operation: See "Sweep Time" on page 233

[SENSe:]SWEep:FFTSubspan?

Returns the number of FFT subspans required to cover the entire measurement range (read-only).

Only available in FFT sweep mode in the Spectrum application, and not for SEM, ACLR, or Spurious emissions measurements.

Return values:

<NoOfPartialSpans> integer

Usage: Query only

Manual operation: See "FFT Subspans" on page 237

[SENSe:]SWEep:OPTimize <Mode>

In FFT mode, several FFT analysis steps are required to cover the entire measurement span. The span which is covered by one FFT analysis step is called *subspan*. The subspan cannot be defined directly, but it can be optimized according to measurement requirements.

Table 6-4: Optimization parameters in FFT mode

Optimization mode	Description
DYNamic	Optimizes the dynamic range by using the narrowest possible subspan (depending on the RBW).
SPEed	Optimizes the sweep rate by using the widest possible subspan (depending on the RBW). It is recommended that you set the Sweep Time to "Auto" to optimize the sweep rate.
AUTO	Uses a medium-sized subspan to obtain a compromise between a large dynamic range and a fast sweep rate.

Zero span mode

For zero span measurements, the optimization mode defines the selection of the A/D converter prefilter.

Table 6-5: 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 236

[SENSe:]SWEep[:WINDow<n>]: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.

Suffix:

<n>

Parameters:

<SweepPoints> Range: 101 to 100001
*RST: 1001

Example:

SWE:POIN 251

Manual operation: See "[Sweep Points](#)" on page 235

[SENSe:]SWEep:TIME <Time>

Defines the sweep time. It automatically decouples the time from any other settings.

In the Spectrum application, the command decouples the sweep time from the span and resolution and video bandwidths. Note that this command queries only the time required to capture the data, not to process it. To obtain an estimation of the total capture and processing time, use the [\[SENSe:\]SWEep:DURation?](#) command.

Parameters:

<Time> refer to data sheet
*RST: depends on current settings (determined automatically)
Default unit: S

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

[SENSe:]SWEep:TIME:AUTO <State>

Couples and decouples the sweep time to the span and the resolution and video bandwidths.

Parameters:

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

Example:

SWE:TIME:AUTO ON
Activates automatic sweep time.

Manual operation: See "[Harmonic Sweep Time](#)" on page 147

[SENSe:]SWEep:TYPE <Type>

Selects the sweep type.

The R&S EPL1000 automatically sets the optimal sweep type for the current measurement (sweep or FFT). The sweep type cannot be defined manually, except for EMI measurements. For measurements other than EMI, the sweep type is set to "Auto" automatically.

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 236

[SENSe:]SWEep:TYPE:USED

Queries the sweep type if you have turned on automatic selection of the sweep type.

Return values:

<Type> **SWE**
Normal sweep
FFT
FFT mode

6.8.7 Trigger configuration

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6.8.7.1 Trigger conditions

TRIGger[:SEQuence]:DTIME.....	551
TRIGger<tp>[:SEQuence]:HOLDoff[:TIME].....	551
TRIGger[:SEQuence]:IFPower:HOLDoff.....	552
TRIGger[:SEQuence]:IFPower:HYSTeresis.....	552
TRIGger[:SEQuence]:LEVel:IFPower.....	552
TRIGger[:SEQuence]:LEVel:VIDeo.....	553
TRIGger<tp>[:SEQuence]:SLOPe.....	553
TRIGger<tp>[:SEQuence]:SOURce.....	553
TRIGger[:SEQuence]:TIME:RINTerval.....	554

TRIGger[:SEQuence]:DTIME <DropoutTime>

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

Parameters:

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

Manual operation: See "[Drop-Out Time](#)" on page 245

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

Defines the time offset between the trigger event and the start of the sweep (data capturing).

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay affect the trigger offset as well.

Suffix:

<tp> irrelevant

Parameters:

<Offset> Range for measurements in the frequency domain:
 0 s to 10 s
 Range for measurements in the time domain:
 negative sweep time to 10 s
 *RST: 0 s
 Default unit: s

Example:

```
//Define a trigger offset
TRIG:HOLD 500us
```

Manual operation: See "[Trigger Offset](#)" on page 245

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

Defines the holding time before the next trigger event.

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

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S EPL1000 ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:

<Period> Range: 0 s to 10 s
 *RST: 0 s
 Default unit: S

Example:

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

Manual operation: See "[Trigger Holdoff](#)" on page 246

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

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
 *RST: 3 dB
 Default unit: DB

Example:

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

Manual operation: See "[Hysteresis](#)" on page 246

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

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths,
 see the data sheet.
 *RST: -20 dBm
 Default unit: DBM

Example:

```
TRIG:LEV:IFP -30DBM
```


Manual operation: See ["Trigger Level"](#) on page 245

TRIGger[:SEquence]:LEVel:VIDeo <Level>

Defines the level the video signal must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:

<Level> Range: 0 PCT to 100 PCT
 *RST: 50 PCT
 Default unit: PCT

Example: TRIG:LEV:VID 50PCT

TRIGger<tp>[:SEquence]:SLOPe <Type>

Selects the trigger slope.

Suffix:

<tp> irrelevant

Parameters:

<Type> **POSitive**
 Triggers when the signal rises to the trigger level (rising edge).
 NEGative
 Triggers when the signal drops to the trigger level (falling edge).
 *RST: POSitive

Example: //Select trigger slope
 TRIG:SLOP NEG

Manual operation: See ["Slope"](#) on page 246

TRIGger<tp>[:SEquence]:SOURce <Source>

Selects the trigger source.

Using a trigger or gated measurements in the Spectrum application turns the squelch off (see [\[SENSe:\]DEMod:SQUelch\[:STATE\]](#) on page 522).

Note on external triggers:

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

Suffix:

<tp> irrelevant

Parameters:

<Source> See table below.
 *RST: IMMEDIATE

Example: //Select external trigger input as source of the trigger signal
TRIG:SOUR EXT

Manual operation: See ["Trigger Source"](#) on page 243

Table 6-6: Available trigger sources

SCPI parameter	Trigger source
EXTernal	Trigger signal from the [Trigger Input] connector.
IFPower	Second intermediate frequency.
IMMediate	Free Run trigger.
TIME	Time interval
VIDeo	Trigger source is the video signal.

TRIGger[:SEquence]:TIME:RINTerval <Interval>

Defines the repetition interval for the time trigger.

Parameters:

<Interval> numeric value
 Range: 2 ms to 5000 s
 *RST: 1.0 s
 Default unit: S

Example: TRIG:SOUR TIME
 Selects the time trigger input for triggering.
 TRIG:TIME:RINT 5
 The sweep starts every 5 s.

Manual operation: See ["Repetition Interval"](#) on page 245

6.8.7.2 Gated measurements

[SENSe:]SWEep:EGATe.....	554
[SENSe:]SWEep:EGATe:HOLDoff.....	555
[SENSe:]SWEep:EGATe:LENGth.....	555
[SENSe:]SWEep:EGATe:POLarity.....	556
[SENSe:]SWEep:EGATe:SOURce.....	556
[SENSe:]SWEep:EGATe:TYPE.....	556

[SENSe:]SWEep:EGATe <State>

Turns gated measurements on and off.

The measurement ends when a particular number of measurement points has been recorded.

(See [SENSe:]SWEep[:WINDow<n>]:POINTs on page 549).

Performing gated measurements turns the squelch off.

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example:

SWE:EGAT ON
 Switches on the gate mode.
 SWE:EGAT:TYPE EDGE
 Switches on the edge-triggered mode.
 SWE:EGAT:HOLD 100US
 Sets the gate delay to 100 µs.
 SWE:EGAT:LEN 500US
 Sets the gate opening time to 500 µs.
 INIT;*WAI
 Starts a sweep and waits for its end.

Manual operation: See "[Gated Trigger](#)" on page 130

[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>

Defines the delay time between the gate signal and the continuation of the measurement.

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S EPL1000 ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q mode measurements.

Parameters:

<DelayTime> Range: 0 s to 30 s
 *RST: 0 s
 Default unit: S

Example: SWE:EGAT:HOLD 100us

Manual operation: See "[Gate Delay](#)" on page 251

[SENSe:]SWEep:EGATe:LENGth <GateLength>

Defines the gate length.

Parameters:

<GateLength> Range: 125 ns to 30 s
 *RST: 400µs
 Default unit: S

Example: SWE:EGAT:LENG 10ms

Manual operation: See "[Gate Length](#)" on page 251

[SENSe:]SWEep:EGATe:POLarity <Polarity>

Selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

Parameters:

<Polarity> POSitive | NEGative
*RST: POSitive

Example: SWE:EGAT:POL POS

Manual operation: See "[Slope](#)" on page 246

[SENSe:]SWEep:EGATe:SOURce <Source>

Selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information see "[Trigger Source](#)" on page 243.

Parameters:

<Source> EXTernal | IFPower | TIME
*RST: IFPower

Example: SWE:EGAT:SOUR IFP
Switches the gate source to IF power.

Manual operation: See "[Trigger Source](#)" on page 243

[SENSe:]SWEep:EGATe:TYPE <Type>

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 EPL1000 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 250

6.8.8 Automatic configuration

[SENSe:]ADJust:ALL.....	557
[SENSe:]ADJust:CONFigure:LEVel:DURation.....	557
[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE.....	558
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer.....	558
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer.....	558
[SENSe:]ADJust:CONFigure:TRIGger.....	559
[SENSe:]ADJust:FREQUency.....	559
[SENSe:]ADJust:LEVel.....	560

[SENSe:]ADJust:ALL

Initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Reference level

Example: ADJ:ALL

Manual operation: See ["Adjusting all Determinable Settings Automatically \(Auto All\)"](#) on page 252

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

To determine the ideal reference level, the R&S EPL1000 performs a measurement on the current input data. This command defines the length of the measurement if [\[SENSe:\]ADJust:CONFigure:LEVel:DURation:MODE](#) is set to `MANual`.

Parameters:

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

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

Manual operation: See ["Changing the Automatic Measurement Time \(Meas Time Manual\)"](#) on page 253

[SENSe:]ADJJust:CONFigure:LEVel:DURation:MODE <Mode>

To determine the ideal reference level, the R&S EPL1000 performs a measurement on the current input data. This command selects the way the R&S EPL1000 determines the length of the measurement .

Parameters:

<Mode>

AUTO

The R&S EPL1000 determines the measurement length automatically according to the current input data.

MANual

The R&S EPL1000 uses the measurement length defined by [\[SENSe:\]ADJJust:CONFigure:LEVel:DURation](#) on page 557.

*RST: AUTO

Manual operation: See "[Resetting the Automatic Measurement Time \(Meas Time Auto\)](#)" on page 253

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

When the reference level is adjusted automatically using the [\[SENSe:\]ADJJust:LEVel](#) on page 560 command, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>

Range: 0 dB to 200 dB

*RST: +1 dB

Default unit: dB

Example:

SENS:ADJ:CONF:HYST:LOW 2

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

Manual operation: See "[Lower Level Hysteresis](#)" on page 254

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

When the reference level is adjusted automatically using the [\[SENSe:\]ADJJust:LEVel](#) on page 560 command, the internal attenuators and the preamplifier are also adjusted. To avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold> Range: 0 dB to 200 dB
 *RST: +1 dB
 Default unit: dB

Example: SENS:ADJ:CONF:HYST:UPP 2

Example: For an input signal level of currently 20 dBm, the reference level is only adjusted when the signal level rises above 22 dBm.

Manual operation: See "[Upper Level Hysteresis](#)" on page 254

[SENSe:]ADJust:CONFigure:TRIGger <State>

Defines the behavior of a triggered measurement when adjusting a setting automatically (using SENS:ADJ:LEV ON, for example).

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 (default:) The measurement for adjustment waits for the next trigger.
 ON | 1
 The measurement for adjustment is performed without waiting for a trigger (corresponds to "Continue" in manual operation).
 *RST: 0

Example: //Use default ref level at 0.00 dBm.
 //Define an RF power trigger at -20 dBm
 :TRIG:SEQ:SOUR RFP
 :TRIG:SEQ:LEV:RFP -20
 //Perform adjustment measurement without waiting for trigger
 SENS:ADJ:CONF:TRIG ON
 //Perform auto level adjustment
 :SENS:ADJ:LEV;*WAI

[SENSe:]ADJust:FREQuency

Sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: ADJ:FREQ

Manual operation: See "[Adjusting the Center Frequency Automatically \(Auto Frequency\)](#)" on page 253

[SENSe:]ADJust:LEVel

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. Thus, the settings of the RF attenuation and the reference level are optimized for the signal level. The R&S EPL1000 is not overloaded and the dynamic range is not limited by an S/N ratio that is too small.

Example: ADJ:LEV

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 222

6.9 Analysis

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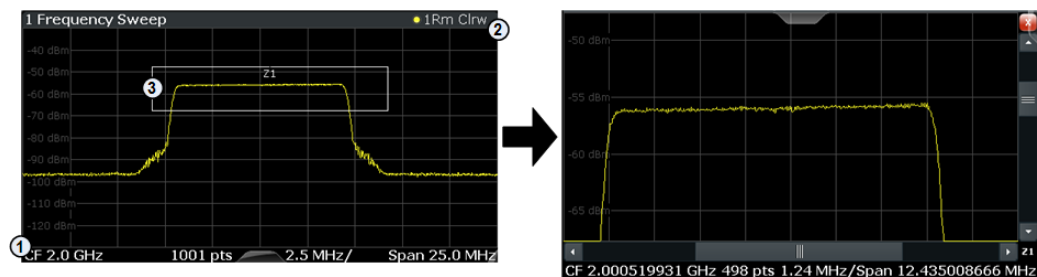
6.9.1 Zoom

- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:ZOOM:AREA](#)..... 560
- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:ZOOM:MULTiple<zn>:AREA](#).....561
- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:ZOOM:MULTiple<zn>\[:STATE\]](#)..... 562
- [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:ZOOM\[:STATE\]](#)..... 563

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

Defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



- 1 = origin of coordinate system (x1 = 0, y1 = 0)
- 2 = end point of system (x2 = 100, y2= 100)
- 3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:
<n> [Window](#)

<w> subwindow
Not supported by all applications

Parameters:

<x1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT

<y1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT

<x2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT

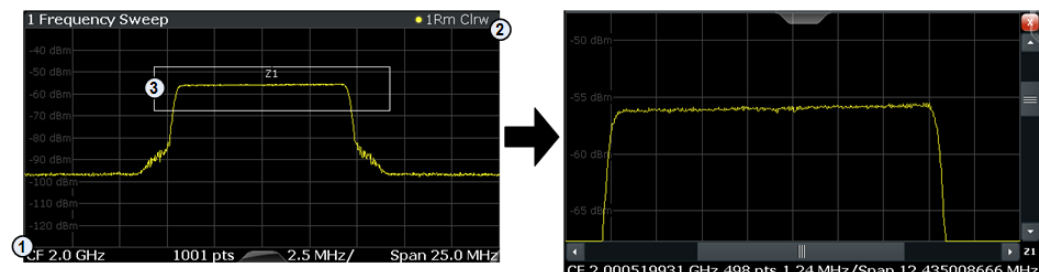
<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT

Manual operation: See "Single Zoom" on page 264

DISPlay[:WINDow<n>][:SUBWIndow<w>]:ZOOM:MULTiple<zn>:AREA
<x1>,<y1>,<x2>,<y2>

Defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



- 1 = origin of coordinate system (x1 = 0, y1 = 0)
- 2 = end point of system (x2 = 100, y2= 100)
- 3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

- <n> [Window](#)
- <w> subwindow
Not supported by all applications
- <zn> Selects the zoom window.

Parameters:

- <x1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT
- <y1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT
- <x2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.
Range: 0 to 100
Default unit: PCT
- <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 "[Multi-Zoom](#)" on page 264

DISPlay[:WINDow<n>][:SUBWIndow<w>]:ZOOM:MULTiple<zn>[:STATe] <State>

Turns the multiple zoom on and off.

Suffix:

- <n> [Window](#)
- <w> subwindow
Not supported by all applications

<zn> 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 | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Manual operation: See "[Multi-Zoom](#)" on page 264

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe] <State>

Turns the zoom on and off.

Suffix:

<n> [Window](#)
<w> subwindow
Not supported by all applications

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example:

DISP:ZOOM ON
Activates the zoom mode.

Manual operation: See "[Single Zoom](#)" on page 264

6.9.2 Trace configuration

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6.9.2.1 Trace data retrieval

MMEMory:STORe<n>:TRACe.....	564
TRACe<n>[:DATA].....	564
TRACe<n>[:DATA]:MEMory?.....	566
TRACe<n>[:DATA]:X?.....	566

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

Exports trace data from the specified window to an ASCII file.

For details on the file format, see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312.

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 574).

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1, 'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file TEST.ASC.

Manual operation: See ["Export Trace to ASCII File"](#) on page 296

TRACe<n>[:DATA] <Trace>, <Data>

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

This command queries current trace data and measurement results.

In the Spectrum application only, you can use it as a setting command to transfer trace data from an external source to the R&S EPL1000.

The data format depends on [FORMat\[:DATA\]](#) on page 572.

Suffix:

<n> [Window](#)

Parameters:

<Trace> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
Selects the trace to write the data to (Spectrum application only).

<Data> Contains the data to transfer (Spectrum application only).

Query parameters:

<ResultType> Selects the type of result to be returned. See [Table 6-7](#).
Note that not all result types are available for all applications.
See the application-specific documentation for details.

- Example:** (Spectrum application only):
`TRAC TRACE1,-30,-20,-10`
 Transfers trace data (-30,-20,-10) to trace 1.
- Example:** `TRAC? TRACE3`
 Queries the data of trace 3.
- Example:** See [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513.
- Example:** See [Chapter 6.7.7.10, "Example: SEM measurement"](#), on page 450.
- Manual operation:** See ["List Evaluation State \(result summary\)"](#) on page 97

Table 6-7: Return values for result type parameters

Parameter	Result display / measurement	Results
TRACE1 ... TRACE6		Returns the trace data for the corresponding trace. The trace data consists of a list of measured power levels. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the configured unit. For the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.) For SEM or Spurious Emission measurement results, query the x-values as well, as they are not equidistant (see TRACe<n>[:DATA]:X? on page 566).
LIST	SEM measurements	Peak list evaluation, one peak per range is returned.
	Spurious emission measurements	Peak list evaluation; The number of peaks returned for each measurement range is defined by the "Peaks per Range" parameter (see CALCulate<n>:PEAKsearch:SUBRanges on page 463), regardless of the "Details" setting. For each peak, the command returns 11 values in the following order: <ul style="list-style-type: none"> • <No>: range number • <StartFreq>,<StopFreq>: start and stop frequency of the range • <RBW>: resolution bandwidth • <PeakFreq>: frequency of the peak in a range • <PowerAbs>: absolute power of the peak in dBm • <PowerRel>: power of the peak in relation to the channel power in dBc • <PowerDelta>: distance from the peak to the limit line in dB, positive values indicate a failed limit check • <LimitCheck>: state of the limit check (0 = PASS, 1 = FAIL) • <Unused1>,<Unused2>: reserved (0.0)
SPURious		Peak list evaluation of Spurious Emission measurements.
SPECTrogram SGRam		For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the configured unit. Only REAL, 32 format is supported.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

Queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command returns the same results as `TRAC:DATA? TRACE1`.

For details on the returned values see the `TRAC:DATA? <TRACE...>` command.

Suffix:

<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.

Return values:

<SweepPointValues>

Example:

`TRAC:DATA:MEM? TRACE1,25,100`

Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage:

Query only

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

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

Suffix:

<n> [Window](#)

Query parameters:

<TraceNumber> Trace number.

TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

Return values:

<X-Values>

Example:

`TRAC3:X? TRACE1`

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

Usage:

Query only

6.9.2.2 Trace settings

[SENSe:][WINDow<n>:]DETEctor<t>[:FUNcTion]:AUTO.....	567
[SENSe:][WINDow<n>:]DETEctor<t>[:FUNcTion].....	567
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture.....	568
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE.....	568
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous.....	569
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe].....	570
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe].....	570
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing.....	571

[SENSe:][WINDow<n>:]DETEctor<t>[:FUNcTion]:AUTO <State>

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 292

[SENSe:][WINDow<n>:]DETEctor<t>[:FUNcTion] <Detector>

Defines the trace detector to be used for trace analysis.

For details see [Chapter 5.3.1.1, "Mapping samples to sweep points with the trace detector"](#), on page 269.

Suffix:

<n> Window

<t> Trace

Parameters:

<Detector> **APEak**
 Autopeak
NEGative
 Negative peak
POSitive
 Positive peak
QPEak
 Quasipeak (CISPR filter only)
SAMPIe
 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 292

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture
<Aperture>

Defines the degree (aperture) of the trace smoothing, if `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]TRUE`.

Suffix:<n> [Window](#)

<w> subwindow

<t> [Trace](#)**Parameters:**

<Aperture> Range: 1 to 50
*RST: 2
Default unit: PCT

Example: DISP3:TRAC2:SMO:APER 5
Defines an aperture of 5% for trace 2 in window 3

Manual operation: See "[Smoothing](#)" on page 292

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

Selects the trace mode. If necessary, the selected trace is also activated.

For max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNT`. Note that synchronization to the end of the measurement is possible only in single sweep mode.

Suffix:<n> [Window](#)

<w> subwindow
Not supported by all applications

<t>

[Trace](#)**Parameters:**

<Mode>

WRITe

(default:) Overwrite mode: the trace is overwritten by each sweep.

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 EPL1000 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 EPL1000 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 291

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous
<State>

Turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Suffix:

<n>

[Window](#)

<w>

subwindow

<t> [Trace](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: DISP:WIND:TRAC3:MODE:HCON ON
 Switches off the reset function.

Manual operation: See "[Hold](#)" on page 292

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

Turns trace smoothing for a particular trace on and off.

If enabled, the trace is smoothed by the value specified using [DISPlay\[:WINDow<n>\]\[:SUBWindow<w>\]:TRACe<t>:SMOothing:APERTure](#) on page 568.

For more information see [Chapter 5.3.1.5, "Trace smoothing"](#), on page 279.

Suffix:

<n> [Window](#)
 <w> subwindow
 <t> [Trace](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: DISP3:TRAC2:SMO ON
 Turns on trace smoothing for trace 2 in window 3

Manual operation: See "[Smoothing](#)" on page 292

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

Turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> [Window](#)
 Irrelevant in the Receiver application.
 <w> subwindow
 Not supported by all applications

<t> [Trace](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: DISP:TRAC3 ON

Manual operation: See "[Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6](#)" on page 291

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:X:SPACing <Scale>

Selects the scaling of the x-axis.

Suffix:

<n> [Window](#)
 <w> subwindow
 <t>

Parameters:

<Scale> **LOGarithmic**
 Logarithmic scaling.
LINear
 Linear scaling.
 *RST: LINear

Example: DISP:TRAC:X:SPAC LOG

Manual operation: See "[Frequency Axis Scaling](#)" on page 175

6.9.2.3 Trace import and export

FORMat[:DATA]	572
FORMat:DEXPort:CSEParator	572
FORMat:DEXPort:DSEParator	573
FORMat:DEXPort:FORMat	573
FORMat:DEXPort:HEADer	573
FORMat:DEXPort:TRACes	574
FORMat:DIMPort:TRACes	574
MMEMory:LOAD<n>:TRACe	575
MMEMory:STORe<n>:TRACe	575
MMEMory:STORe<n>:LIST	575

FORMat[:DATA] <Format>[, <BitLength>]

Selects the data format that is used for transmission of trace data from the R&S EPL1000 to the controlling computer.

Note that the command has no effect for data that you send to the R&S EPL1000. The R&S EPL1000 automatically recognizes the data it receives, regardless of the format.

For details on data formats, see [Chapter 5.3.4.2, "Formats for returned values: ASCII format and binary format"](#), on page 316.

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 can be.

REAL

Floating-point numbers (according to IEEE 754) in the "definite length block format".

The format setting `REAL` is used for the binary transmission of trace data.

<BitLength>

Length in bits for floating-point results

16

16-bit floating-point numbers.

Compared to `REAL, 32` format, half as many numbers are returned.

32

32-bit floating-point numbers

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

64

64-bit floating-point numbers

Compared to `REAL, 32` format, twice as many numbers are returned.

Example:

```
FORM REAL, 32
```

FORMat:DEXPort:CSEPARATOR <Separator>

Selects the column separator for exported trace data.

The selected value is not affected by a preset. The command therefore has no reset value.

Parameters:

<Separator>

COMMa

Selects a comma as a separator.

SEMicolon

Selects a semicolon as a separator.

TAB

Selects a tabulator as a separator.

*RST: n/a

Example: //Select column separator
FORM:DEXP:CSEP TAB

Manual operation: See ["Column Separator"](#) on page 297

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> POINT | COMMa

COMMa

Uses a comma as decimal separator, e.g. 4,05.

POINT

Uses a point as decimal separator, e.g. 4.05.

*RST: *RST has no effect on the decimal separator.
Default is POINT.

Example: FORM:DEXP:DSEP POIN
Sets the decimal point as separator.

Manual operation: See ["Saving the Result Summary \(Evaluation List\) to a File"](#) on page 98

FORMat:DEXPort:FORMat <FileFormat>

Determines the format of the ASCII file to be imported or exported. Depending on the external program that creates the data file or evaluates it, a comma-separated list (CSV) or a plain data format (DAT) file is required.

Parameters:

<FileFormat> CSV | DAT

*RST: DAT

Example: FORM:DEXP:FORM CSV

Manual operation: See ["File Type"](#) on page 297

FORMat:DEXPort:HEADer <State>

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

See [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312 for details.

Parameters:

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

Manual operation: See ["Include Instrument & Measurement Settings"](#) on page 295

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file (see [MMEMory:STORe<n>:TRACe](#) on page 564).

For details on exporting data, see [Chapter 5.3.2.2, "Exporting and importing traces"](#), on page 294.

Parameters:

<Selection> SINGle | ALL

SINGle

Only a single trace is selected for export, namely the one specified by the [MMEMory:STORe<n>:TRACe](#) command.

ALL

Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.

The <trace> parameter for the [MMEMory:STORe<n>:TRACe](#) command is ignored.

*RST: SINGle

Manual operation: See ["Export all Traces and all Table Results"](#) on page 295

FORMat:DIMPort:TRACes <Selection>

Selects the data to be included in a data import file (see [MMEMory:LOAD<n>:TRACe](#) on page 575).

For details on importing data see [Chapter 5.3.3.3, "How to import traces"](#), on page 308.

Parameters:

<Selection> SINGle | ALL

SINGle

Only a single trace is selected for import, namely the one specified by the [MMEMory:LOAD<n>:TRACe](#) on page 575 command.

ALL

Imports several traces at once, overwriting the existing trace data for any active trace in the result display with the same trace number. Data from the import file for currently not active traces is not imported.

The <trace> parameter for the [MMEMory:LOAD<n>:TRACe](#) on page 575 command is ignored.

*RST: SINGle

Manual operation: See ["Import All Traces/Import to Trace"](#) on page 297

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

Imports trace data from the specified window to an ASCII file.

Suffix:

<n> [Window](#)

Parameters:

<Trace> Number of the trace to be stored
(This parameter is ignored for [FORMat:DIMPort:TRACesALL](#)).

<FileName> String containing the path and name of the import file.

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

Exports trace data from the specified window to an ASCII file.

For details on the file format see [Chapter 5.3.4.1, "Reference: ASCII file export format"](#), on page 312.

Suffix:

<n> [Window](#)

Setting parameters:

<Trace> Number of the trace to be stored
(This parameter is ignored if the option "Export all Traces and all Table Results" is activated in the Export configuration settings, see [FORMat:DEXPort:TRACes](#) on page 574).

<Filename> String containing the path and name of the target file.

Example:

MMEM:STOR1:TRAC 1, 'C:\TEST.ASC'
Stores trace 1 from window 1 in the file TEST.ASC.

Usage:

Setting only

MMEMory:STORe<n>:LIST <FileName>

Exports the SEM and spurious emission list evaluation to a file.

The file format is *.dat.

Suffix:

<n> [Window](#)

Parameters:

<FileName> String containing the path and name of the target file.

Example:

MMEM:STOR:LIST 'test'
Stores the current list evaluation results in the test.dat file.

Manual operation: See "Saving the Result Summary (Evaluation List) to a File" on page 98

6.9.2.4 Trace copy

TRACe<n>:COPY.....576

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

Copies data from one trace to another.

Suffix:

<n> [Window](#)

Parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
 The first parameter is the destination trace, the second parameter is the source.
 (Note the 'e' in the parameter is required!)

Example:

TRAC:COPY TRACE1, TRACE2

Copies the data from trace 2 to trace 1.

Manual operation: See "Copy Trace" on page 298

6.9.2.5 Trace mathematics

CALCulate<n>:MATH<t>[:EXPRession][:DEFine].....576

CALCulate<n>:MATH<t>:MODE.....577

CALCulate<n>:MATH<t>:POSition.....577

CALCulate<n>:MATH<t>:STATe.....578

CALCulate<n>:MATH<t>[:EXPRession][:DEFine] <Expression>

Selects the mathematical expression for trace mathematics.

Before you can use the command, you have to turn trace mathematics on.

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

<Expression> **(TRACE1-TRACE2)**
 Subtracts trace 2 from trace 1.

(TRACE1-TRACE3)
 Subtracts trace 3 from trace 1.

(TRACE1-TRACE4)
 Subtracts trace 4 from trace 1.

Example: `CALC:MATH:STAT ON`
 Turns trace mathematics on.
`CALC:MATH:EXPR:DEF (TRACE1-TRACE3)`
 Subtracts trace 3 from trace 1.

Manual operation: See "[Trace Math Function](#)" on page 299

CALCulate<n>:MATH<t>:MODE <Mode>

Selects the way the R&S EPL1000 calculates trace mathematics.

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

<Mode> For more information on the way each mode works see [Trace Math Mode](#).

LINear

Linear calculation.

LOGarithmic

Logarithmic calculation.

POWER

Linear power calculation.

*RST: LOGarithmic

Example: `CALC:MATH:MODE LIN`
 Selects linear calculation.

Manual operation: See "[Trace Math Mode](#)" on page 299

CALCulate<n>:MATH<t>:POSition <Position>

Defines the position of the trace resulting from the mathematical operation.

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

<Position> Vertical position of the trace in % of the height of the diagram area.

100 PCT corresponds to the upper diagram border.

Range: -100 to 200

*RST: 50

Default unit: PCT

Example: `CALC:MATH:POS 100`
 Moves the trace to the top of the diagram area.

Manual operation: See "[Trace Math Position](#)" on page 299

CALCulate<n>:MATH<t>:STATe <State>

Turns the trace mathematics on and off.

Suffix:

<n> [Window](#)

<t> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

CALC:MATH:STAT ON

Turns on trace mathematics.

Manual operation: See "[Trace Math Function](#)" on page 299

6.9.2.6 Trace labels

[DISPlay\[:WINDow<n>\]:TRACe<t>:LABel\[:STATe\].....578](#)

[DISPlay\[:WINDow<n>\]:TRACe<t>:LABel:TEXT.....578](#)

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

This command turns the display of the trace label for a specific trace on and off.

The command can only be applied to active traces.

Suffix:

<n> 1..n
[Window](#)

<t> 1..n
[Trace](#)

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example:

//Turn on the label for trace 2

DISP:TRAC2:LAB ON

DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT <Label>

This command defines the contents of a trace label.

Suffix:

<n> 1..n
[Window](#)

<t> 1..n
Trace

Parameters:

<Label> String containing the trace label.

Example:

```
//Assign a label to trace 2.
DISP:TRAC2:LAB:TEXT 'A YELLOW TRACE'
```

6.9.2.7 Spectrogram configuration

CALCulate<n>:SPECtrogram:CLEar[:IMMediate]	579
CALCulate<n>:SPECtrogram:CONTInuous	579
CALCulate<n>:SPECtrogram:FRAMe:COUNT	580
CALCulate<n>:SPECtrogram:FRAMe:SElect	580
CALCulate<n>:SPECtrogram:HDEPth	581
CALCulate<n>:SPECtrogram:TSTamp:DATA?	581
CALCulate<n>:SPECtrogram:TSTamp[:STATe]	582
CALCulate<n>:SPECtrogram[:STATe]	582
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault	583
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer	583
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE	583
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPER	583
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]	584
MMEMory:STORe<n>:SPECtrogram	584

CALCulate<n>:SPECtrogram:CLEar[:IMMediate]

Resets the spectrogram and clears the history buffer.

Suffix:

<n> Window

Example:

```
//Reset the result display and clear the memory
CALC:SGR:CLE
```

Manual operation: See "[Clear Spectrogram](#)" on page 239

CALCulate<n>:SPECtrogram:CONTInuous <State>

Determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

This setting applies to all spectrograms in the channel setup.

Suffix:

<n> Window

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

```
INIT:CONT OFF
```

Selects single sweep mode.

```
INIT; *WAI
```

Starts the sweep and waits for the end of the sweep.

```
CALC:SGR:CONT ON
```

Repeats the single sweep measurement without deleting the results of the last measurement.

Manual operation: See ["Single Sweep / Run Single"](#) on page 237

CALCulate<n>:SPECtrogram:FRAME:COUNT <Frames>

Defines the number of frames to be recorded in a single sweep.

This value applies to all spectrograms in the channel setup.

Suffix:

<n> [Window](#)

Parameters:

<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth

Increment: 1

*RST: 1

Example:

```
//Select single sweep mode
```

```
INIT:CONT OFF
```

```
//Set the number of frames to 200
```

```
CALC:SGR:FRAM:COUN 200
```

Manual operation: See ["Frame Count"](#) on page 238

CALCulate<n>:SPECtrogram:FRAME:SELEct <Frame> | <Time>

Selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:

<n> [Window](#)

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.

The range depends on the history depth.

Default unit: S

<Time>

Selects a frame via its time stamp. Valid if the time stamp is on.

The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example: INIT:CONT OFF
 Stop the continuous sweep.
 CALC:SGR:FRAM:SEL -25
 Selects frame number -25.

Manual operation: See ["Select Frame"](#) on page 238

CALCulate<n>:SPECtrogram:HDEPth <History>

Defines the number of frames to be stored in the R&S EPL1000 memory.

Suffix:

<n> [Window](#)

Parameters:

<History> The maximum number of frames depends on the number of sweep points.

Range: 781 to 20000

Increment: 1

*RST: 3000

Example: //Set the history depth to 1500
 CALC:SGR:SPEC 1500

Manual operation: See ["History Depth"](#) on page 303

CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

Queries the starting time of the frames.

The return values consist of four values for each frame. If the "Spectrogram" is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with TRAC:DATA? SGR

See [TRACe<n> \[:DATA\]](#) on page 564.

Suffix:

<n> [Window](#)

Query parameters:

<Frames>

CURRent

Returns the starting time of the current frame.

ALL

Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

Return values:

<Seconds>

Number of seconds that have passed since 01.01.1970 until the frame start

<Nanoseconds>	Number of nanoseconds that have passed <i>in addition to the</i> <Seconds> since 01.01.1970 until the frame start.
<Reserved>	The third value is reserved for future uses.
<Reserved>	The fourth value is reserved for future uses.
Example:	<code>CALC:SGR:TST:DATA? ALL</code> Returns the starting times of all frames sorted in a descending order.
Usage:	Query only
Manual operation:	See " Time Stamp " on page 303

CALCulate<n>:SPECTrogram:TSTamp[:STATe] <State>

Activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- [CALCulate<n>:DELTaMarker<m>:SPECTrogram:FRAMe](#) on page 612
- [CALCulate<n>:MARKer<m>:SPECTrogram:FRAMe](#) on page 608
- [CALCulate<n>:SPECTrogram:FRAMe:SElect](#) on page 580

Suffix:

<n> 1..n
[Window](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: //Activates the time stamp
`CALC:SGR:TST ON`

Manual operation: See "[Time Stamp](#)" on page 303

CALCulate<n>:SPECTrogram[:STATe] <State>

Turns the spectrogram on and off.

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: CALC:SGR ON
 Activates the Spectrogram result display.

Manual operation: See "[State](#)" on page 302

DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

Restores the original color map.

Suffix:
<n> [Window](#)

Manual operation: See "[Set to Default](#)" on page 306

DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

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 305

DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPE <Shape>

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 305

DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

Defines the end point of the color map.

Suffix:
<n> [Window](#)

Parameters:

<Percentage> Statistical frequency percentage.
 Range: 0 to 66
 *RST: 0
 Default unit: %

Example:

DISP:WIND:SGR:COL:UPP 95
 Sets the start of the color map to 95%.

Manual operation: See "[Start / Stop](#)" on page 305

DISPlay[:WINDow<n>]:SPECTrogram:COLor[:STYLE] <ColorScheme>

Selects the color scheme.

Parameters:

<ColorScheme> **HOT**
 Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.

COLD
 Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
 Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
 Shows the results in shades of gray.
 *RST: HOT

Example:

DISP:WIND:SPEC:COL GRAY
 Changes the color scheme of the spectrogram to black and white.

Manual operation: See "[Hot/Cold/Radar/Grayscale](#)" on page 306

MMEMory:STORe<n>:SPECTrogram <FileName>

Exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Suffix:

<n> [Window](#)

Parameters:

<FileName> String containing the path and name of the target file.

Example: MMEM:STOR:SGR 'Spectrogram'
Copies the spectrogram data to a file.

Manual operation: See ["Export Trace to ASCII File"](#) on page 296

6.9.2.8 Programming example: configuring a spectrogram

This example demonstrates how to configure a spectrogram for a basic frequency sweep in a remote environment. The spectrogram is displayed in addition to the spectrum display, in a new window. In addition, the usage of special spectrogram markers is demonstrated.



Basic trace settings are demonstrated in the [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513.

```
//-----Preparing the Measurement -----
*RST
//Resets the instrument
LAY:ADD? '1',BEL,SGR
//Displays a new window below window 1 and activates spectrogram display.
//The new window name is returned as a result: '2'.
//The spectrogram is updated with each new sweep.
INIT:CONT OFF
//Selects single sweep mode.

//-----Configuring the Spectrogram-----
CALC:SGR:CLE
//Clears the displayed spectrogram to start a new one.
CALC:SGR:CONT ON
//Configures a continuous spectrogram for a series of measurements.
//The display is not cleared when a new measurement is started.
CALC:SGR:FRAM:COUN 100
//Sets the number of frames to be recorded per sweep to 100.
CALC:SGR:HDEP 1000
//Sets the number of frames to be stored to 1000 (=10 sweeps)
CALC:SGR:TST ON
//Activates a time stamp for each frame.

//-----Configuring the Color Map-----
DISP:WIND:SGR:COL GRAY
//Defines a gray-scaled coloring: low values light gray, high values dark gray.
DISP:WIND:SGR:COL:LOW 30
DISP:WIND:SGR:COL:UPP 70
DISP:WIND:SGR:COL:SHAP 0.8
//Defines a color map for a range that comprises 40% of the measurement range,
//excluding 30% at each end. The colors are not scaled linearly; the light gray
//colors are stretched to distinguish low values better.

//-----Performing the Measurement-----
```

```

SWE:COUN 10
//Defines 10 sweeps to be performed per measurement.
INIT;*WAI
//Initiates a new measurement and waits until the sweeps have finished.
//The spectrogram is updated with each new sweep.

//-----Positioning Markers-----
CALC:MARK:SGR:SAR MEM
//Includes all frames in the memory in the search area

CALC:MARK1:SGR:FRAM -1s
//Sets marker 1 to the frame 1 second after measurement begin. (Note the
//negative value!
CALC:MARK1:MIN
//Sets marker 1 to the minimum level in this frame.
CALC:MARK1:SGR:Y:MIN
//Sets marker 1 to the minimum level for the same frequency the marker is
//currently positioned at in all frames.

CALC:MARK2:SGR:XY:MAX
//Sets marker 2 to the maximum level in the entire spectrogram.

CALC:DELT1:SGR:FRAM 3s
//Sets the deltamarker 1 to the frame captured 3 seconds after marker 1. By default
//it is set to the peak of that frame and displays the level difference to marker 1.
//Note the positive value!
CALC:DELT1:MIN
//Sets deltamarker 1 to the minimum level in this frame.

CALC:DELT3:SGR:XY:MAX
//Sets deltamarker 3 to the maximum level in the entire spectrogram. By default
//its value is the difference to marker 1. We will change it to refer to marker 2.
CALC:DELT3:MREF 2
//Deltamarker 3 now refers to marker 2, both are positioned on the maximum of the
//spectrogram. Thus, D3=0. We will move deltamarker 3 to the next peak level
//for the same frequency.
CALC:DELT3:SGR:Y:MAX:NEXT

//-----Retrieving Results-----
CALC:MARK1:X?
CALC:MARK1:Y?
CALC:MARK1:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of marker 1.

CALC:MARK2:X?
CALC:MARK2:Y?
CALC:MARK2:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of marker 2.

```

```

CALC:DELT1:X?
CALC:DELT1:Y?
CALC:DELT1:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of deltamarker 1.

CALC:DELT3:X?
CALC:DELT3:Y?
CALC:DELT3:SGR:FRAM?
//Queries the frequency (x), level (y) and frame values of deltamarker 3.

CALC:SGR:TST:DATA? ALL
//Queries the time stamps of all stored frames.
CALC:SGR:FRAM:SEL -1
//Selects the frame that was captured 1 second after measurement start (Note the
//negative value!). This frame is displayed in the Spectrum window.
TRAC:DATA? SGR
//Retrieves the trace data for the spectrogram. For each frame, the power level
//and frequency at each sweep point are returned.
TRAC:DATA? TRACE1
//Retrieves the trace data for the selected frame only.

```

6.9.3 Marker configuration

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6.9.3.1 Individual marker configuration

CALCulate<n>:DELTamarker<m>:AOFF.....	588
CALCulate<n>:DELTamarker<m>:LINK.....	588
CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md>.....	588
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>.....	589
CALCulate<n>:DELTamarker<m>:MODE.....	590
CALCulate<n>:DELTamarker<m>:MREFerence.....	590
CALCulate<n>:DELTamarker<m>[:STATE].....	590
CALCulate<n>:DELTamarker<m>:TRACe.....	591
CALCulate<n>:DELTamarker<m>:X.....	591
CALCulate<n>:MARKer<m>:AOFF.....	592
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>.....	592
CALCulate<n>:MARKer<m>[:STATE].....	592
CALCulate<n>:MARKer<m>:TRACe.....	593
CALCulate<n>:MARKer<m>:X.....	593

CALCulate<n>:DELTamarker<m>:AOFF

Turns off *all* delta markers.

Suffix:

<n> [Window](#)

<m> irrelevant

Example:

CALC:DELT:AOFF

Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

Links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the [CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>](#) or [CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>](#) commands.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

CALC:DELT2:LINK ON

Manual operation: See "[Linking to Another Marker](#)" on page 170

CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTA<md> <State>

Links the delta source marker <ms> to any active destination delta marker <md>.

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:

<n> [Window](#)

<ms> source marker, see [Marker](#)

<md> destination marker, see [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

```
CALC:DELT2:LINK:TO:DELT3 ON
```

Links D2 and D3.

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

Links the delta source marker <ms> to any active destination marker <md> (normal or delta marker).

In Spectrum mode only:

- If <md> is a delta marker, it is turned into a normal marker. To maintain the delta marker, use `CALCulate<n>:DELTamarker<ms>:LINK:TO:DELTa<md>` on page 588.
- If <md> is the reference marker for the delta marker <ms>, the delta marker is initially set to the same horizontal position as the normal marker. To change the relative distance (delta) value again, use `CALCulate<n>:DELTamarker<m>:X` on page 591. Then the delta between the two markers is maintained when you move the normal marker.

In I/Q Analyzer mode, if <md> is the reference marker for the delta marker <ms>, the relative distance (delta) between the two markers is maintained when you move the normal marker.

In other applications, the delta marker is set to the same horizontal position as the marker <md>, and if <md> is moved along the x-axis, <ms> follows to the same horizontal position.

Suffix:

<n>	Window
<ms>	source marker, see Marker
<md>	destination marker, see Marker

Parameters:

<State>	ON OFF 0 1
	OFF 0
	Switches the function off
	ON 1
	Switches the function on

Example:

```
CALC:DELT4:LINK:TO:MARK2 ON
```

Links the delta marker 4 to the marker 2.

Example:

D2 and D3 are active.

```
CALC:DELT2:LINK:TO:MARK3 ON
```

Converts D3 into M3 and links D2 and M3

Manual operation: See "[Linking to Another Marker](#)" on page 170

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

Defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker. Note that this setting applies to *all* windows.

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see `CALCulate<n>:DELTamarker<m>:X` on page 591)!

Suffix:

<n> irrelevant

<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>:MREFerence <Reference>

Selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Reference>

FIXed

Selects the fixed reference as the reference.

Example:

`CALC:DELT3:MREF 2`

Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See ["Reference Marker"](#) on page 170

CALCulate<n>:DELTamarker<m>[:STATe] <State>

Turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTmarker turns on delta marker 1.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: `CALC:DELT2 ON`
 Turns on delta marker 2.

Manual operation: See "[Marker State](#)" on page 169

CALCulate<n>:DELTaMarker<m>:TRACe <Trace>

Selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
 Positions delta marker 2 on trace 2.

CALCulate<n>:DELTaMarker<m>:X <Position>

Moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Position> Numeric value that defines the marker position on the x-axis. The position is relative to the reference marker. A query returns the absolute position of the delta marker.
 Range: The value range and unit depend on the measurement and scale of the x-axis.
 Default unit: HZ

Example: `CALC:DELT:X?`
 Outputs the absolute x-value of delta marker 1.

Manual operation: See "[Marker 1/Marker 2/Marker 3/Marker 4](#)" on page 155

CALCulate<n>:MARKer<m>:AOFF

Turns off all markers.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Example:

CALC:MARK:AOFF
Switches off all markers.

Manual operation: See "[All Markers Off](#)" on page 323

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

Links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:

<n> [Window](#)

<ms> source marker, see [Marker](#)

<md> destination marker, see [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example:

CALC:MARK4:LINK:TO:MARK2 ON
Links marker 4 to marker 2.

Manual operation: See "[Linking to Another Marker](#)" on page 170

CALCulate<n>:MARKer<m>[:STATe] <State>

Turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "[Marker State](#)" on page 169

CALCulate<n>:MARKer<m>:TRACe <Trace>

Selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: `//Assign marker to trace 1`
`CALC:MARK3:TRAC 2`

Manual operation: See "[Assigning the Marker to a Trace](#)" on page 171

CALCulate<n>:MARKer<m>:X <Position>

Moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "[Marker 1/Marker 2/Marker 3/Marker 4](#)" on page 155

6.9.3.2 General marker configuration

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:MAXimum[:PEAK].....	594
CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:X.....	594
CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:Y.....	594
CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:Y:OFFSet.....	595
CALCulate<n>:DELTaMarker<m>:FUNction:FIXed[:STATe].....	595
CALCulate<n>:MARKer<m>:X:SSIZe.....	596
DISPlay[:WINDow<n>]:MINFo[:STATe].....	596
DISPlay[:WINDow<n>]:MTABLe.....	597

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:MAXimum[:PEAK]

Moves the fixed reference marker to the peak power.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Example:

CALC:DELT:FUNC:FIX:RPO:MAX

Sets the reference point level for delta markers to the peak of the selected trace.

Manual operation: See ["Defining a Fixed Reference"](#) on page 325

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:X <RefPoint>

Defines the horizontal position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<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

Default unit: HZ

Example:

CALC:DELT:FUNC:FIX:RPO:X 128 MHz

Sets the frequency reference to 128 MHz.

Manual operation: See ["Defining a Fixed Reference"](#) on page 325

CALCulate<n>:DELTaMarker<m>:FUNction:FIXed:RPOint:Y <RefPointLevel>

Defines the vertical position of the fixed delta marker reference point. The coordinates of the reference may be anywhere in the diagram.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<RefPoint> Numeric value that defines the vertical position of the reference. The unit and value range is variable.

*RST: Fixed Reference: OFF

Default unit: DBM

Example:

CALC:DELT:FUNC:FIX:RPO:Y -10dBm

Sets the reference point level for delta markers to -10 dBm.

Manual operation: See "[Defining a Fixed Reference](#)" on page 325**CALCulate<n>:DELTamarker<m>:FUNCTioN:FIXed:RPOint:Y:OFFSet <Offset>**

Defines a level offset for the fixed delta marker reference point.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<Offset> Numeric value

*RST: 0

Default unit: dB

CALCulate<n>:DELTamarker<m>:FUNCTioN:FIXed[:STATe] <State>

Activates or deactivates a marker that defines a fixed reference point for relative marker analysis.

If necessary, the command activates a marker and positions it on the peak power.

Subsequently, you can change the coordinates of the fixed reference independent of the marker. The fixed reference is independent of the trace and is applied to all active delta markers.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example: `CALC:DELT:FUNC:FIX ON`
Switches on the measurement with fixed reference value for all delta markers.
`CALC:DELT:FUNC:FIX:RPO:X 128 MHZ`
Sets the frequency reference to 128 MHz.
`CALC:DELT:FUNC:FIX:RPO:Y 30 DBM`
Sets the reference level to +30 dBm.

Manual operation: See "[Defining a Fixed Reference](#)" on page 325

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

Selects the marker step size mode for *all* markers in *all* windows.

The step size defines the distance the marker moves when you move it with the rotary knob.

It therefore takes effect in manual operation only.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<StepSize>

STANdard

the marker moves from one pixel to the next

POINTs

the marker moves from one sweep point to the next

*RST: POINTs

Example:

`CALC:MARK:X:SSIZ STAN`

Sets the marker step size to one pixel.

Manual operation: See "[Marker Stepsize](#)" on page 324

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

Turns the marker information in all diagrams on and off.

Suffix:

<n> irrelevant

Parameters:

<State>

ON | 1

Displays the marker information in the diagrams.

OFF | 0

Hides the marker information in the diagrams.

*RST: 1

Example:

`DISP:MINF OFF`

Hides the marker information.

Manual operation: See "[Marker Info](#)" on page 324

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

Turns the marker table on and off.

Suffix:

<n> irrelevant

Parameters:

<DisplayMode>

ON | 1

Turns on the marker table.

OFF | 0

Turns off the marker table.

AUTO

Turns on the marker table if 3 or more markers are active.

*RST: AUTO

Example:

DISP:MTAB ON

Activates the marker table.

Manual operation: See "[Marker Table Display](#)" on page 324

6.9.3.3 Marker search

CALCulate<n>:MARKer<m>:LOEXclude.....	597
CALCulate<n>:MARKer<m>:PEXCursion.....	598
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT.....	598
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT.....	599
CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe].....	599
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe].....	600
CALCulate<n>:THReshold.....	600
CALCulate<n>:THReshold:STATe.....	600

CALCulate<n>:MARKer<m>:LOEXclude <State>

Turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State>

ON | OFF | 0 | 1

*RST: 1

Example:

CALC:MARK:LOEX ON

Manual operation: See "[Exclude LO](#)" on page 327

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

Defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB
Receiver	dB

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

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

*RST: 6 dB

Example:

CALC:MARK:PEXC 10dB

Defines peak excursion as 10 dB.

Manual operation: See "[Peak Excursion](#)" on page 327

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

Defines the left limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<SearchLimit> The value range depends on the frequency range or sweep time.

The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border

Default unit: HZ

Example: `CALC:MARK:X:SLIM ON`
 Switches the search limit function on.
 `CALC:MARK:X:SLIM:LEFT 10MHz`
 Sets the left limit of the search range to 10 MHz.

Manual operation: See "[Search Limits \(Left / Right\)](#)" on page 68

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <SearchLimit>

Defines the right limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<Limit> The value range depends on the frequency range or sweep time.
 The unit is Hz for frequency domain measurements and s for time domain measurements.
 *RST: right diagram border
 Default unit: HZ

Example: `CALC:MARK:X:SLIM ON`
 Switches the search limit function on.
 `CALC:MARK:X:SLIM:RIGH 20MHz`
 Sets the right limit of the search range to 20 MHz.

Manual operation: See "[Search Limits \(Left / Right\)](#)" on page 68

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

Adjusts the marker search range to the zoom area for *all* markers in *all* windows.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> `ON | OFF | 0 | 1`
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on

Example: `CALC:MARK:X:SLIM:ZOOM ON`
 Switches the search limit function on.
 `CALC:MARK:X:SLIM:RIGH 20MHz`
 Sets the right limit of the search range to 20 MHz.

Manual operation: See ["Use Zoom Limits"](#) on page 328

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

Turns marker search limits on and off for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

CALC:MARK:X:SLIM ON

Switches on search limitation.

Manual operation: See ["Search Limits \(Left / Right\)"](#) on page 68

CALCulate<n>:THReshold <Level>

Defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Note that you must enable the use of the threshold using [CALCulate<n>:THReshold:STATe](#) on page 600.

Suffix:

<n> irrelevant

Parameters:

<Level> Numeric value. The value range and unit are variable.

*RST: -120 dBm

Default unit: DBM

Example:

CALC:THR:STAT ON

Example:

CALC:THR -82DBM

Enables the search threshold and sets the threshold value to -82 dBm.

Manual operation: See ["Search Threshold"](#) on page 328

CALCulate<n>:THReshold:STATe <State>

Turns a threshold for the marker peak search on and off (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example:

CALC:THR:STAT ON
 Switches on the threshold line.

Manual operation: See ["Search Limits Off"](#) on page 68

6.9.3.4 Marker positioning

CALCulate<n>:DELTaMarker<m>:MAXimum:LEFT.....	601
CALCulate<n>:DELTaMarker<m>:MAXimum:NEXT.....	602
CALCulate<n>:DELTaMarker<m>:MAXimum:RIGHT.....	602
CALCulate<n>:DELTaMarker<m>:MAXimum[:PEAK].....	602
CALCulate<n>:DELTaMarker<m>:MINimum:LEFT.....	602
CALCulate<n>:DELTaMarker<m>:MINimum:NEXT.....	603
CALCulate<n>:DELTaMarker<m>:MINimum:RIGHT.....	603
CALCulate<n>:DELTaMarker<m>:MINimum[:PEAK].....	603
CALCulate<n>:MARKer<m>:MAXimum:AUTO.....	604
CALCulate<n>:MARKer<m>:MAXimum:LEFT.....	604
CALCulate<n>:MARKer<m>:MAXimum:NEXT.....	604
CALCulate<n>:MARKer<m>:MAXimum:RIGHT.....	605
CALCulate<n>:MARKer<m>:MAXimum[:PEAK].....	605
CALCulate<n>:MARKer<m>:MINimum:AUTO.....	605
CALCulate<n>:MARKer<m>:MINimum:LEFT.....	606
CALCulate<n>:MARKer<m>:MINimum:NEXT.....	606
CALCulate<n>:MARKer<m>:MINimum:RIGHT.....	606
CALCulate<n>:MARKer<m>:MINimum[:PEAK].....	606

CALCulate<n>:DELTaMarker<m>:MAXimum:LEFT

Moves a delta marker to the next positive peak value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See ["Search Next Peak"](#) on page 330

CALCulate<n>:DELTaMarker<m>:MAXimum:NEXT

Moves a marker to the next positive peak value.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> 1..n
Window

<m> 1..n
Marker

Manual operation: See "[Search Next Peak](#)" on page 330

CALCulate<n>:DELTaMarker<m>:MAXimum:RIGHT

Moves a delta marker to the next positive peak value on the trace.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> Window

<m> Marker

Manual operation: See "[Search Next Peak](#)" on page 330

CALCulate<n>:DELTaMarker<m>:MAXimum[:PEAK]

Moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See "[Peak Search](#)" on page 330

CALCulate<n>:DELTaMarker<m>:MINimum:LEFT

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Minimum](#)" on page 330

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Minimum](#)" on page 330

CALCulate<n>:DELTamarker<m>:MINimum:RIGHT

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Minimum](#)" on page 330

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

Moves a delta marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Minimum](#)" on page 330

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

Turns an automatic marker peak search for a trace maximum on and off (using marker 1). The R&S EPL1000 performs the peak search after each sweep.

Suffix:

<n> [Window](#)

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

`CALC:MARK:MAX:AUTO ON`

Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See "[Auto Max Peak Search / Auto Min Peak Search](#)" on page 327

CALCulate<n>:MARKer<m>:MAXimum:LEFT

Moves a marker to the next positive peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Peak](#)" on page 330

CALCulate<n>:MARKer<m>:MAXimum:NEXT

Moves a marker to the next positive peak.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Peak](#)" on page 330

CALCulate<n>:MARKer<m>:MAXimum:RIGHT

Moves a marker to the next positive peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Peak](#)" on page 330

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

Moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Peak Search](#)" on page 330

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

Turns an automatic marker peak search for a trace minimum on and off (using marker 1). The R&S EPL1000 performs the peak search after each sweep.

Suffix:

<n> [Window](#)

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

CALC:MARK:MIN:AUTO ON

Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See "[Auto Max Peak Search / Auto Min Peak Search](#)" on page 327

CALCulate<n>:MARKer<m>:MINimum:LEFT

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Minimum](#)" on page 330

CALCulate<n>:MARKer<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Minimum](#)" on page 330

CALCulate<n>:MARKer<m>:MINimum:RIGHT

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Manual operation: See "[Search Next Minimum](#)" on page 330

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

Moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:<n> [Window](#)<m> [Marker](#)**Manual operation:** See "[Search Minimum](#)" on page 330**6.9.3.5 Marker results**

Commands to retrieve marker positions described elsewhere.

- [CALCulate<n>:DELTamarker<m>:X](#) on page 591
- [CALCulate<n>:MARKer<m>:X](#) on page 593

CALCulate<n>:DELTamarker<m>:X:RELative?	607
CALCulate<n>:DELTamarker<m>:Y?	607
CALCulate<n>:MARKer<m>:Y?	608

CALCulate<n>:DELTamarker<m>:X:RELative?

Queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:<n> [Window](#)<m> [Marker](#)**Return values:**

<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/Marker 2/Marker 3/Marker 4](#)" on page 155**CALCulate<n>:DELTamarker<m>:Y?**

Queries the result at the position of the specified delta marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.

Default unit: DBM

Usage:

Query only

CALCulate<n>:MARKer<m>:Y?

Queries the result at the position of the specified marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Default unit: DBM

Usage: Query only

Manual operation: See "Marker Table" on page 256

6.9.3.6 Spectrogram markers

- [Marker configuration](#)..... 608
- [Delta markers](#)..... 612

Marker configuration

Commands to configure markers in spectrograms described elsewhere.

- [CALCulate<n>:MARKer<m>:MAXimum:LEFT](#) on page 604
- [CALCulate<n>:MARKer<m>:MAXimum:NEXT](#) on page 604
- [CALCulate<n>:MARKer<m>:MAXimum\[:PEAK\]](#) on page 605
- [CALCulate<n>:MARKer<m>:MAXimum:RIGHT](#) on page 605
- [CALCulate<n>:MARKer<m>:MINimum:LEFT](#) on page 606
- [CALCulate<n>:MARKer<m>:MINimum:NEXT](#) on page 606
- [CALCulate<n>:MARKer<m>:MINimum\[:PEAK\]](#) on page 606
- [CALCulate<n>:MARKer<m>:MINimum:RIGHT](#) on page 606

CALCulate<n>:MARKer<m>:SPEctrogram:FRAME	608
CALCulate<n>:MARKer<m>:SPEctrogram:SARea	609
CALCulate<n>:MARKer<m>:SPEctrogram:XY:MAXimum[:PEAK]	609
CALCulate<n>:MARKer<m>:SPEctrogram:XY:MINimum[:PEAK]	610
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:ABOVe	610
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:BELOW	610
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum:NEXT	610
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MAXimum[:PEAK]	610
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:ABOVe	611
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:BELOW	611
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum:NEXT	611
CALCulate<n>:MARKer<m>:SPEctrogram:Y:MINimum[:PEAK]	611

CALCulate<n>:MARKer<m>:SPEctrogram:FRAMe <Frame> | <Time>

Positions a marker on a particular frame.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example:

```
CALC:MARK:SGR:FRAM -20
```

Sets the marker on the 20th frame before the present.

```
CALC:MARK2:SGR:FRAM -2s
```

Sets second marker on the frame 2 seconds ago.

Manual operation: See "[Frame \(Spectrogram only\)](#)" on page 322

CALCulate<n>:MARKer<m>:SPECTrogram:SARea <SearchArea>

Defines the marker search area for all spectrogram markers in the channel setup.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<SearchArea>

VISible

Performs a search within the visible frames.

Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory

Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "[Marker Search Area](#)" on page 329

CALCulate<n>:MARKer<m>:SPECTrogram:XY:MAXimum[:PEAK]

Moves a marker to the highest level of the spectrogram.

Suffix:<n> [Window](#)<m> [Marker](#)

CALCulate<n>:MARKer<m>:SPECTrogram:XY:MINimum[:PEAK]

Moves a marker to the minimum level of the spectrogram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:ABOVE

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:BELOW

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum:NEXT

Moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MAXimum[:PEAK]

Moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:ABOVE

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:BELOW

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum:NEXT

Moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SPECTrogram:Y:MINimum[:PEAK]

Moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:

<n> Window

<m> Marker

Delta markers

Commands to configure delta markers in spectrograms described elsewhere.

- `CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 601
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 602
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 602
- `CALCulate<n>:DELTamarker<m>:MAXimum:RIGHT` on page 602
- `CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 602
- `CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 603
- `CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 603
- `CALCulate<n>:DELTamarker<m>:MINimum:RIGHT` on page 603

<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAMe</code>	612
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:SARea</code>	613
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:XY:MAXimum[:PEAK]</code>	613
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:XY:MINimum[:PEAK]</code>	613
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:ABOVe</code>	613
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:BELow</code>	614
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum:NEXT</code>	614
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MAXimum[:PEAK]</code>	614
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:ABOVe</code>	614
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:BELow</code>	614
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum:NEXT</code>	615
<code>CALCulate<n>:DELTamarker<m>:SPECTrogram:Y:MINimum[:PEAK]</code>	615

`CALCulate<n>:DELTamarker<m>:SPECTrogram:FRAMe <Frame>`

Positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame either by its frame number or time stamp.
 The frame number is available if the time stamp is off. The range depends on the history depth.
 The time stamp is available if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.
 Default unit: S

Example:

```
CALC:DELT4:SGR:FRAM -20
```

Sets fourth deltamarker 20 frames below marker 1.

```
CALC:DELT4:SGR:FRAM 2 s
```

Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "[Frame \(Spectrogram only\)](#)" on page 322

CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

Defines the marker search area for *all* spectrogram markers in the channel setup.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<SearchArea>

VISible

Performs a search within the visible frames.

Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory

Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "[Marker Search Area](#)" on page 329

CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

Moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

Moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVE

Moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MAXimum:BELOW

Moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MAXimum:NEXT

Moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MAXimum[:PEAK]

Moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MINimum:ABOVE

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MINimum:BELOW

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MINimum:NEXT

Moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

CALCulate<n>:DELTaMarker<m>:SPECTrogram:Y:MINimum[:PEAK]

Moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Suffix:

<n> [Window](#)

<m> [Marker](#)

6.9.3.7 Marker functions

- [Signal count](#)..... 615
- [Noise marker](#)..... 617
- [Phase noise marker](#)..... 618
- [n dB down marker](#)..... 621
- [Band power marker](#)..... 624
- [Marker demodulation](#)..... 627
- [Marker peak list](#)..... 630

Signal count

- [CALCulate<n>:MARKer<m>:COUNT](#)..... 616
- [CALCulate<n>:MARKer<m>:COUNT:FREQuency?](#)..... 616
- [CALCulate<n>:MARKer<m>:COUNT:RESolution](#)..... 617

CALCulate<n>:MARKer<m>:COUNT <State>

Turns the frequency counter at the marker position on and off.

The frequency counter works for one marker only. If you perform a frequency count with another marker, the R&S EPL1000 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.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

```
INIT:CONT OFF
```

Switches to single sweep mode.

```
CALC:MARK ON
```

Switches on marker 1.

```
CALC:MARK:COUN ON
```

Switches on the frequency counter for marker 1.

```
INIT;*WAI
```

Starts a sweep and waits for the end.

```
CALC:MARK:COUN:FREQ?
```

Outputs the measured value.

Manual operation: See ["Signal Count Marker State"](#) on page 333

CALCulate<n>:MARKer<m>:COUNT:FREQUency?

Queries the frequency at the marker position.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

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:

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK ON
Switches on marker 2.
CALC:MARK:COUN ON
Activates the frequency counter for marker 1.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:COUN:FREQ?
Outputs the measured value of marker 1.
```

Usage: Query only

Manual operation: See ["Signal Count Marker State"](#) on page 333

CALCulate<n>:MARKer<m>:COUNT:RESolution <Resolution>

Defines the resolution of the frequency counter.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Resolution> 0.001 | 0.01 | 0.1 | 1 | 10 | 100 | 1000 | 10000 Hz
 *RST: 0.1 Hz
 Default unit: HZ

Example:

```
CALC:MARK:COUN:RES 1kHz
Sets the resolution of the frequency counter to 1 kHz.
```

Manual operation: See ["Resolution"](#) on page 333

Noise marker

[CALCulate<n>:MARKer<m>:FUNCTION:NOISe:RESult?](#).....617
[CALCulate<n>:MARKer<m>:FUNCTION:NOISe\[:STATE\]](#).....618

CALCulate<n>:MARKer<m>:FUNCTION:NOISe:RESult?

Queries the result of the noise measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> [Window](#)

<m>	Marker
Return values:	
<NoiseLevel>	Current noise level. The unit is the one currently active.
Example:	<pre>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.</pre>
Usage:	Query only
Manual operation:	See "Noise Measurement State" on page 336

CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] <State>

Turns the noise measurement at the marker position on and off.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example:

```
CALC:MARK:FUNC:NOIS ON
```


 Switches on the noise measurement.

Manual operation: See ["Noise Measurement State"](#) on page 336

Phase noise marker

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO.....	618
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?.....	619
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe].....	619
CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?.....	620
CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe].....	620

CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO <State>

Turns an automatic peak search for the fixed reference marker at the end of a sweep on and off.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:`CALC:DELT:FUNC:PNO:AUTO ON`

Activates an automatic peak search for the reference marker in a phase-noise measurement.

Manual operation: See ["Defining Reference Point"](#) on page 339**CALCulate<n>:DELTamarker<m>:FUNCTioN:PNOise:RESult?**

Queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

Is only available in the Spectrum application.

Suffix:<n> [Window](#)<m> [Marker](#)**Return values:**

<PhaseNoise> numeric value

The difference in level between the reference point and the noise power density at the position of the specified delta marker.

Example:`CALC:DELT2:FUNC:PNO:RES?`

Outputs the result of phase-noise measurement of the delta-marker 2.

Usage: Query only**Manual operation:** See ["Phase Noise Measurement State"](#) on page 338**CALCulate<n>:DELTamarker<m>:FUNCTioN:PNOise[:STATe] <State>**

Turns the phase noise measurement at the delta marker position on and off.

The reference marker for phase noise measurements is either a normal marker or a fixed reference. If necessary, the command turns on the reference marker.

The correction values for the bandwidth and the log amplifier are taken into account in the measurement.

Suffix:<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example:

CALC:DELT:FUNC:PNO ON
 Switches on the phase-noise measurement with all delta markers.
 CALC:DELT:FUNC:FIX:RPO:X 128 MHZ
 Sets the frequency reference to 128 MHz.
 CALC:DELT:FUNC:FIX:RPO:Y 30 DBM
 Sets the reference level to +30 dBm

Manual operation: See "[Phase Noise Measurement State](#)" on page 338

CALCulate<n>:MARKer<m>:FUNCtion:PNOise:RESult?

Queries the result of a phase noise measurement.

If necessary, the command activates the measurement first.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<PhaseNoise> numeric value
 The difference between the measured carrier power and the noise power at the position of the specified (normal) marker.

Example:

CALC:MARK2:FUNC:PNO:RES?
 Outputs the result of phase-noise measurement of the marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:PNOise[:STATe] <State>

Turns the phase noise measurement at the marker position on and off.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off

ON | 1

Switches the function on

Example:

```
CALC:MARK2:FUNC:PNO ON
```

Switches on the phase-noise measurement for the marker 2.

n dB down marker

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown.....	621
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?.....	621
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:QFACtor?.....	622
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult?.....	622
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe.....	623
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME?.....	623

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown <Distance>

Defines the distance of the n dB down markers to the reference marker.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<Distance>	Distance of the temporary markers to the reference marker in dB. For a positive offset, the markers T1 and T2 are placed <i>below</i> the active reference point. For a negative offset (for example for notch filter measurements), the markers T1 and T2 are placed <i>above</i> the active reference point. *RST: 6dB Default unit: DB
------------	---

Example:

```
CALC:MARK:FUNC:NDBD 3dB
```

Sets the distance to the reference marker to 3 dB.

CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?

Queries the position of the n dB down markers on the x-axis when measuring in the frequency domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n>	irrelevant
-----	------------

<m> irrelevant

Return values:

<Frequency>

<frequency 1>

absolute frequency of the n dB marker to the left of the reference marker in Hz

<frequency 2>

absolute frequency of the n dB marker to the right of the reference marker in Hz.

Example:

```
INIT:CONT OFF
```

Switches to single sweep mode.

```
CALC:MARK:FUNC:NDBD ON
```

Switches on the n dB down function.

```
INIT;*WAI
```

Starts a sweep and waits for the end.

```
CALC:MARK:FUNC:NDBD:FREQ?
```

This command would return, for example, 100000000, 200000000, meaning that the first marker position is at 100 MHz, the second marker position is at 200 MHz

Usage: Query only

Manual operation: See "[n dB down Value](#)" on page 341

CALCulate<n>:MARKer<m>:FUNCTion:NDBDown:QFACTOR?

Queries the Q factor of n dB down measurements.

Suffix:

<n> irrelevant

<m> irrelevant

Return values:

<QFactor>

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCTion:NDBDown:RESult?

Queries the distance of the n dB down markers from each other.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> irrelevant

<m> irrelevant

Return values:

<Distance> The result depends on the span.
 In case of frequency domain measurements, the command returns the bandwidth between the two n dB down markers in Hz.
 In case of time domain measurements, the command returns the pulse width between the two n dB down markers in seconds.

Example:

```
INIT:CONT OFF
Switches to single sweep mode.
CALC:MARK:FUNC:NDBD ON
Switches on the n dB down function.
INIT;*WAI
Starts a sweep and waits for the end.
CALC:MARK:FUNC:NDBD:RES?
Outputs the measured value.
```

Usage: Query only

Manual operation: See "[n dB down Marker State](#)" on page 341

CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:STATE <State>

Turns the n dB Down marker function on and off.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: CALC:MARK:FUNC:NDBD:STAT ON
 Turns the n dB Down marker on.

Manual operation: See "[n dB down Marker State](#)" on page 341

CALCulate<n>:MARKer<m>:FUNCTION:NDBDown:TIME?

Queries the position of the n dB down markers on the x-axis when measuring in the time domain.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTinuous](#) on page 393.

Suffix:

<n> irrelevant

<m> irrelevant

Return values:

<TimeX1> absolute position in time of the n dB marker to the left of the reference marker in seconds

<TimeX2> absolute position in time of the n dB marker to the right of the reference marker in seconds

Example:

```
INIT:CONT OFF
```

Switches to single sweep mode

```
CALC:MARK:FUNC:NDBD ON
```

Switches on the n dB down function.

```
INIT;*WAI
```

Starts a sweep and waits for the end.

```
CALC:MARK:FUNC:NDBD:TIME?
```

Outputs the time values of the temporary markers.

Usage: Query only

Manual operation: See "[n dB down Value](#)" on page 341

Band power marker

CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:MODE	624
CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:RESult?	625
CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer:SPAN	625
CALCulate<n>:DELTamarker<m>:FUNCTion:BPOWer[:STATe]	625
CALCulate<n>:MARKer<m>:FUNCTion:BPOWer:RESult?	626
CALCulate<n>:MARKer<m>:FUNCTion:BPOWer:SPAN	626
CALCulate<n>:MARKer<m>:FUNCTion:BPOWer:MODE	627
CALCulate<n>:MARKer<m>:FUNCTion:BPOWer[:STATe]	627

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

Selects the way the results for a band power delta marker are displayed.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Mode>

POWER

Result is displayed as an absolute power. The power unit depends on the [CALCulate<n>:UNIT:POWER](#) setting.

DENSity

Result is displayed as a density in dBm/Hz.

RPOWer

This setting is only available for a delta band power marker. The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.

$$[\text{Relative band power (Delta2) in dB}] = [\text{absolute band power (Delta2) in dBm}] - [\text{absolute (band) power of reference marker in dBm}]$$

For details see ["Relative band power markers"](#) on page 342.

*RST: POWer

Manual operation: See ["Power Mode"](#) on page 344

CALCulate<n>:DELTaMarker<m>:FUNction:BPOWer:RESult?

Queries the results of the band power measurement.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<Power> Signal power over the delta marker bandwidth.

Usage: Query only

**CALCulate<n>:DELTaMarker<m>:FUNction:BPOWer:SPAN **

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 EPL1000 model.

*RST: 5% of current span

Default unit: Hz

Manual operation: See ["Span"](#) on page 344

CALCulate<n>:DELTaMarker<m>:FUNction:BPOWer[:STATe] <State>

Turns delta markers for band power measurements on and off.

If necessary, the command also turns on a reference marker.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Manual operation: See "[Band Power Measurement State](#)" on page 344

CALCulate<n>:MARKer<m>:FUNCtion:BPOWER:RESult?

Queries the results of the band power measurement.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Return values:

<Power> Signal power over the marker bandwidth.

Example:

Activate the band power marker:

```
CALC:MARK:FUNC:BPOW:STAT ON
```

Select the density mode for the result:

```
CALC:MARK:FUNC:BPOW:MODE DENS
```

Query the result:

```
CALC:MARK:FUNC:BPOW:RES?
```

Response:

```
20dBm/Hz
```

Usage: Query only

**CALCulate<n>:MARKer<m>:FUNCtion:BPOWER:SPAN **

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 EPL1000 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 344

CALCulate<n>:MARKer<m>:FUNCTion:BPOWER:MODE <Mode>

Selects the way the results for a band power marker are displayed.

(Note: relative power results are only available for delta markers, see `CALCulate<n>:DELTAmarker<m>:FUNCTion:BPOWER:MODE` on page 624)

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 344

CALCulate<n>:MARKer<m>:FUNCTion:BPOWER[:STATe] <State>

Turns markers for band power measurements on and off.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State>

ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

`CALC:MARK4:FUNC:BPOW:STAT ON`

Activates or turns marker 4 into a band power marker.

Manual operation: See ["Band Power Measurement State"](#) on page 344

Marker demodulation

Commands to configure marker demodulation described elsewhere.

- `[SENSe:]DEMod:SQUelch:LEVel`
- `[SENSe:]DEMod:SQUelch[:STATe]`

CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTInuous.....	628
CALCulate<n>:MARKer<m>:FUNction:DEModulation:HOLDoff.....	628
CALCulate<n>:MARKer<m>:FUNction:DEModulation:SElect.....	628
CALCulate<n>:MARKer<m>:FUNction:DEModulation[:STATe].....	629
SYSTem:SPEaker[:STATe].....	629
SYSTem:SPEaker:VOLume.....	630

CALCulate<n>:MARKer<m>:FUNction:DEModulation:CONTInuous <State>

Turns continuous demodulation of the signal at the marker position in the frequency domain on and off.

In the time domain continuous demodulation is always on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: CALC2:MARK3:FUNC:DEM:CONT ON
 Switches on the continuous demodulation.

Manual operation: See "[Continuous Demodulation](#)" on page 346

CALCulate<n>:MARKer<m>:FUNction:DEModulation:HOLDoff <Duration>

Defines for how long the the signal at the marker position is demodulated.

In the time domain continuous demodulation is always on.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<Duration> Range: 10 ms to 1000 s
 *RST: Marker demodulation = OFF
 Default unit: S

Example: CALC:MARK:FUNC:DEM:HOLD 3s

Manual operation: See "[Marker Stop Time](#)" on page 347

CALCulate<n>:MARKer<m>:FUNction:DEModulation:SElect <DemodMode>

Selects the demodulation mode at the marker position.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<DemodMode> **AM**
AM demodulation

FM
FM demodulation

PM
FM demodulation

AC
AC video demodulation

AUDio
Audio demodulation

*RST: AM

Example: CALC:MARK:FUNC:DEM:SEL FM**Manual operation:** See "[Modulation](#)" on page 347**CALCulate<n>:MARKer<m>:FUNCTion:DEModulation[:STATe] <State>**

Turns the audio demodulator on and off when the measurement reaches a marker position.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:MARK3:FUNC:DEM ON
Switches on the demodulation for marker 3.**Manual operation:** See "[Marker Demodulation State](#)" on page 346**SYSTem:SPEaker[:STATe] <State>**

Switches the built-in loudspeaker on or off for demodulated signals. This setting applies only to the current application.

The command is available in the time domain in Spectrum mode and in Analog Modulation Analysis mode.

To set the volume, use the `SYSTem:SPEaker:VOLume` command.

Parameters:

<State> ON | OFF | 0 | 1
 OFF | 0
 Switches the function off
 ON | 1
 Switches the function on

Example:

```
SYST:SPE ON
SYST:SPE:VOL 0.5
```

Sets the loudspeaker to half the full volume.

Manual operation: See "[Loudspeaker](#)" on page 347

SYSTem:SPEaker:VOLume <Volume>

Defines the volume of the built-in loudspeaker for demodulated signals. This setting is maintained for all applications.

The command is available in the time domain in Spectrum mode and in Analog Modulation Analysis mode.

Parameters:

<Volume> Percentage of the maximum possible volume.
 Range: 0 to 1
 *RST: 0.5

Example:

```
SYST:SPE:VOL 0
```

Switches the loudspeaker to mute.

Manual operation: See "[Audio Output Volume](#)" on page 347

Marker peak list

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:ANNotation:LABel[:STATe]	630
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:COUNt?	631
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks[:IMMediate]	631
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:LIST:SIZE	632
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:SORT	632
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:STATe	632
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:X?	633
CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:Y?	633
CALCulate<n>:MARKer<m>:FUNCTion:FMEasurement:PEAKsearch:AUTO	634
MMEMory:STORe<n>:PEAK	634

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:ANNotation:LABel[:STATe]
 <State>

Turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<State> ON | OFF | 0 | 1

*RST: 1

Example:

CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF

Removes the peak labels from the diagram

Manual operation: See "[Display Marker Numbers](#)" on page 350**CALCulate<n>:MARKer<m>:FUNCTion:FPEaks:COUNT?**

Queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

Suffix:

<n> irrelevant

<m> irrelevant

Return values:

<NumberOfPeaks>

Example:

CALC:MARK:FUNC:FPE:COUN?

Queries the number of peaks.

Usage:

Query only

CALCulate<n>:MARKer<m>:FUNCTion:FPEaks[:IMMEDIATE] <Peaks>

Initiates a peak search.

Suffix:<n> [Window](#)<m> [Marker](#)**Parameters:**

<Peaks> This parameter defines the number of peaks to find during the search.

Note that the actual number of peaks found during the search also depends on the peak excursion you have set with

[CALCulate<n>:MARKer<m>:PEXCursion](#).

Range: 1 to 200

Example: `CALC:MARK:PEXC 5`
 Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.
`CALC:MARK:FUNC:FPE 10`
 Initiates a search for 10 peaks on the current trace.

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:LIST:SIZE <MaxNoPeaks>

Defines the maximum number of peaks that the R&S EPL1000 looks for during a peak search.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<MaxNoPeaks> Maximum number of peaks to be determined.

Range: 1 to 500

*RST: 50

Example: `CALC:MARK:FUNC:FPE:LIST:SIZE 10`
 The marker peak list will contain a maximum of 10 peaks.

Manual operation: See "[Maximum Number of Peaks](#)" on page 350

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:SORT <SortMode>

Selects the order in which the results of a peak search are returned.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<SortMode> **X**
 Sorts the peaks according to increasing position on the x-axis.

Y

Sorts the peaks according to decreasing position on the y-axis.

*RST: X

Example: `CALC:MARK:FUNC:FPE:SORT Y`
 Sets the sort mode to decreasing y values

Manual operation: See "[Sort Mode](#)" on page 350

CALCulate<n>:MARKer<m>:FUNCTION:FPEaks:STATe <State>

Turns a peak search on and off.

Suffix:

<n> [Window](#)

<m> [Marker](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
 Switches the function off
ON | 1
 Switches the function on

Example: CALC:MARK:FUNC:FPE:STAT ON
 Activates marker peak search

Manual operation: See "[Peak List State](#)" on page 350

CALCulate<n>:MARKer<m>:FUNction:FPEaks:X?

Queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with [CALCulate<n>:MARKer<m>:FUNction:FPEaks:SORT](#).

Suffix:

<n> irrelevant
 <m> irrelevant

Return values:

<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNction:FPEaks:Y?

Queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with [CALCulate<n>:MARKer<m>:FUNction:FPEaks:SORT](#).

Suffix:

<n> irrelevant
 <m> irrelevant

Return values:

<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNcTION:FMEasurement:PEAKsearch:AUTO
 <State>

Turns an automatic peak search on and off. If enabled, the search is performed automatically after each sweep.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<State> ON | OFF | 0 | 1

*RST: 0

Example:

CALC:MARK:FUNC:FME:PEAK:AUTO ON

Activates automatic marker peak search after each sweep.

Manual operation: See "[Automatic Peak Search](#)" on page 174

MMEMory:STORe<n>:PEAK <FileName>

Exports the marker peak list to a file.

Suffix:

<n> [Window](#)

Parameters:

<FileName> String containing the path,name and extension of the target file.

Example:

MMEM:STOR:PEAK 'test.dat'

Saves the current marker peak list in the file test.dat.

Manual operation: See "[Export Peak List](#)" on page 351

6.9.3.8 Programming examples for using markers and marker functions

Various programming examples on how to use markers and the special marker functions are provided here.



The use of spectrogram markers is demonstrated in [Chapter 6.9.2.8, "Programming example: configuring a spectrogram"](#), on page 585.

- [Example: basic markers](#).....635
- [Example: marker search in spectrograms](#).....636
- [Basic frequency sweep measurement for marker function examples](#).....637
- [Example: using a fixed reference marker](#).....637
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- [Example: measuring characteristic bandwidths \(using the n db down marker\)...](#) 640
- [Examples: demodulating marker values and providing audio output.....](#) 641
- [Example: performing a highly accurate frequency measurement using the signal count marker.....](#) 642

Example: basic markers

This example demonstrates how to configure and define markers for a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513 has been performed and thus does not begin by presetting the instrument.

```
//-----Configuring marker behavior -----
DISP:MTAB ON
//Marker information is always displayed in a separate table.
CALC:MARK:X:SSIZ STAN
//The marker moves from one pixel to the next instead of sweep points in manual op.
CALC:MARK:PEXC 6dB
//Defines a peak excursion of 6 dB.
CALC:MARK:X:SLIM ON
CALC:MARK:X:SLIM:LEFT 50MHz
CALC:MARK:X:SLIM:RIGH 150MHz
//Restricts the search area for peaks to the frequencies between 50 and 150 MHz.
CALC:THR -100dBm
CALC:THR:STAT ON
//Configures a threshold level for peak searches at -100 dBm.

//-----Defining and positioning markers -----
CALC:MARK1 ON
//Activates marker 1 and sets it to the peak of trace 1.
CALC:MARK2:TRAC 2
//Activates marker 2 and sets it to the peak of trace 2.
CALC:MARK3:X 150MHz
//Activates marker 3 and sets it to the freq. 150 MHz on trace 1.
CALC:MARK4:TRAC 4
//Activates marker 4 and sets it to the peak of trace 4.

CALC:MARK1:MAX:AUTO ON
//Moves M1 to the current peak of trace 1 after each sweep.
CALC:MARK2:MAX:NEXT
//Moves M2 to the next lower peak of trace 2.

CALC:DELT5 ON
CALC:DELT5:LINK ON
//Activates delta marker 5 and links it to marker 1. If M1 moves, so does D5.
CALC:DELT5:MREF 4
//Changes the reference for D5 to marker 4. D5 now shows the difference between
//the peak of trace 1 after each sweep and the value at the same position in
//trace 4, which is a copy of trace 1, averaged over 10 sweeps.
```

```

CALC:DELT5:MODE REL
//Shows the difference as relative values.

CALC:DELT6 ON
CALC:DELT6:MAX:NEXT
//Activates delta marker 6 and sets it to the next lower maximum of trace 1.
//Thus it shows the difference between the two highest peaks in trace 1.

//-----Retrieving marker values -----
CALC:MARK1:Y?
CALC:MARK2:Y?
CALC:MARK3:Y?
CALC:MARK4:Y?
CALC:DELT5:Y?
CALC:DELT6:Y?
//Retrieves the marker levels of each active normal and delta marker.
CALC:DELT5:X:REL?
CALC:DELT6:X:REL?
//Retrieves the frequency difference between the delta marker and marker 1.

//-----Deactivating all markers -----
//CALC:MARK:AOFF
//CALC:DELT:AOFF

```

Example: marker search in spectrograms

This example demonstrates how to search for peak values in spectrograms in a remote environment. It assumes a spectrogram is already available (see [Chapter 6.9.2.8, "Programming example: configuring a spectrogram"](#), on page 585) and thus does not begin by presetting the instrument.

```

//----- Analyzing the results using markers -----
//Set marker1 on the peak power in the most recent spectrum and query
//its position
CALC2:SPEC:FRAM:SEL 0
CALC2:MARK1 ON
CALC2:MARK1:X?
CALC2:MARK1:Y?

//Set marker2 on the peak power in frame at -324ms and query its position
CALC2:MARK2 ON
CALC2:MARK2:SGR:FRAM -324ms
CALC2:MARK2:X?
CALC2:MARK2:Y?

//Set marker3 on peak power level in the entire spectrogram in memory and
//query its position
CALC2:MARK3 ON
CALC2:MARK:SPEC:SAR MEM
CALC2:MARK3:SPEC:XY:MAX
CALC2:MARK3:X?

```

```

CALC2:MARK3:Y?

//Move marker 3 to the next lower peak level for the same frequency
CALC2:MARK3:SPEC:Y:MAX:NEXT
CALC2:MARK3:X?
CALC2:MARK3:Y?

//Set marker 4 to the highest level in the (visible) spectrogram.
CALC2:MARK:SPEC:SAR VIS
CALC2:MARK4:SPEC:XY:MAX
//Move marker 4 to the next higher level in the frames above its current position.
CALC2:MARK4:SPEC:Y:MAX:ABOV

```

Basic frequency sweep measurement for marker function examples

Since markers can only be placed on an existing trace, the following example provides a simple frequency sweep measurement to be used as a basis for the subsequent marker function scripts.

```

//----- Configuring the basic frequency sweep -----
*RST
//Resets the instrument
INIT:CONT OFF
//Selects single sweep mode.
FREQ:CENT 100MHz
//Defines the center frequency
FREQ:SPAN 200MHz
//Sets the span to 100 MHz on either side of the center frequency.
DISP:TRAC1:Y:RLEV 0dBm
//Sets the reference level to 0 dBm.

//----- Performing the measurement -----
INIT;*WAI
//Performs a measurement and waits for it to end

```

Example: using a fixed reference marker

This example demonstrates how to configure and use reference markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in "[Basic frequency sweep measurement for marker function examples](#)" on page 637 has been performed and thus does not begin by presetting the instrument.

```

//-----Configuring the reference marker -----
//Activate a fixed reference marker. It is set to the current maximum of trace 1.
CALC:DELT:FUNC:FIX ON
//Set the reference frequency to 128 MHz.
CALC:DELT:FUNC:FIX:RPO:X 128 MHZ
//Set the reference level to +30 dBm.
CALC:DELT:FUNC:FIX:RPO:Y 30 DBM

//Use the fixed reference marker as a reference for deltamarker 2

```

```

CALC:DELT2:MREF FIX

//Reset the reference marker to the current maximum of trace 1
CALC:DELT:FUNC:FIX:RPO:MAX
//Query the new position of the reference marker
CALC:DELT:FUNC:FIX:RPO:X?
CALC:DELT:FUNC:FIX:RPO:Y?

```

Example: obtaining a marker peak list

This example demonstrates how to obtain a marker peak list in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 637 has been performed and thus does not begin by presetting the instrument.

In this example, the peak search is restricted to the frequency range of 50 MHz to 150 MHz. The top 5 power levels with a peak excursion of 10dB and a minimum of -100 dBm are to be determined and displayed with their marker numbers. The results are sorted by frequency values. The resulting peak list is then exported to a file.

```

//----- Configuring the peak search -----
CALC:MARK:X:SLIM ON
CALC:MARK:X:SLIM:LEFT 50MHz
CALC:MARK:X:SLIM:RIGH 150MHz
CALC:MARK:PEXC 10DB
CALC:THR -100DBM
CALC:THR:STAT ON

CALC:MARK:FUNC:FPE:STAT ON
CALC:MARK:FUNC:FPE:LIST:SIZE 5
CALC:MARK:FUNC:FPE:SORT X
CALC:MARK:FUNC:FPE:ANN:LAB ON

//----- Retrieving results -----
CALC:MARK:FUNC:FPE:COUN?
CALC:MARK:FUNC:FPE:X?
CALC:MARK:FUNC:FPE:Y?

//----- Exporting the peak list -----
MMEM:STOR:PEAK 'PeakList'

```

Example: measuring noise density

This example demonstrates how to measure noise density using noise markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 637 has been performed and thus does not begin by presetting the instrument.

```

CALC:MARK1:FUNC:NOIS ON
//Switches on noise measurement at marker 1.

```

```

INIT;*WAI
//Performs a measurement and waits for it to end

CALC:MARK1:FUNC:NOIS:RES?
//Queries the measured noise level (per Hz bandwidth)

```

Example: measuring phase noise

This example demonstrates how to measure phase noise using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 637 has been performed and thus does not begin by presetting the instrument.

```

//----- Configuring the phase noise marker -----
DET SAMP
//Switches to Sample detector

CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level

CALC:DELT:FUNC:PNO ON
//Activates phase noise marker function

CALC:DELT1 ON
CALC:DELT1:X 100kHz

CALC:DELT2 ON
CALC:DELT2:X 500kHz

CALC:DELT3 ON
CALC:DELT3:X 1MHz

CALC:DELT4 ON
CALC:DELT4:X 1.5MHz

//Activates the phase noise measurement function for offsets 100kHz/500kHz/1MHz/1.5MHz.

BAND:VID?
//Queries the used VBW (= 0.1*RBW)

//----- Querying the phase noise results -----

CALC:DELT1:FUNC:PNO:RES?
CALC:DELT2:FUNC:PNO:RES?
CALC:DELT3:FUNC:PNO:RES?
CALC:DELT4:FUNC:PNO:RES?

```

```
//Queries the difference in level between the peak and the noise power density
//measured at the deltamarkers, referred to the carrier power level (dBc)
```

Example: measuring the power in a channel using band power markers

This example demonstrates how to measure the power in a specific channel or band using markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in ["Basic frequency sweep measurement for marker function examples"](#) on page 637 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the band power marker -----
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around marker 1
CALC:MARK1:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:MARK1:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

CALC:DELT2 ON
//Activates deltamarker2
CALC:DELT2:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around deltamarker 2
CALC:DELT2:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:DELT2:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

CALC:DELT3 ON
//Activates deltamarker3
CALC:DELT3:FUNC:BPOW:STAT ON
//Activates the band power measurement for the band around deltamarker 3
CALC:DELT3:FUNC:BPOW:SPAN 30MHz
//Sets the bandwidth to be measured to 30 MHz
CALC:DELT3:FUNC:BPOW:MODE DENS
//Sets the result to be a density (power per Hz bandwidth)

//-----Retrieving Results-----
CALC:MARK1:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around marker 1.
CALC:DELT2:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around deltamarker 2.
CALC:DELT3:FUNC:BPOW:RES?
//Returns the power sum for the specified bandwidth around deltamarker 3.
```

Example: measuring characteristic bandwidths (using the n db down marker)

This example demonstrates how to measure a characteristic bandwidth using markers in a basic spectrum measurement in a remote environment. It assumes that the basic

frequency sweep described in [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the n dB down marker -----
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:NDBD 3DB
//Sets the level offset to 3 dB
CALC:MARK1:FUNC:NDBD:STAT ON
//Activates the n dB down measurement

//-----Retrieving Results-----
CALC:MARK:FUNC:NDBD:RES?
//Returns the bandwidth at the specified power offset.
CALC:MARK:FUNC:NDBD:FREQ?
//Returns the frequencies of the temporary markers at the power offsets
CALC:MARK:FUNC:NDBD:QFAC?
//Returns the quality factor of the resulting bandwidth
```

Examples: demodulating marker values and providing audio output

The following examples demonstrate how to demodulate markers and provide audio output in a remote environment.

- [Example: providing audio output for individual marker values](#)..... 641
- [Example: demodulating and providing audio output continuously](#)..... 642

Example: providing audio output for individual marker values

This example demonstrates how to demodulate markers and provide audio output in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513 has been performed and thus does not begin by presetting the instrument.

Audio output is provided for 5s each time the signal reaches its initial maximum, however only if it is higher than -90 dBm (10% of the total y-axis range) in order to ignore noise.

```
//----- Configuring the marker demodulation -----
CALC:MARK1 ON
//Activates marker1 and sets it to the maximum power level
CALC:MARK1:FUNC:DEM:SEL FM
//Selects FM demodulation
CALC:MARK1:FUNC:DEM:HOLD 5s
//Defines an output duration of 5s
DEM:SQU:LEV 10
//Sets a squelch level for noise
DEM:SQU ON
//Activates squelching
CALC:MARK1:FUNC:DEM ON
//Activates demodulation
```

```
//----- Performing the measurement -----
INIT;*WAI
//Performs a measurement and waits for it to end

//-----Retrieving Results-----
//Results are only provided as audio output!
```

Example: demodulating and providing audio output continuously

This example demonstrates how to demodulate markers and provide audio output in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the marker demodulation -----
CALC:MARK1 ON
//Activates marker1
CALC:MARK1:FUNC:DEM:SEL FM
//Selects FM demodulation
DEM:SQU:LEV 10
//Sets a squelch level for noise
DEM:SQU ON
//Activates squelching
CALC:MARK1:FUNC:DEM:CONT ON
//Activates continuous demodulation

//----- Performing the measurement -----
INIT:CONT ON
//Performs a measurement and provides continuous audio output

//-----Retrieving Results-----
//Results are only provided as audio output!
```

Example: performing a highly accurate frequency measurement using the signal count marker

This example demonstrates how to determine highly accurate frequency values using signal count markers in a basic spectrum measurement in a remote environment. It assumes that the basic frequency sweep described in [Chapter 6.7.19, "Programming example: performing a basic frequency sweep"](#), on page 513 has been performed and thus does not begin by presetting the instrument.

```
//----- Configuring the signal count marker -----
CALC:MARK1 ON
//Activates marker1
CALC:MARK1:COUN ON
//Switches on the frequency counter for marker 1.
CALC:MARK1:COUN:RES 1kHz
//Sets the resolution of the frequency counter to 1kHz
```

```
//----- Performing the measurement -----
INIT;*WAI
//Performs a measurement and waits for it to end

//-----Retrieving Results-----
CALC:MARK1:COUN:FREQ?
//Returns the signal counter value as the precise marker frequency.
```

6.9.4 Lines

- [Display lines](#)..... 643
- [Limit lines](#)..... 646

6.9.4.1 Display lines

CALCulate<n>:DLINe<dl>	643
CALCulate<n>:DLINe<dl>:STATe	643
CALCulate<n>:FLINe<dl>	644
CALCulate<n>:FLINe<dl>:STATe	644
CALCulate<n>:PLINe<dl>	645
CALCulate<n>:PLINe<dl>:STATe	645
CALCulate<n>:TLINe<dl>	645
CALCulate<n>:TLINe<dl>:STATe	646

CALCulate<n>:DLINe<dl> <Position>

Defines the (horizontal) position of a display line.

Suffix:

<n> [Window](#)

<dl> 1 | 2

Parameters:

<Position>

The value range is variable.

You can use any unit you want, the R&S EPL1000 then converts the unit to the currently selected unit. If you omit a unit, the R&S EPL1000 uses the currently selected unit.

*RST: (state is OFF)

Default unit: DBM

Example:

`CALC:DLIN2 -20dBm`

Positions the second display line at -20 dBm.

Manual operation: See "[Horizontal Line 1/ Horizontal Line 2](#)" on page 356

CALCulate<n>:DLINe<dl>:STATe <State>

Turns a display line on and off

Suffix:<n> [Window](#)

<dl> 1 | 2

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:

```
CALC:DLIN2:STAT ON
```

Turns on display line 2.

CALCulate<n>:FLINE<dl> <Frequency>

Defines the position of a frequency line.

Suffix:<n> [Window](#)<dl> 1 to 4
frequency line**Parameters:**

<Frequency> Note that you can not set a frequency line to a position that is outside the current span.

Range: 0 Hz to Fmax

*RST: (STATe to OFF)

Default unit: HZ

Example:

```
CALC:FLIN2 120MHz
```

Sets frequency line 2 to a frequency of 120 MHz.

Manual operation: See "[Vertical Line <x>](#)" on page 355**CALCulate<n>:FLINE<dl>:STATe <State>**

Turns a frequency line on and off

Suffix:<n> [Window](#)<dl> 1 | 2
frequency line**Parameters:**

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example: `CALC:FLIN2:STAT ON`
Turns frequency line 2 on.

CALCulate<n>:PLINe<dl> <Generator Level>

Defines the position of a power line.

Suffix:

<n> [Window](#)

Parameters:

<Generator Level> Range: -60 to +10
*RST: line 1: -30 dBm, line 2: -20 dBm
Default unit: DBM

Example: `CALC:PLIN2 1dBm`
Sets power line 2 to a level of 1 dBm.

Manual operation: See "[Vertical Line <x>](#)" on page 355

CALCulate<n>:PLINe<dl>:STATe <State>

Turns a power line on and off

Suffix:

<n> [Window](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: `CALC:PLIN2:STAT ON`
Turns power line 2 on.

CALCulate<n>:TLINe<dl> <Time>

Defines the position of a time line.

Suffix:

<n> [Window](#)

<dl> 1 to 4
time line

Parameters:

<Time> Note that you can not set a time line to a position that is higher than the current sweep time.
Range: 0 s to 1600 s
*RST: (STATe to OFF)
Default unit: S

Example: CALC:TLIN 10ms
Sets the first time line to 10 ms.

Manual operation: See "[Vertical Line <x>](#)" on page 355

CALCulate<n>:TLINe<dl>:STATe <State>

Turns a time line on and off

Suffix:

<n> [Window](#)

<dl> 1 | 2
time line

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example: CALC:TLIN:STAT ON
Turns the first time line on.

6.9.4.2 Limit lines

CALCulate<n>:LIMit:ACTive?	647
CALCulate<n>:LIMit:CLEar[:IMMediate]	647
CALCulate<n>:LIMit:COMMeNt	647
CALCulate<n>:LIMit:CONTRol[:DATA]	648
CALCulate<n>:LIMit:CONTRol:DOMain	648
CALCulate<n>:LIMit:CONTRol:MODE	648
CALCulate<n>:LIMit:CONTRol:OFFSet	649
CALCulate<n>:LIMit:CONTRol:SHIFt	649
CALCulate<n>:LIMit:CONTRol:SPACing	650
CALCulate<n>:LIMit:COPY	650
CALCulate<n>:LIMit:DELeTe	650
CALCulate<n>:LIMit:FAIL?	650
CALCulate<n>:LIMit:LOWer[:DATA]	651
CALCulate<n>:LIMit:LOWer:MARGin	651
CALCulate<n>:LIMit:LOWer:MODE	652
CALCulate<n>:LIMit:LOWer:OFFSet	652
CALCulate<n>:LIMit:LOWer:SHIFt	652
CALCulate<n>:LIMit:LOWer:SPACing	653
CALCulate<n>:LIMit:LOWer:STATe	653
CALCulate<n>:LIMit:LOWer:THReshold	654
CALCulate<n>:LIMit:NAME	654
CALCulate<n>:LIMit:STATe	654
CALCulate<n>:LIMit:TRACe<t>	655
CALCulate<n>:LIMit:TRACe<t>:CHECK	655

CALCulate<n>:LIMit:UNIT.....	656
CALCulate<n>:LIMit:UPPer[:DATA].....	656
CALCulate<n>:LIMit:UPPer:MARGin.....	657
CALCulate<n>:LIMit:UPPer:MODE.....	657
CALCulate<n>:LIMit:UPPer:OFFSet.....	657
CALCulate<n>:LIMit:UPPer:SHIFt.....	658
CALCulate<n>:LIMit:UPPer:SPACing.....	658
CALCulate<n>:LIMit:UPPer:STATe.....	658
CALCulate<n>:LIMit:UPPer:THReshold.....	659
MMEMory:COpy.....	659
MMEMory:LOAD<n>:LIMit.....	659
MMEMory:STORe<n>:LIMit.....	659

CALCulate<n>:LIMit:ACTive?

Queries the names of *all* active limit lines.

Suffix:

<n>	irrelevant
	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 363

CALCulate<n>:LIMit:CLEar[:IMMEDIATE]

Deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time.

Suffix:

<n>	Window
	irrelevant

Example:

CALC:LIM:CLE

Deletes the result of the limit check.

CALCulate<n>:LIMit:COMMent <Comment>

Defines a comment for a limit line.

Suffix:

<n>	irrelevant
	Limit line

Parameters:

<Comment> String containing the description of the limit line.

Manual operation: See "[Comment](#)" on page 365

CALCulate<n>:LIMit:CONTrol[:DATA] <LimitLinePoints>

Defines the horizontal definition points of a limit line.

Suffix:

<n> irrelevant

 [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:LOWer\[:DATA\]](#) or [CALCulate<n>:LIMit:UPPer\[:DATA\]](#). If not, the R&S EPL1000 either adds missing values or ignores surplus values.
 The unit is Hz or s.

*RST: -

Default unit: HZ

Manual operation: See "[Data Points](#)" on page 366

CALCulate<n>:LIMit:CONTrol:DOMain <SpanSetting>

Selects the domain of the limit line.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<SpanSetting> FREQUENCY | TIME

FREQUENCY

For limit lines that apply to a range of frequencies.

TIME

For limit lines that apply to a period of time.

*RST: FREQUENCY

Example:

CALC:LIM:CONT:DOM FREQ

Select a limit line in the frequency domain.

Manual operation: See "[X-Axis](#)" on page 366

CALCulate<n>:LIMit:CONTrol:MODE <Mode>

Selects the horizontal limit line scaling.

Suffix:

<n> irrelevant

 [Limit line](#)**Parameters:**

<Mode>

ABSolute

Limit line is defined by absolute physical values (Hz or s).

RELative

Limit line is defined by relative values related to the center frequency (frequency domain) or the left diagram border (time domain).

*RST: ABSolute

Manual operation: See "[X-Axis](#)" on page 366**CALCulate<n>:LIMit:CONTrol:OFFSet <Offset>**

Defines an offset for a complete limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:

<n> irrelevant

 [Limit line](#)**Parameters:**

<Offset>

Numeric value.

The unit depends on the scale of the x-axis.

*RST: 0

Default unit: HZ

Manual operation: See "[X-Offset](#)" on page 363**CALCulate<n>:LIMit:CONTrol:SHIFt <Distance>**

Moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> irrelevant

 [Limit line](#)**Parameters:**

<Distance>

Numeric value.

The unit depends on the scale of the x-axis.

Default unit: HZ

Manual operation: See "[Shift x](#)" on page 367

CALCulate<n>:LIMit:CONTrol:SPACing <InterpolMode>

Selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<InterpolMode> LINear | LOGarithmic

*RST: LIN

Example: CALC:LIM:CONT:SPAC LIN

Manual operation: See "[X-Axis](#)" on page 366

CALCulate<n>:LIMit:COPY <Line>

Copies a limit line.

Suffix:

<n> [Window](#)

 [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 364

CALCulate<n>:LIMit:DELeTe

Deletes a limit line.

Suffix:

<n> [Window](#)

 [Limit line](#)

Manual operation: See "[Delete Line](#)" on page 364

CALCulate<n>:LIMit:FAIL?

Queries the result of a limit check in the specified window.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also [INITiate<n>:CONTInuous](#) on page 393.

Suffix:

<n> [Window](#)

 [Limit line](#)

Return values:

<Result> **0**
 PASS
1
 FAIL

Example:

```
INIT;*WAI
```

Starts a new sweep and waits for its end.

```
CALC2:LIM3:FAIL?
```

Queries the result of the check for limit line 3 in window 2.

Usage:

Query only

Manual operation: See "[Limit Check <n>](#)" on page 88

CALCulate<n>:LIMit:LOWer[:DATA] <LimitLinePoints>

Defines the vertical definition points of a lower limit line.

Suffix:

<n> irrelevant

 [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:CONTRol\[:DATA\]](#). If not, the R&S EPL1000 either adds missing values or ignores surplus values.
The unit depends on [CALCulate<n>:LIMit:UNIT](#) on page 656.

*RST: Limit line state is OFF

Default unit: DBM

Manual operation: See "[Data Points](#)" on page 366

CALCulate<n>:LIMit:LOWer:MARGin <Margin>

Defines an area around a lower limit line where limit check violations are still tolerated.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Margin> **numeric value**

*RST: 0

Default unit: dB

Manual operation: See "[Margin](#)" on page 366

CALCulate<n>:LIMit:LOWer:MODE <Mode>

Selects the vertical limit line scaling.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<Mode> **ABSolute**

Limit line is defined by absolute physical values.

The unit is variable.

RELative

Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual operation: See "[Y-Axis](#)" on page 366

CALCulate<n>:LIMit:LOWer:OFFSet <Offset>

Defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<Offset> Numeric value.

*RST: 0

Default unit: dB

Manual operation: See "[Y-Offset](#)" on page 363

CALCulate<n>:LIMit:LOWer:SHIFt <Distance>

Moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<Distance> Defines the distance that the limit line moves.
The unit depends on [CALCulate<n>:LIMit:UNIT](#) on page 656.
Default unit: DB

Manual operation: See "[Shift y](#)" on page 367

CALCulate<n>:LIMit:LOWer:SPACing <InterpolType>

Selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<InterpolType> LINear | LOGarithmic
*RST: LIN

Manual operation: See "[Y-Axis](#)" on page 366

CALCulate<n>:LIMit:LOWer:STATe <State>

Turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with [CALCulate<n>:LIMit:NAME](#) on page 654.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Manual operation: See "[Visibility](#)" on page 363

CALCulate<n>:LIMit:LOWer:THReshold <Threshold>

Defines a threshold for relative limit lines.

The R&S EPL1000 uses the threshold for the limit check, if the limit line violates the threshold.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Threshold> Numeric value.
The unit depends on [CALCulate<n>:LIMit:UNIT](#) on page 656.

*RST: -200 dBm

Default unit: DBM

Manual operation: See "[Threshold](#)" on page 365

CALCulate<n>:LIMit:NAME <Name>

Selects a limit line that already exists or defines a name for a new limit line.

Suffix:

<n> [Window](#)

 [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 365

CALCulate<n>:LIMit:STATe <State>

Turns the limit check for a specific limit line on and off.

To query the limit check result, use [CALCulate<n>:LIMit: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:TRACe<t>:CHECK](#) on page 655).

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0

Switches the function off

ON | 1

Switches the function on

Example:`CALC:LIM:STAT ON`

Switches on the limit check for limit line 1.

Manual operation: See "[Disable All Lines](#)" on page 364**CALCulate<n>:LIMit:TRACe<t> <TraceNumber>**

Links a limit line to one or more traces.

Note that this command is maintained for compatibility reasons only. Limit lines no longer need to be assigned to a trace explicitly. The trace to be checked can be defined directly (as a suffix) in the new command to activate the limit check (see [CALCulate<n>:LIMit:TRACe<t>:CHECK](#) on page 655).

Suffix:

<n>	Window
	Limit line
<t>	irrelevant

Parameters:

<TraceNumber>	1 to 6
*RST:	1

Example:`CALC:LIM2:TRAC 3`

Assigns limit line 2 to trace 3.

CALCulate<n>:LIMit:TRACe<t>:CHECK <State>

Turns the limit check for a specific trace on and off.

To query the limit check result, use [CALCulate<n>:LIMit:FAIL?](#).

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- [CALCulate<n>:LIMit:TRACe<t>](#) on page 655
- [CALCulate<n>:LIMit:STATe](#) on page 654

Suffix:

<n>	Window
	Limit line
<t>	Trace

Parameters:

<State>	ON OFF 0 1
	OFF 0
	Switches the function off

ON | 1

Switches the function on

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 363

CALCulate<n>:LIMit:UNIT <Unit>

Defines the unit of a limit line.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Unit> DBM | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere | DB | DBUV_M | DBUA_M | DBM_hz | DBM_mhz | DBUV_mhz | DBMV_mhz | DBUa_mhz | DBUV_m | DBUa_m | DBUV_mmhz | DBUa_mmhz | DBPW_mhz | DBPT_mhz | DBPT | (unitless)

If you select a dB-based unit for the limit line, the command automatically turns the limit line into a relative limit line.

*RST: DBM

Manual operation: See ["Y-Axis"](#) on page 366

CALCulate<n>:LIMit:UPPer[:DATA] <LimitLinePoints>...

Defines the vertical definition points of an upper limit line.

Suffix:

<n> irrelevant

 [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:CONTRol\[:DATA\]](#). If not, the R&S EPL1000 either adds missing values or ignores surplus values.

The unit depends on [CALCulate<n>:LIMit:UNIT](#) on page 656.

*RST: Limit line state is OFF

Default unit: DBM

Manual operation: See ["Data Points"](#) on page 366

CALCulate<n>:LIMit:UPPer:MARGin <Margin>

Defines an area around an upper limit line where limit check violations are still tolerated.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Margin> **numeric value**

*RST: 0

Default unit: dB

Manual operation: See "[Margin](#)" on page 366

CALCulate<n>:LIMit:UPPer:MODE <Mode>

Selects the vertical limit line scaling.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<Mode>

ABSolute

Limit line is defined by absolute physical values.

The unit is variable.

RELative

Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual operation: See "[Y-Axis](#)" on page 366

CALCulate<n>:LIMit:UPPer:OFFSet <Offset>

Defines an offset for a complete upper limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Offset> Numeric value.

*RST: 0

Default unit: dB

Manual operation: See "Y-Offset" on page 363

CALCulate<n>:LIMit:UPPer:SHIFt <Distance>

Moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Distance> Defines the distance that the limit line moves.
The unit depends on [CALCulate<n>:LIMit:UNIT](#) on page 656.

Manual operation: See "Shift y" on page 367

CALCulate<n>:LIMit:UPPer:SPACing <InterpolType>

Selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

Suffix:

<n> [Window](#)

 [Limit line](#)

Parameters:

<InterpolType> LINear | LOGarithmic
*RST: LIN

Manual operation: See "Y-Axis" on page 366

CALCulate<n>:LIMit:UPPer:STATe <State>

Turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with [CALCulate<n>:LIMit:NAME](#) on page 654.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off

ON | 1

Switches the function on

Manual operation: See "[Visibility](#)" on page 363

CALCulate<n>:LIMit:UPPer:THReshold <Limit>

Defines an absolute limit for limit lines with a relative scale.

The R&S EPL1000 uses the threshold for the limit check, if the limit line violates the threshold.

Suffix:

<n> irrelevant

 [Limit line](#)

Parameters:

<Limit> Numeric value.

The unit depends on [CALCulate<n>:LIMit:UNIT](#) on page 656.

*RST: -200

Default unit: dBm

Manual operation: See "[Threshold](#)" on page 365

MMEMory:COpy <FileName>, <FileName>

This command copies one or more files to another directory.

Parameters:

<FileName> String containing the path and file name of the source file.

<FileName> String containing the path and name of the target file.
The path may be relative or absolute.

MMEMory:LOAD<n>:LIMit <FileName>

Loads the limit line from the selected file in .CSV format.

Suffix:

<n> irrelevant

Parameters:

<FileName> String containing the path and name of the CSV import file.

Example: `MMEM:LOAD:LIM 'C:\TEST.CSV'`

Manual operation: See "[Import](#)" on page 367

MMEMory:STORe<n>:LIMit <FileName>, <LimitLineName>

Exports limit line data to an ASCII (CSV) file.

For details on the file format see [Chapter 5.5.2.4, "Reference: limit line file format"](#), on page 372.

Suffix:

<n> irrelevant

Parameters:

<FileName> String containing the path and name of the target file.

<LimitLineName> Name of the limit line to be exported.

Example:

```
M MEM:STOR:LIM 'C:\TEST', 'UpperLimitLine'  
Stores the limit line named "UpperLimitLine" in the file  
TEST.CSV.
```

Manual operation: See ["Export"](#) on page 368

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