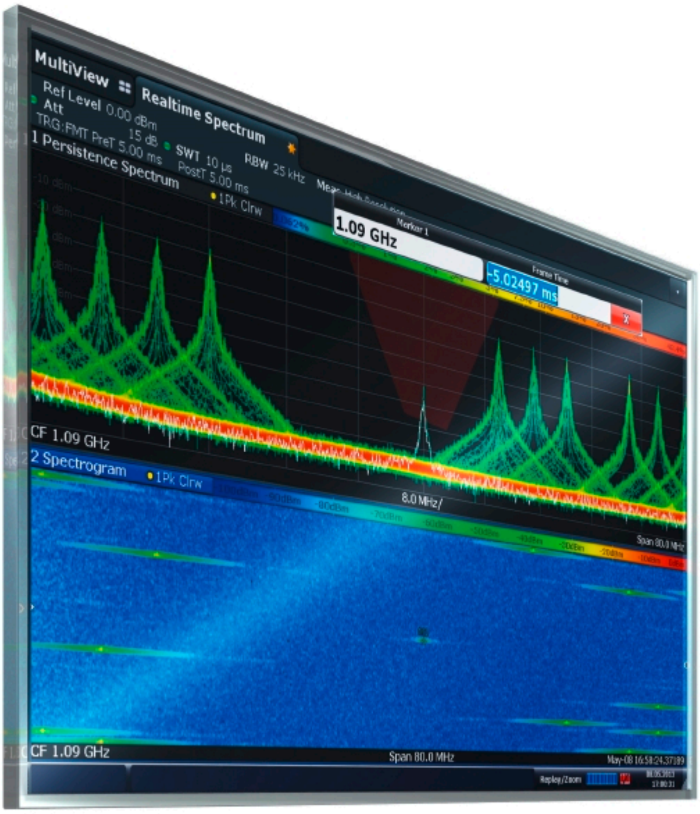
R&S®ESW-K55
Real-Time Analysis
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

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

- R&S®ESW-K55 (1328.4968K02)

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

Contents

1 Welcome to the R&S ESW Real-Time Extension

The R&S ESW real-time extension options provide both an application and an operating mode to display RF spectra in real-time and gapless, allowing for quick and simple error analysis and signal characterization.

This user manual contains a description of the functionality specific to the Real-Time Spectrum application, including remote control operation.

Functions not discussed in this manual are the same as in Signal and Spectrum Analyzer mode and are described in the R&S ESW User Manual. The latest version is available for download at the product homepage (http://www.rohde-schwarz.com/product/FSW.html).

Installation

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

1.1 Starting the R&S ESW Real-Time application

The Real-Time Spectrum application adds real-time measurement analysis to the R&S ESW. It is available with the optional real-time hardware component.

To activate the R&S ESW Real-Time application

1. Press the MODE key on the front panel of the R&S ESW.

   A dialog box opens that contains all operating modes and applications currently available on your R&S ESW.

2. Select the "Real-Time Spectrum" item.

   The R&S ESW opens a new measurement channel for the R&S ESW Real-Time application.

The measurement is started immediately with the default settings. It can be configured in the Real-Time Spectrum "Overview".

(See Chapter 5.1, "Configuration Overview", on page 41)

1.2 Understanding the Display Information

1.2.1 R&S ESW Real-Time application

The following figure shows a measurement diagram in the R&S ESW Real-Time application (with R&S ESW-B160R). All different information areas are labeled. They are explained in more detail in the following sections.

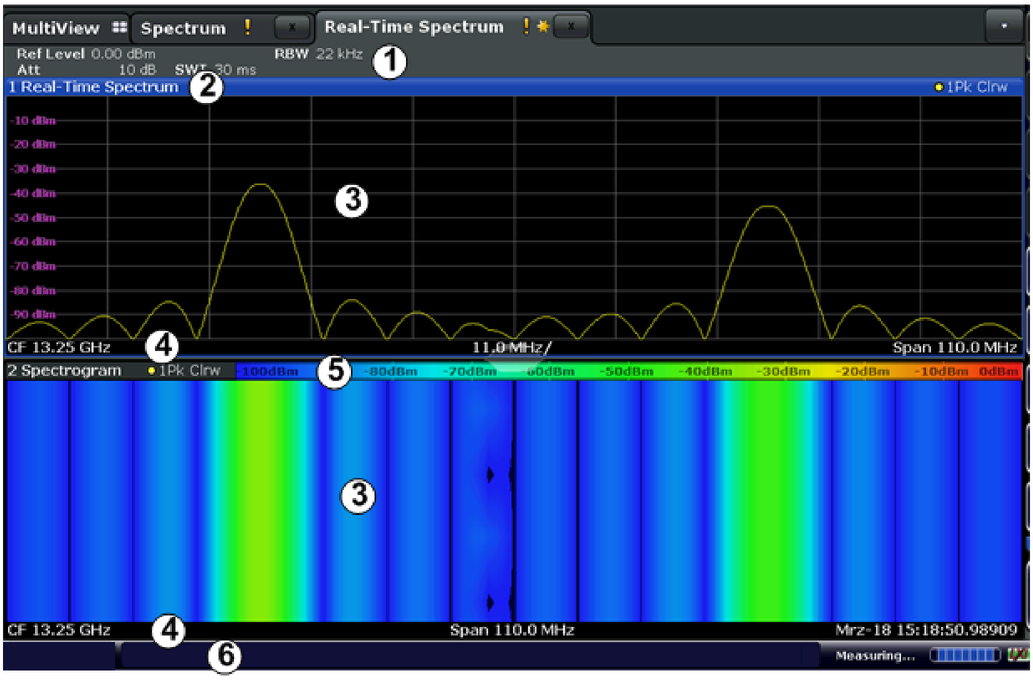


Figure 1-1: Screen elements in the REal-Time Spectrum channel (using option R&S ESW-B160R)

1 = Channel bar for firmware and measurement settings
2 = Window title bar with diagram-specific (trace) information
3 = Spectrum and Spectrogram displays
4 = Diagram footer with diagram-specific information, depending on evaluation
5 = Spectrogram color map legend
6 = Instrument status bar with error messages, progress bar and date/time display

Channel bar information

In the R&S ESW Real-Time application, the R&S ESW shows the following settings:

Table 1-1: Information displayed in the channel bar in the R&S ESW Real-Time application

"Ref Level"	Reference level
"Att" / "m.+el.Att"	Mechanical RF attenuation / Mechanical and electronic RF attenuation
"Offset"	Reference level offset
"SWT"	Data acquisition time for single spectrogram line in frequency domain
"RBW"	Resolution bandwidth

"TRG"	Trigger source
"PreTrigger"/"PostTrigger"	Data acquisition time before / after the trigger event
"SGL"	The measurement is set to single sweep mode.

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

Window title bar information

For each diagram, the header provides the following information:

1 = Window number
2 = Window type
3 = Trace color
4 = Trace number
5 = Trace detector
6 = Trace mode
7 = Color map legend

Diagram footer information

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

Spectrum displays:

- Center frequency (CF)
- Displayed frequency span per division
- Displayed frequency span

Spectrograms:

- Center frequency (CF)
- Displayed frequency span
- Timestamp or index of current frame

Time domain displays:

- Center frequency (CF)
- Displayed time span per division

Status bar information

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

2 Typical Applications

A common challenge when developing RF applications are sporadic and transient interferences. In order to keep the time for development short, it is essential that such interferences are detected quickly and that the exact cause is determined. Possible causes may be interference from digital circuits or short-term effects from frequency hopping techniques in sending devices. Thus, a seamless data acquisition and a frequency mask trigger are required.

A further application for Real-Time Spectrum measurement is various standards working in the same frequency range, for example Bluetooth and WLAN. Frequent collisions reduce the data rates. To develop effective algorithms that elude collisions, the spectrum must be analyzed seamlessly.

Precise analysis of frequency-variant senders (hoppers) is not only indispensable for wireless data transfer, but also for radar applications or satellite communication. Administrative or regulatory authorities also depend on seamless spectrum analysis to supervise the frequency bands.

3 Measurements and Result Displays

In order to accommodate for different requirements, different measurement types and result displays are provided for Real-Time Spectrum measurements.

3.1 Real-Time Spectrum Result Displays

The R&S ESW Real-Time Spectrum measurements not only process data in real-time, but also offer several result displays that help you analyze the data as it is displayed. The human eye has a limited capability of detecting changes – therefore the R&S ESW Real-Time application result displays visualize the time axis, i.e. the changes of a signal over time. Display modes with information on past and present spectra at the same time allow for a quick analysis of changes for human eyes.

For Real-Time Spectrum measurements, up to 6 result displays can be displayed simultaneously in separate windows.

Real-Time Spectrum

The Real-Time Spectrum diagram displays the measured power levels for a frequency span of 80 MHz around the selected center frequency.

The displayed data corresponds to one particular frame in the spectrogram. During a running measurement, the most recently captured frame is always displayed. During analysis, which frame is displayed depends on the selected frame in the spectrogram configuration (see "Selecting a frame to display" on page 66) or the marker position in the spectrogram (see "Frame" on page 76). The displayed frame is indicated by small white arrows on the left and right border of the spectrogram/PVT waterfall.

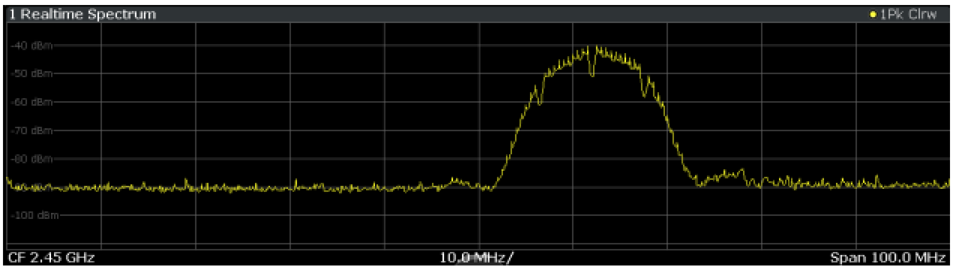


Figure 3-1: Real-Time Spectrum result display

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

Remote command:
`LAY:ADD? '1',RIGH, 'XFRequency'`, see `LAYout:ADD[:WINDow]?` on page 145

Spectrogram

The spectrogram is a way of displaying multiple consecutive spectrums over time. The power level, which is usually displayed over frequency, is displayed over frequency and time. Graphically, time and frequency represent the vertical and horizontal axes of the diagram. The color of each point of the diagram represents the power level for the corresponding frequency and time.

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

As the graph fills from top to bottom, the latest spectrum is always the topmost line, whereas older frames move towards the bottom.

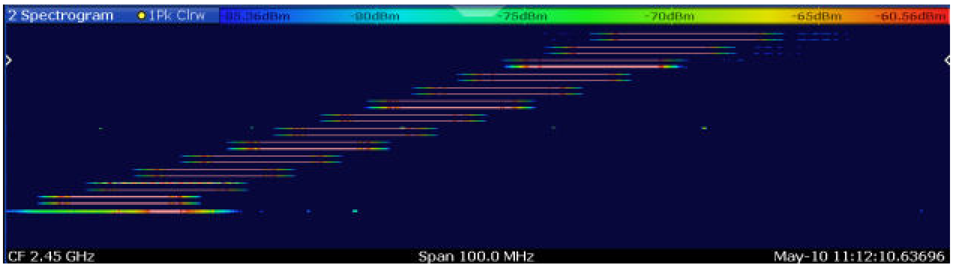


Figure 3-2: Frequency hopper exhibiting a transition with significant RF level from lowest to intermediate frequency

The currently selected frame is indicated by small white arrows on the left and right border of the spectrogram.

The spectrogram is a powerful tool to analyze time-variant spectrums. Typical applications are the transient oscillation of a VCO and the analysis of frequency hopping signals. In Figure 3-2 a frequency hopper is shown. It is clearly visible that the signal is not completely off during the first hop (lowest frequency to middle frequency), whereas no significant RF level can be observed during the second hop.

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

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

For more information on working with spectrograms see Chapter 4.6, "Working with Spectrogram Diagrams", on page 26.

Remote command:

`LAY:ADD? '1',RIGH,'XFRequency:SGRam'`, see `LAYout:ADD[:WINDow]?` on page 145

Persistence Spectrum
In addition to the Real-Time Spectrum, a Persistence Spectrum is provided. This result is also referred to as a spectrumsl histogram. Both terms indicate the main features of this result display: persistence and histogram information. Persistence helps you view even very short events that the human eye could not capture otherwise. Moreover, it also allows for comparison between two events that are separated in time, but which share a time frame called *persistence granularity*. This time frame specifies the amount of time it takes for a singular event to fade completely.

Histogram information

Histogram information is basically a counter that sums up the appearance of a certain frequency/level pair within a certain amount of time. Instead of displaying the total of a counter, the Persistence Spectrum displays the counter result normalized to the maximum achievable count, which yields a probability of appearance for each frequency/level pair.

The Persistence Spectrum is made up of a horizontal frequency axis and a vertical level axis just as a normal spectrum display. The color of each dot in the Persistence Spectrum contains the histogram information, i.e. the probability information.

A typical application for the Persistence Spectrum is the analysis of signals that vary over time. It is an especially powerful tool to give the user a first idea of a signal, before it can be analyzed in detail.

Persistence

Using a Persistence Spectrum, fast frequency hops can be distinguished clearly from amplitude drops, whereas conventional analyzers may mislead the user. As opposed to the spectrogram display, the Persistence Spectrum offers a higher level resolution, as it does not employ color coding for the power.

Another application for the Persistence Spectrum is the separation of superimposed signals if they can be distinguished in terms of probability distribution of frequency/level pairs.

The Figure 3-3 shows a Persistence Spectrum of a noise-like signal resulting from a motor with brushes. A weak GSM signal is clearly visible in the center of the span. A standard spectrum analyzer cannot resolve the two different signals, as it does not display probabilities for each signal point.

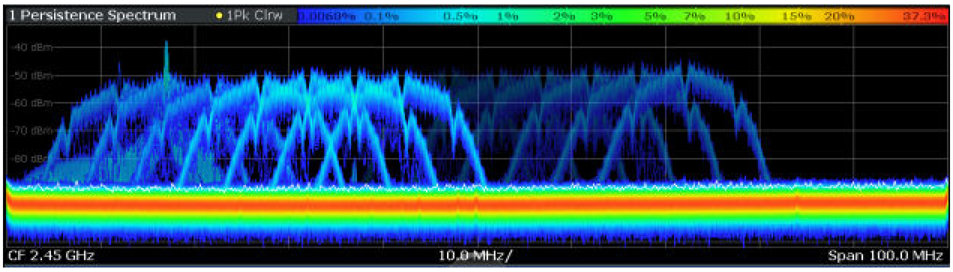


Figure 3-3: Wideband noise-like signal covering a GSM signal

Max Hold function

An optional Max Hold function indicates the maximum probabilities ever measured during the entire measurement for each point in the diagram. The intensity of the Max Hold display is configurable so that it can be distinguished from the current trace, but it is not time-dependant (indefinite persistence).

(See Chapter 6.2, "Persistence Spectrum Settings", on page 62).

Spectrum trace

The Persistence Spectrum display also includes a standard trace in clear/write mode with a peak-to-peak detector, which corresponds to the current Real-Time Spectrum trace. This trace is displayed for reference and can be disabled using the common trace settings.

(See Chapter 6.5, "Trace Settings", on page 69).

For more information on how the histogram and persistence are evaluated see Chapter 4.7, "Understanding Persistence", on page 35.

Remote command:
`LAY:ADD? '1',RIGH,'XFRequency:PSPectrum'`, see `LAYout:ADD[:WINDow]?` on page 145

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

This table may be displayed automatically if configured accordingly.

6 Marker Table

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

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

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 145
Results:
`CALCulate<n>:MARKer<m>:X` on page 175
`CALCulate<n>:MARKer<m>:Y?` on page 175

4 Real-Time Basics

Some background knowledge on basic terms and principles used in Real-Time Spectrum measurements (such as the mechanisms behind data capturing without blind times and triggering on frequency masks) is provided here for a better understanding of the required configuration settings.

4.1 Increasing Measurement Sensitivity (or Avoiding an Input Mixer Overload)

Measurements often confront you with unknown or unintentional signals with unknown signal levels (and often with pulse characteristics). Such signals can either have very weak signal levels, in which case you might miss them during the measurement. Or they can have very strong signal levels, in which case they might damage the input mixer.

NOTICE

Risk of damage to the input mixer

Do not overload the input mixer.

Overloading the input mixer can damage it. The following topics contain advice on how to avoid an overload of the input mixer. Read them carefully before applying a signal.

Protecting the input mixer

Protecting the input mixer from damage should always be considered first when setting up a measurement.

The input mixer of the R&S ESW is equipped with an overload protection mechanism. If you apply a signal whose power exceeds the specified limit (see datasheet), the connection between the RF input and the input mixer is cut off and the R&S ESW displays a corresponding message in the status display.

Note that pulses have different level characteristics. Refer to the data sheet for more information on the allowed maximum pulse energy.

The signal level at the input mixer is calculated as follows.

Mixer Level = Input Level - attenuation + gain

RF input protection

The R&S ESW is equipped with an overload protection mechanism. This mechanism becomes active as soon as the signal level at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

In this case you must decrease the level at the RF input connector and then close the message box. Then measurements are possible again.

4.1.1 Using the RF Attenuator

The first tool provided by the R&S ESW to control measurement sensitivity is the RF attenuator.

The RF attenuator is available in all hardware configurations of the R&S ESW.

Attenuation has the following effects on the measurement:

- High attenuation protects the input mixer: the main purpose of the attenuator is to protect the input mixer.
- High attenuation makes sure that the measurement results are reliable (signals that are stronger than allowed might distort the results)
- High attenuation helps you to avoid intermodulation
- High attenuation increases inherent noise (i.e. the noise floor) and thus decreases measurement sensitivity: if you increase attenuation by 10 dB, the sensitivity is reduced by 10 dB (in other words: the displayed noise increases by 10 dB)

Depending on the required test setup, a compromise must be found between a high sensitivity, low intermodulation and input mixer protection. This is best done by letting the R&S ESW determine the ideal attenuation automatically.

You can determine the attenuation automatically with the auto ranging feature in the Receiver application and the auto attenuation feature in the other applications. Determining the attenuation automatically might not necessarily utilize the maximum dynamic range, but still yields valid and reliable results.

When you select the attenuation manually and are measuring unknown signals, especially DUTs with a high RFI voltage, always select the highest possible attenuation level before you apply the signal.

If you need a better sensitivity or signal-to-noise ratio, make sure that the applied signal does not exceed the specified limits, before you lower the attenuation.

For further protection of the input mixer, the R&S ESW does not allow you to select attenuation levels of less than 10 dB unless you explicitly turn this feature on ("10 dB Minimum Attenuation").

NOTICE

Risk of damage to the input mixer

- Do not apply a 0 dB attenuation when you measure unknown signals or RFI voltage in combination with an artificial network (LISN).
  During phase switching, such test setups generate very strong pulses which can damage the input mixer.
- When you allow attenuation of less than 10 dB in combination with auto ranging, make sure that the signal level at the RF input does not exceed the allowed limits. Exceeding the limits can damage the input mixer.

4.1.2 Using the Preamplifier

The second tool that allows you to control measurement sensitivity is the preamplifier.

In addition to the standard preamplifier available in every R&S ESW, an additional Low Noise amplifier is available as an optional component (R&S ESW-B24).

Signal gain has the following effects on the measurement:

- The preamplifier allows you to detect even weak signals.
- The preamplifier reduces the noise figure of the R&S ESW and thus increases its sensitivity. Thus, it is recommended to use the preamplifier for measurements that require maximum sensitivity.
- The preamplifier reduces the dynamic range. If a measurement should be performed at maximum dynamic range, you should turn off the preamplifier.
- The preamplifier is located after the preselection filters; this reduces the risk of overloading the input mixer by strong out-of-band signals.
- The optional Low Noise amplifier is located in front of the preselection filters which increases the measurement sensitivity.

The gain of the preamplifier is automatically considered in the level display. The disadvantage of a poorer large-signal immunity (intermodulation) is reduced by the preselector.

4.1.3 Using the Preselector

Note: The preselector is unavailable in the Real-Time application.

The third tool that allows you to control measurement sensitivity is the preselector.

Preselection has the following effects on the measurement:

- Preselection rejects most of the spectrumsl energy which helps to protect the input mixer and thus makes sure that the measurement results are valid and reliable.
- Preselection filters out signals that you do not want to be displayed (selectivity) and thus allows you to analyze only the frequency range you are interested in.

The preselector of the R&S ESW consists of several filters which are automatically applied during measurements. The filter that is currently used depends on the frequency that is currently measured. You can see the list of filters and the progress in the "Preselector" result display (the currently applied filter is indicated by a green LED, filters that are outside the scan range are ignored).

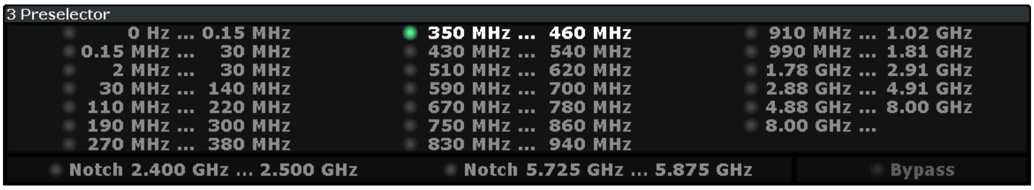


Figure 4-1: Preselector result display. The green LED indicates the currently applied filter.

In the frequency range from 150 kHz to 30 MHz, you can select whether to preselect in a single stage (150 kHz to 30 MHz), or split the preselection into two stages, each of which applies a separate filter: one from 150 kHz to 2 MHz, and another from 2 MHz to 30 MHz.

In addition, the R&S ESW provides several notch filters to suppress certain frequency ranges completely.

Using the preselector

Switching the filters is a mechanical process. Avoid excessive filters switches, because the hardware may wear out.

Note that results in a frequency band are only displayed if there is at least one valid measurement point in the corresponding range. If a particular measurement point is captured by more than one filter, the R&S ESW displays the combined results.

Notch filter

The R&S ESW provides additional notch filters that suppress signals in the frequency bands from 2.4 GHz to 2.5 GHz and 5.725 GHz to 5.875 GHz.

4.2 Data Acquisition and Processing in Real-Time

This chapter shows the way the R&S ESW Real-Time application acquires and processes the data compared to a conventional spectrum analyzer.

For more background information see the Rohde & Schwarz White Paper "Implementation of Real-Time Spectrum Analysis" available at: http://www.rohde-schwarz.com/appnote/1ef77.

A conventional spectrum analyzer typically loses information after it has captured the signal ('blind time'). This is because the LO has to return to the start frequency after a sweep of the selected frequency range (LO flyback). Blind time therefore occurs after the data capture and signal processing and before the next data capture can begin.

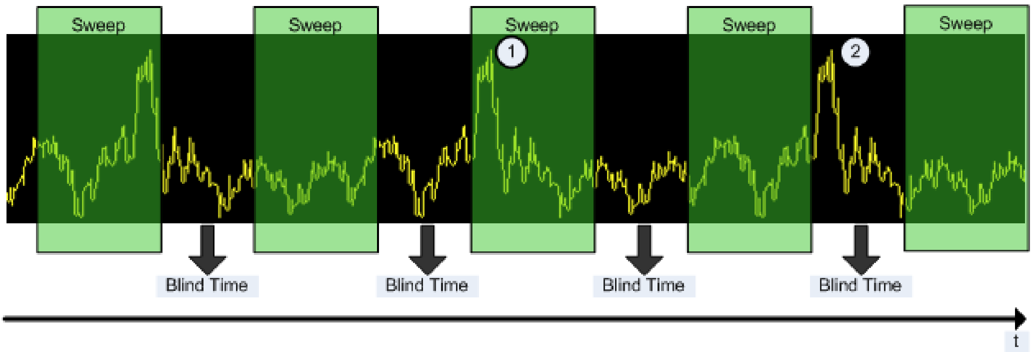


Figure 4-2: Conventional spectrum analyzer measurement principle

1 = Signals are captured by the sweep
2 = Signal is missed by the sweep because of LO flyback (blind time; extended for clarity)

A real-time spectrum analyzer does not lose any information for the following reasons:

- There is no LO flyback because the LO is set to a fixed frequency in the real-time spectrum analyzer.
- It performs overlapping Fast Fourier Transformations (FFT) instead of sweeping the spectrum or performing one FFT after another.
- The R&S ESW captures data and performs FFTs at the same time instead of sequentially.

To get the results, the R&S ESW simultaneously performs several processing stages:

- Acquiring the data
- Processing the data
- Displaying the data

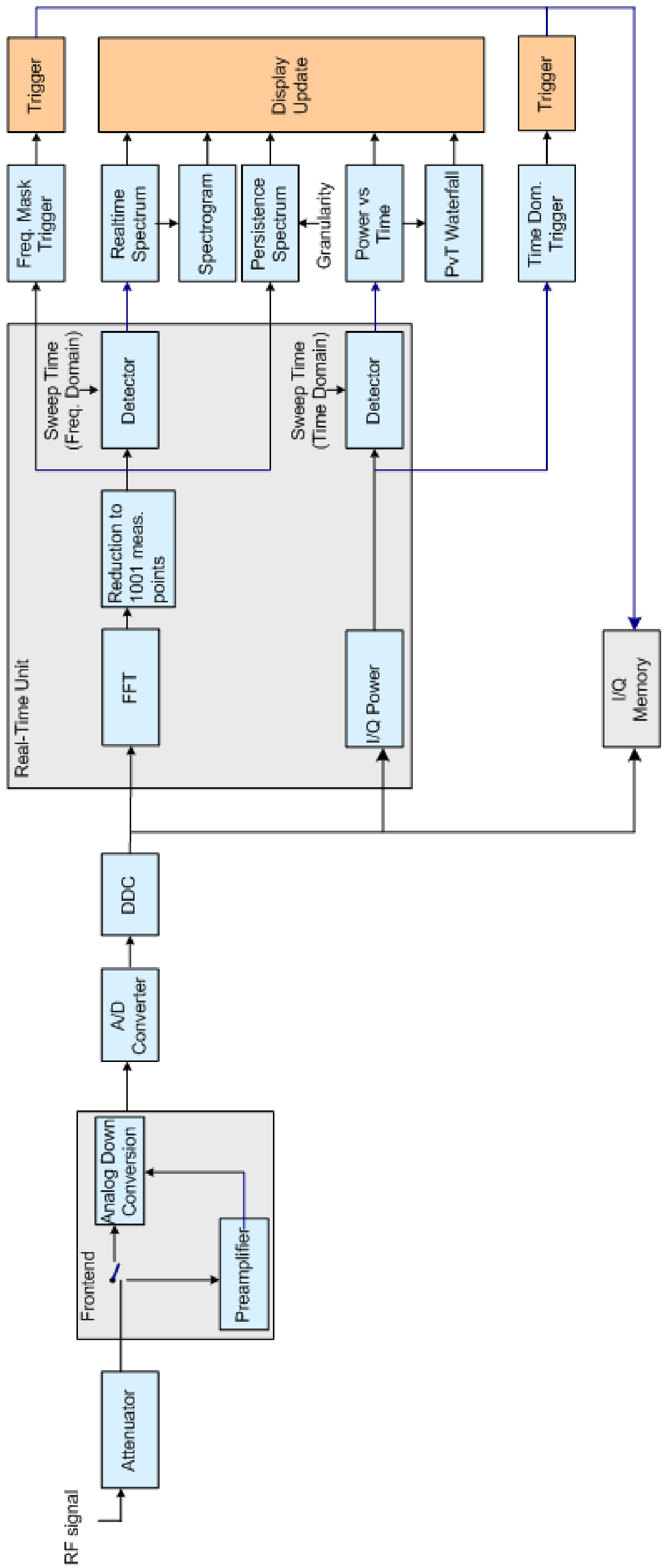


Figure 4-3: Block diagram of the R&S ESW

Acquiring the data

The data acquisition process is the same as in a conventional spectrum analyzer. First, the R&S ESW either attenuates the signal that you have applied to the RF input to get a signal level that the R&S ESW can handle or, if you have a weak signal, pre-amplifies the signal and then down-converts the RF signal to an intermediary frequency (IF), usually in several stages.

After the down-conversion, the R&S ESW samples the signal into a digital data stream that is the basis for the Fast Fourier Transformation (FFT). The sample rate the R&S ESW uses for sampling is variable, but depends on the span you have set.

At the same time, the A/D data is down-converted and captured in the I/Q memory.

Processing the data

The R&S ESW then splits the data stream stored in the I/Q memory into data blocks whose length is between 1024 and 16384 samples each to prepare it for the FFT.

Then the R&S ESW performs the FFT on all data blocks it has acquired. The FFT processing rate of the R&S ESW is variable with a maximum of approximately 600.000 FFTs per second.

The distinctive feature of a real-time analyzer is that it uses a particular amount of data more than once to get the measurement results. It takes the first data block of 1024 samples, for example, and performs the FFT on it. The second and all subsequent data blocks, however, do not start at the next sample (in the case of the second block, the 1025th), but at an earlier one. In fact, all data, except the first few samples, is processed more than once and overlapped to get the results.

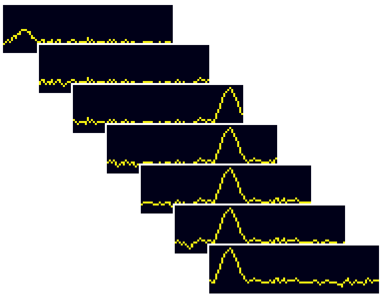


Figure 4-4: Overlapping FFTs

After the FFT is done and the spectra have been calculated, the result is a stream of spectra without information loss.

4.3 Defining the Resolution Bandwidth

The resolution bandwidth has an effect on how the spectrum is measured and displayed. It determines the frequency resolution of the measured spectrum. A small resolution bandwidth has several advantages. The smaller the resolution bandwidth, the better you can observe signals whose frequencies are close together and the less noise is displayed. However, a small resolution bandwidth also increases the time required to ensure that *all* possible signal distortions are detected and the level is measured accurately. This requirement is also referred to as *100% probability of intercept (POI)*.

The resolution bandwidth parameters can be defined in the bandwidth configuration, see Chapter 5.7, "Bandwidth and Sweep Settings", on page 56.

4.4 Sweep Time and Detector

The Sweep Time parameter determines the amount of time used to sample data for one spectrum. One spectrum is defined by all FFTs calculated and combined from the sampled data in one sweep time period. In conventional spectrum analysis, the sweep time parameter describes the amount of time needed to sweep over the selected frequency span. As the effect is the same, i.e. it takes the sweep time to complete one spectrum, the real-time parameter is also called sweep time.

Combining several FFTs into one spectrum during the selected sweep time offers several possibilities of weighting the FFT results: determining the maximum level is an obvious one. Other possibilities of combining several FFTs are selecting the minimum for each frequency point, determining the average result, or selecting an arbitrary FFT result to represent the entire sweep time. The FTs are combined by detectors; a detector is available for each of the mentioned methods: Positive Peak, Negative Peak, Average, and Sample. Positive Peak is the default selection to make sure that even the shortest events can be analyzed.

Thus, the detector and sweep time parameters describe the data reduction from multiple FFTs to a single spectrum. A detector is not required for the "Persistence Spectrogram" display, which evaluates the individual FFTs (see Chapter 4.7, "Understanding Persistence", on page 35).

4.5 Triggering Real-Time Measurements

Real-time measurements pose some specific challenges to triggering, which require special trigger functions and options.

4.5.1 Frequency Mask Trigger

One way to analyze rare events in a given frequency range is to capture real-time data over a very long time. This method requires large amounts of fast memory. As a consequence, post-processing the bulk of stored data to find the event may be extremely time consuming.

Another way is to trigger on the event in the frequency spectrum and to acquire exactly the data of interest. This method reduces the necessary memory size dramatically, and in addition keeps the time to spot the event of interest in the acquired memory low. The question is: how can the analyzer trigger on events which show up in a certain frequency range only now and then?

Detecting rare events

The answer is the *Frequency Mask Trigger*. Speaking graphically, the frequency mask trigger is a mask in the frequency domain, which is checked with every calculated FFT. This allows for a 100% probability of intercept with full level accuracy even on short pulses.

The minimum detectable pulse length is specified in the data sheet.

Mask definition

The frequency mask is configured by a list of individual trace points, defined as frequency (position) / level (value) pairs, which are connected to form a mask area. The individual mask points can also be defined simply by dragging the points to the required position on the touchscreen. The frequency mask can consist of up to 1001 points and may have an arbitrary shape.

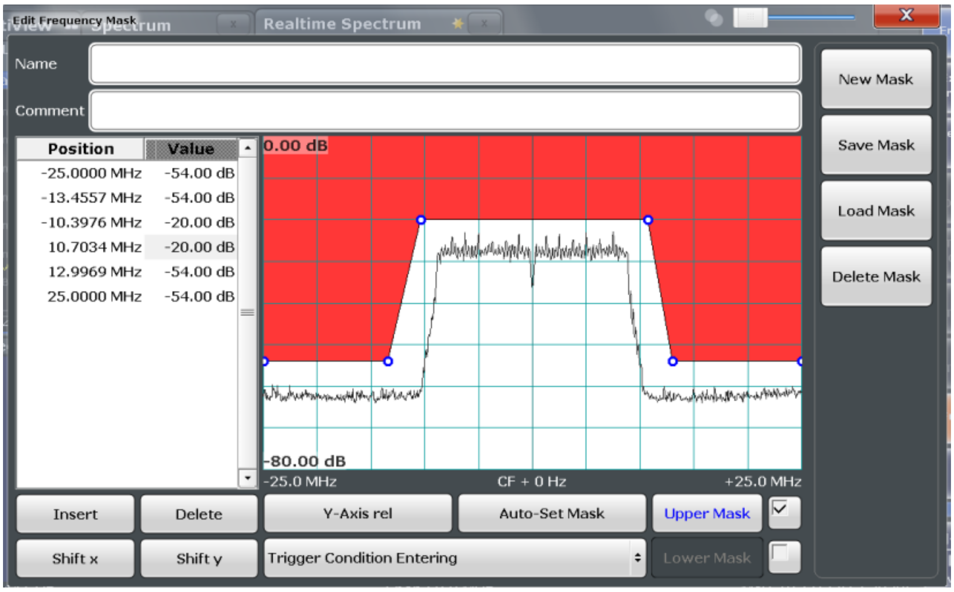


Figure 4-5: Frequency mask defined manually

Alternatively, a mask can be defined automatically according to the currently measured data. In this case, the mask is configured to follow the measurement trace with a specific distance to the power levels.

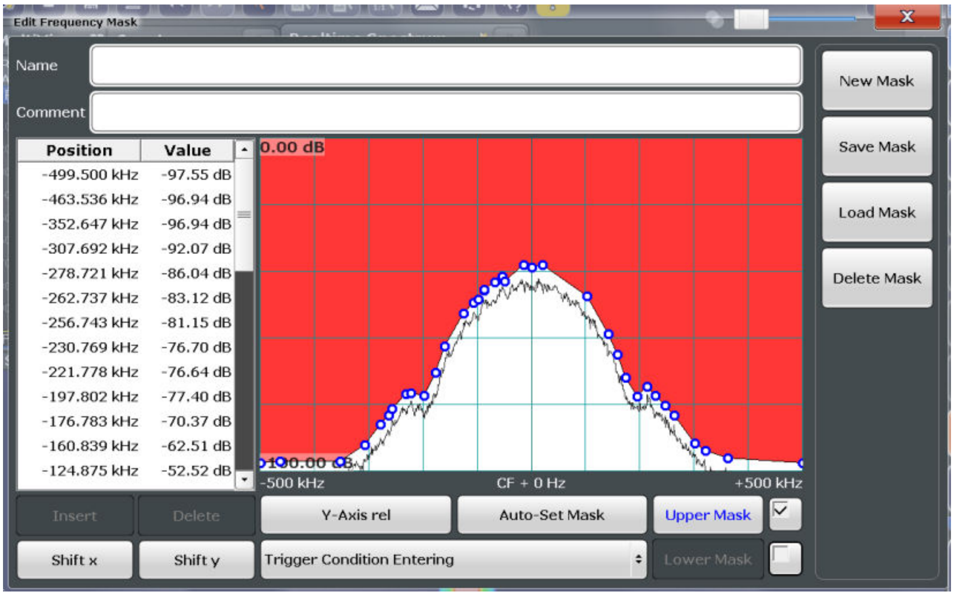


Figure 4-6: Frequency mask defined automatically according to measured data

Upper and lower masks

By default, the defined mask is an upper mask, i.e. the mask is the area *above* the defined mask points. In addition or alternatively, a mask can be defined as a lower mask. In this case, the mask is the area *below* the defined mask points. This is useful, for example, to determine if the measured signal leaves a defined "corridor" of allowed values.

The lower limit mask is defined in the same manner as the upper limit mask. However, it must be activated explicitly and cannot be configured automatically according to the currently measured values.

Trigger conditions

The frequency mask can be evaluated in different ways to control data acquisition, depending on whether the mask area represents the relevant or irrelevant value range.

"Entering": mask area represents the relevant value range

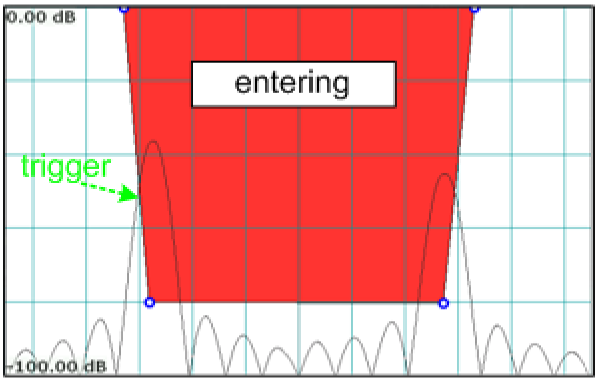


Figure 4-7: Trigger condition "entering": Data acquisition starts when the signal enters the mask area and continues until the measurement is stopped or completed

"Leaving": mask area represents the irrelevant value range

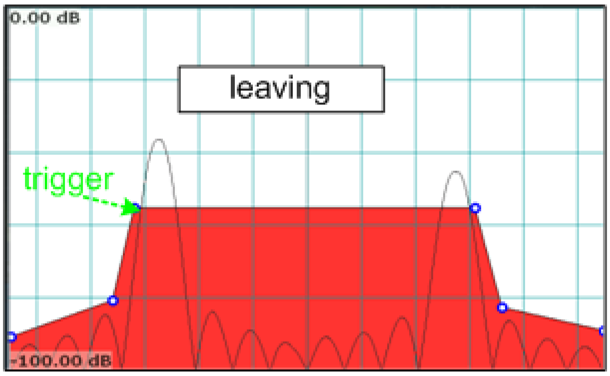


Figure 4-8: Trigger condition "leaving": Data acquisition starts when the signal leaves the mask area and continues until the measurement is stopped or completed

The selected trigger condition applies to any active limits; that means the calculated FFTs are compared to the upper or lower, or both the upper and lower limits, if activated.

Availability

The frequency mask trigger can be selected as a trigger source for all measurements in the R&S ESW Real-Time application. As it is evaluated in parallel to the selected result displays, there is no influence on the real-time capabilities of the R&S ESW.

A detailed description of how to define a frequency mask trigger is provided in Chapter 8.4, "How to Work with Frequency Mask Triggers", on page 93.

Storing and loading frequency masks

As frequency masks can have a very complex structure, they can be stored for later use with other signals. The masks are stored in a file with the extension `.FMT` in the `C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\freqmask` directory. By default, the mask name is used as the file name.

Trigger output

The frequency mask trigger is a trigger source which exceeds the capabilities of standard spectrum analyzers. To allow other instruments in a test system to make use of it, R&S ESW provides a special connector (TRIGGER OUT). This trigger pulse may be provided to a system setup as an external trigger source.

4.5.1.1 Technical process

Basically the frequency mask trigger is an extended limit line check: the frequency mask is compared to every FFT spectrum calculated by the real-time hardware.

The R&S ESW performs this mask check up to 600,000 times per second according to the FFT update rate. To ensure a real-time trigger, i.e. a given reaction time, the frequency mask trigger is evaluated by the real-time hardware.

Element-wise comparison of frequency mask with current FFT result shows the element-wise comparison of a real-time FFT with a frequency mask. The FFT-result is subtracted from the frequency mask value. If one result is negative, the R&S ESW triggers.

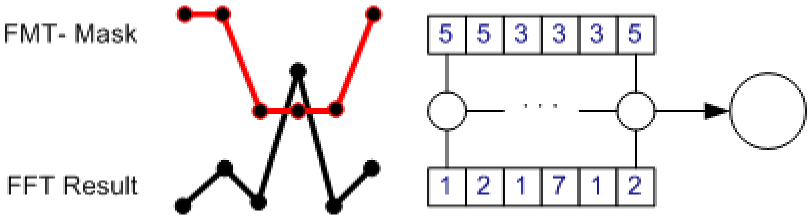


Figure 4-9: Element-wise comparison of frequency mask with current FFT result

Extended limit check means that the frequency mask trigger can link a complex condition to the limit line violation, such as entering or leaving the mask.

As already mentioned, the frequency mask may contain up to 1001 points, but may also be as short as 2 points. Shorter frequency mask trigger definitions are extended to 1001 points by interpolation within the firmware. The frequency mask trigger therefore always compares 1001 FFT points to 1001 frequency mask definition points. If the mask is violated at a single point, the frequency mask trigger will trigger.

In order to get a reliable frequency mask trigger with very short events, it is preferable to set the mask limit levels lower than the expected spectral power levels.

4.5.2 Using Pretrigger and Posttrigger Settings

As described in Chapter 4.4, "Sweep Time and Detector", on page 20, the amount of time required to sample data for one spectrum (or one frame/line in a spectrogram) corresponds to the defined sweep time. If a trigger is used for the measurement, the displayed spectrum starts with the trigger event. However, you can define a pretrigger and posttrigger period in which data is also captured, in addition to the actual sweep time. (As the posttrigger time starts with the trigger event, it only has an effect if it is longer than the sweep time.) This allows you to analyze the data shortly before the actual trigger event or after the regular sweep period.

The data from this "extended" sweep time (pretrigger+posttrigger) is displayed in the real-time Spectrogram.

By default, the frame displayed in the results is the frame that begins with the trigger event. If a pretrigger time is defined, one or more additional frames will be available in the spectrogram/waterfall beneath the frame currently displayed in the diagram window, respectively. If a posttrigger time is defined, one or more additional frames will be available in the spectrogram/waterfall above the frame currently displayed in the diagram window.

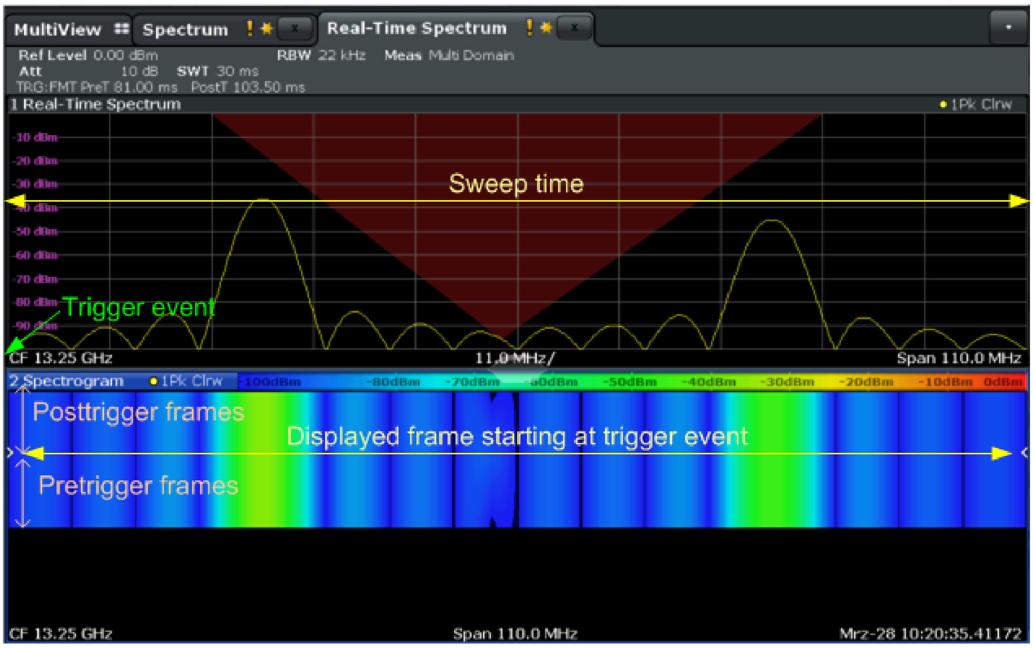


Figure 4-10: Pretrigger, currently displayed, and posttrigger frames

4.5.3 Rearming the Trigger and Stopping on Trigger

By default, a trigger event causes the R&S ESW to start a measurement and to immediately rearm the trigger ("Auto Rearm"). In that case, measurements are continuously triggered and measurement results may become obsolete in a very short time. The pre- and posttrigger periods for each sweep time are displayed.

However, you may be interested in the results after the first trigger event only. For this case, a "Stop on Trigger" option is provided. If active, the trigger is not rearmed after the first trigger event has occurred; thus, data acquisition stops after one measurement. The results for that measurement remain on the display, including the pretrigger and posttrigger periods. Note, however, that if the trigger event occurs before the defined pretrigger time has elapsed, the period between measurement start and the trigger event is shorter than the defined pretrigger time.

4.6 Working with Spectrogram Diagrams

In Real-Time measurements, data is captured seamlessly over a specified time. The most recently measured power levels vs. frequency can then be displayed in the Real-Time Spectrum. In these displays, the results from previous measurements are not included.

However, since the R&S ESW Real-Time application stores the history of the measured data in its memory, the spectrogram display provides a record of the measured spectrum without gaps. You can then analyze the data in detail at a later time by recalling one of the spectra in the spectrogram history.

4.6.1 Time Frames

The time information in the Spectrogram is displayed vertically, along the y-axis. Each line (or trace) of the y-axis represents the data during one sweep time interval and is called a **time frame** or simply "frame". For spectrograms, as with standard spectrum traces, several measured values are combined in one sweep point using the selected detector (see Chapter 4.4, "Sweep Time and Detector", on page 20).

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 sweep measurements unless they are cleared manually.

Clearing the Spectrogram

In order to clear the history buffer and start a new Spectrogram, you must clear it explicitly (see Chapter 6.3, "Spectrogram Settings", on page 65).

The maximum number of stored frames is defined by the *history depth*, which is user-configurable (see "History Depth" on page 65).

Displaying individual frames

In Chapter 4.4, "Sweep Time and Detector", on page 20, the term "frame" was introduced as *one spectrum containing all FFTs calculated and combined from the sampled data in one sweep time period*. Thus, one frame/line in the spectrogram corresponds to one spectrum in the Real-Time Spectrum view.

The Spectrogram diagram includes all stored frames since it was last cleared. Arrows on the left and right border of the Spectrogram indicate the currently selected frame.

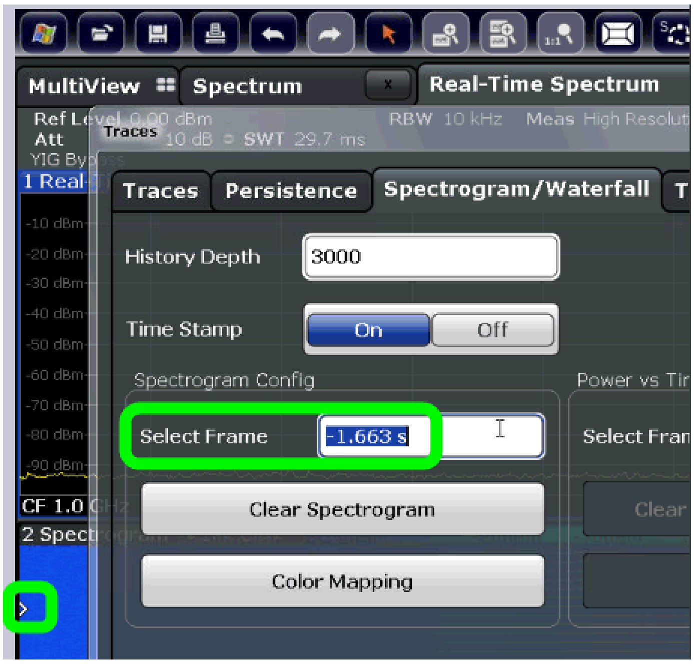


Figure 4-11: Display of a selected frame in the spectrogram

The Real-Time Spectrum diagram always displays the Real-Time Spectrum for the currently selected frame. The current frame number (or alternatively a time stamp, if activated) is indicated in the diagram footer of the Spectrogram. The most recent 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 Real-Time Spectrum diagram of a previous frame by selecting a different frame number.

Separate frame numbers can be selected for the Real-Time Spectrum diagrams.

The displayed frame may also change if a marker is set to a different frame in the Spectrogram result display (see Chapter 4.6.2, "Markers in the Spectrogram", on page 28).

Displaying pretrigger and posttrigger results

By default, the frame displayed in the Real-Time Spectrum results is the frame that begins with the trigger event. In order to display *pre*trigger results, if available, select a frame in the Spectrogram *beneath* the currently selected frame. In order to display *post*trigger results (after the sweep time), if available, select a frame in the Spectrogram *above* the currently selected frame.

Scrolling through frames of a Spectrogram

The Real-Time Spectrum diagram always displays a single frame of the Spectrogram, namely the currently selected frame. In order to scroll through the frames of the Spectrogram as they were recorded, use the rotary knob or arrow keys to change the selected frame continuously. The index or time stamp is increased or decreased in steps of one frame.

Time stamps vs. frame index

By default, the time information of the selected frame is provided as a time stamp in the footer of the Spectrogram. The time stamp shows the time and date the selected frame was recorded. The length of one frame corresponds to the sweep time. To select a specific frame, you have to enter the (negative) time in seconds, relative to the frame that was recorded last. The largest (absolute) time available is the sweep time multiplied with the number of sweeps performed since the diagram was last cleared.

Alternatively to time stamps, the time information can be provided as an index. The index is also relative to the frame that was recorded last, which has the index number 0. The lowest index is a negative number that corresponds to the history depth. To select a specific frame, you have to enter the (negative) index number of the frame you want to analyze.

Frame count vs. sweep count

The maximum number of stored frames depends on the "History Depth" on page 65.

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").

4.6.2 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. The frame to which a marker is assigned automatically becomes the currently selected frame. If no frame number is specified, the marker is positioned on the currently selected frame. (The selected frame is indicated by small white arrows on the left and right border of the diagram.)

All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers (see Chapter 6.8.3, "Marker Search Settings", on page 78) to include the frame information as search criteria.

In the spectrum result display, only the markers positioned on the currently selected frame are visible. In "Continuous Sweep" mode this means that only markers positioned on frame 0 are visible. To view markers that are positioned on a frame other than frame 0 in the spectrum result display, you must stop the measurement and select the corresponding frame.

4.6.3 Color Maps

Spectrogram displays assign power levels to different colors in order to visualize them. The legend above the Spectrogram display describes the power levels the colors represent. Similarly, Persistence Spectrum displays assign colors to the relative numbers of occurrence (percentage) of specific power levels.

The color display is highly configurable to adapt the spectrograms to your needs. You can define:

- Which colors to use (Color scheme)
- Which value range to apply the color scheme to
- How the colors are distributed within the value range, i.e where the focus of the visualization lies (shape of the color curve)

The individual colors are assigned to the power levels automatically by the R&S ESW.

The Color Scheme

You can select which colors are assigned to the measured values. Four different color ranges or "schemes" are available:

- **Hot**

  Uses a color range from blue to red. Blue colors indicate low levels, red colors indicate high ones.
- **Cold**

Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.
The "Cold" color scheme is the inverse "Hot" color scheme.

- **Radar**

Uses a color range from black over green to light turquoise with shades of green in between. Dark colors indicate low levels, light colors indicate high ones.

- **Grayscale**

Shows the results in shades of gray. Dark gray indicates low levels, light gray indicates high ones.

The Value Range of the Color Map

If the measured values only cover a small area in the spectrogram, you can optimize the displayed value range so it becomes easier to distinguish between values that are close together, and only parts of interest are displayed at all.

The Shape and Focus of the Color Curve

The color mapping function assigns a specified color to a specified power level in the spectrogram display. By default, colors on the color map are distributed evenly. However, if a certain area of the value range is to be visualized in greater detail than the rest, you can set the focus of the color mapping to that area. Changing the focus is performed by changing the shape of the color curve.

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large number of results, while the other end distributes several colors over a relatively small result range.

You can use this feature to put the focus on a particular region in the diagram and to be able to detect small variations of the signal.

Example:

In the color map based on the linear color curve, the range from -100 dBm to -60 dBm is covered by blue and a few shades of green only. The range from -60 dBm to -20 dBm is covered by red, yellow and a few shades of green.

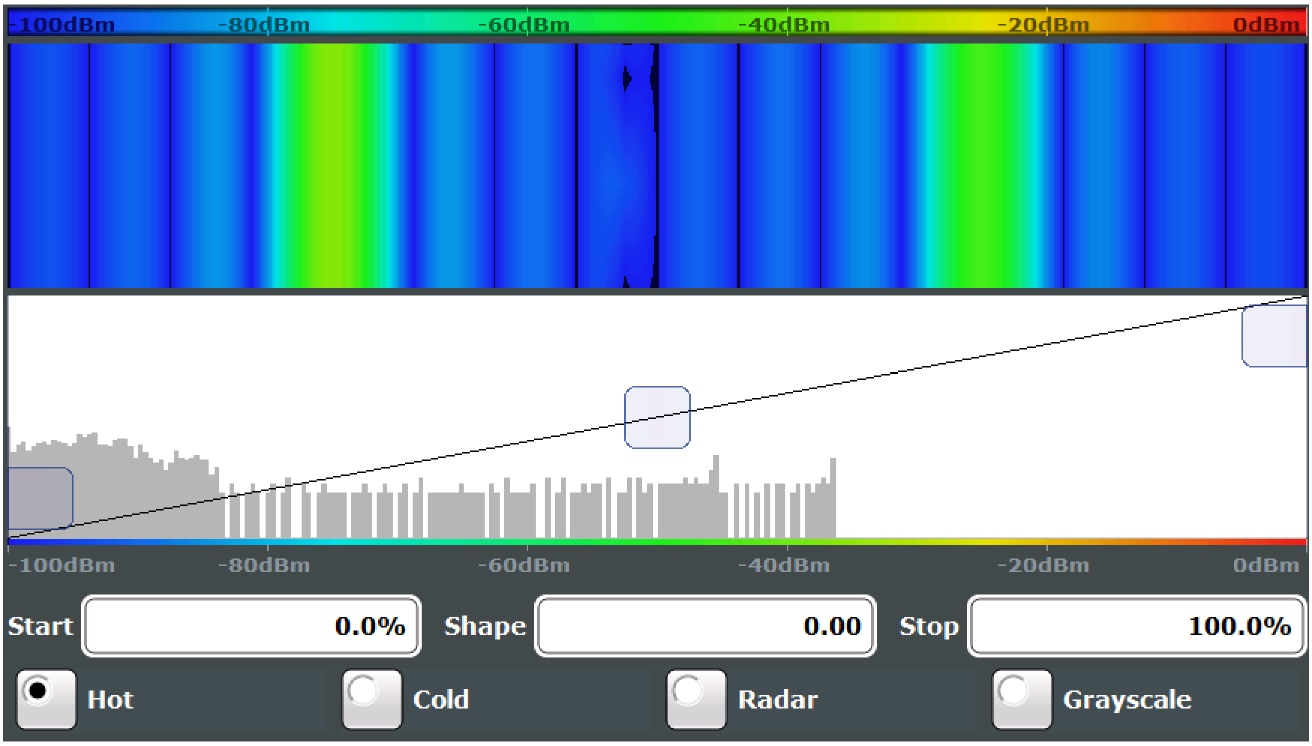


Figure 4-12: Spectrogram with (default) linear color curve shape = 0

The sample spectrogram is dominated by blue and green colors. After shifting the color curve to the left (negative value), more colors cover the range from -100 dBm to -60 dBm (blue, green and yellow), which occurs more often in the example. The range from -60 dBm to -20 dBm, on the other hand, is dominated by various shades of red only.

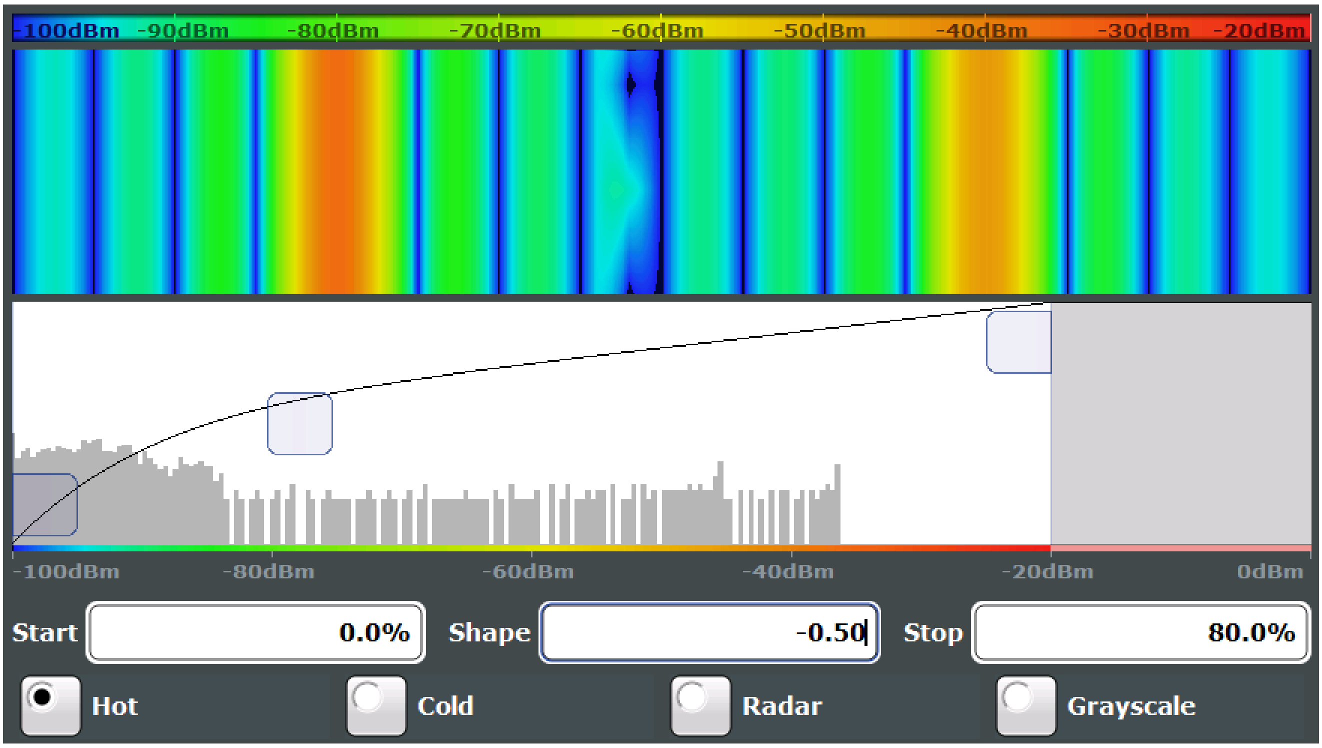


Figure 4-13: Spectrogram with non-linear color curve shape = -0.5

4.6.4 Zooming into the Spectrogram

For further and more detailed analysis of the data you have captured, a zoom function is provided for real-time spectrogram diagrams.

The graphical zoom provided for other measurements on the R&S ESW is **not available** for Real-Time Spectrum measurements.

Instead, a more powerful data zoom is provided, which allows for zooming with increased frequency resolution.

For Real-Time Spectrum measurements, the zoom is available only for the spectrogram result display, but it has effects on other result displays (see "Effects on other result displays" on page 34). The zoom is only available if a spectrogram is active and selected (blue border).

The zoom is activated using the Single Zoom ( ) icon in the toolbar. You define the zoom area by drawing a rectangle on the touchscreen. When you draw the zoom area, its boundaries are shown as a dashed line. The R&S ESW stops the Real-Time Spectrum measurement and recalculates the displays for the area you have selected. The definition of the color map remains the same.

When a zoom is activated in the spectrogram, the sweep time and/or resolution bandwidth and span are temporarily reduced, and the selected data that was measured previously and stored in the R&S ESW memory is reprocessed and re-evaluated. This improves the resolution of the data (while the graphical zoom available in other applications merely interpolates the data).

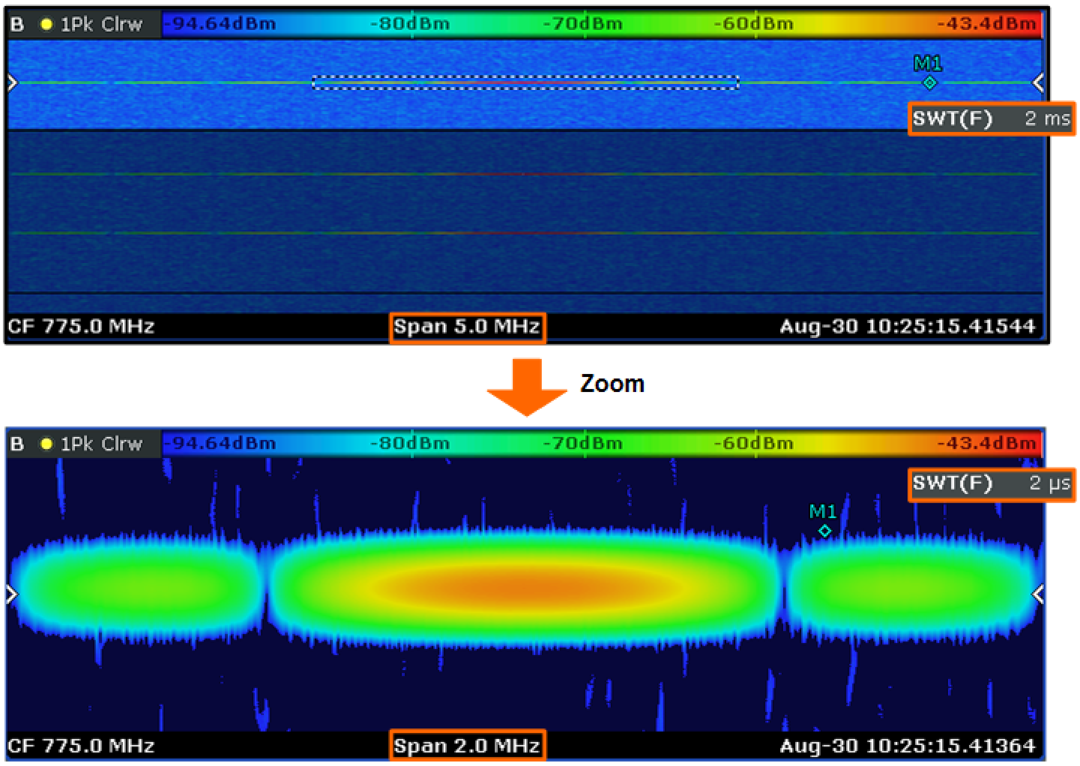


Figure 4-14: Zoomed spectrogram display with increased frequency and time resolution (due to reduced sweep time and span)

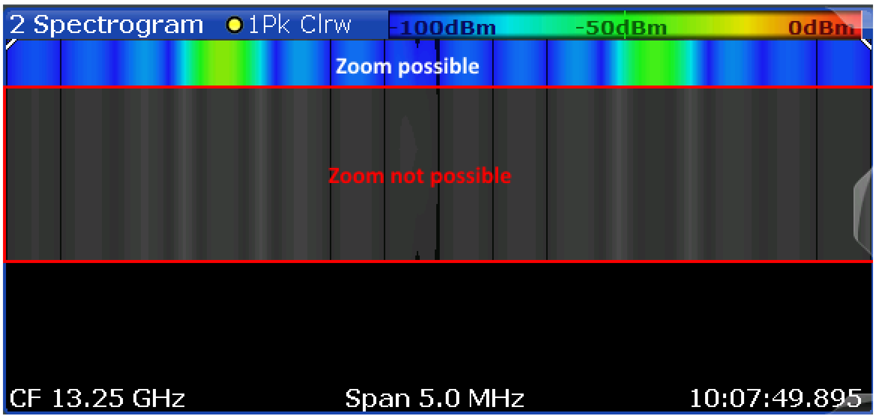
Because the zoom is based on I/Q data that has already been captured, the zoom also allows for faster sweep times (and thus spans) than those possible during live measurements.

Inside the zoom area, you can select frames as usual. The "Replay zoom" function allows you to switch between the zoomed display and the original display quickly for comparison (see "Replay Zoom" on page 85).

Zoom restrictions

Principally, the zoom is available for all measurement situations, whether you measure continuously or in single sweep mode. However, possible zoom areas are restricted by the size of the I/Q data memory. If it is not possible to zoom into a part of the spectrogram area, the R&S ESW colors that area in a darker color when you activate the zoom function.

The zoom factor is restricted to 10% of the original span of the frequency axis.



In addition, the zoom is also restricted by the originally defined bandwidth or span. Zooming into areas that are outside this bandwidth is not possible.

Note also that zoom availability depends on the trigger mode. Zooming while the measurement is running is possible only in "Free Run" mode. For all other trigger modes, you have to wait until the measurement is paused.

Effects on other result displays

Zooming also has an effect on the Real-Time Spectrum and the power vs. time result displays. All other result displays are unaffected.

- The R&S ESW updates the frequency range of the Real-Time Spectrum according to the zoomed (new) spectrogram span. The range has an effect on the start, stop and center frequency as well as the span.
  The Real-Time Spectrum updates the shown spectrum to the currently selected spectrogram frame.
- The R&S ESW updates the time range of the power vs. time result display according to the new height (sweep time) of the spectrogram.
  Note that it is not possible to change the sweep time or the trigger offset for the power vs. time diagram while the zoom is active.

Updates in the result displays only take effect if they are active when the spectrogram data is being recalculated.

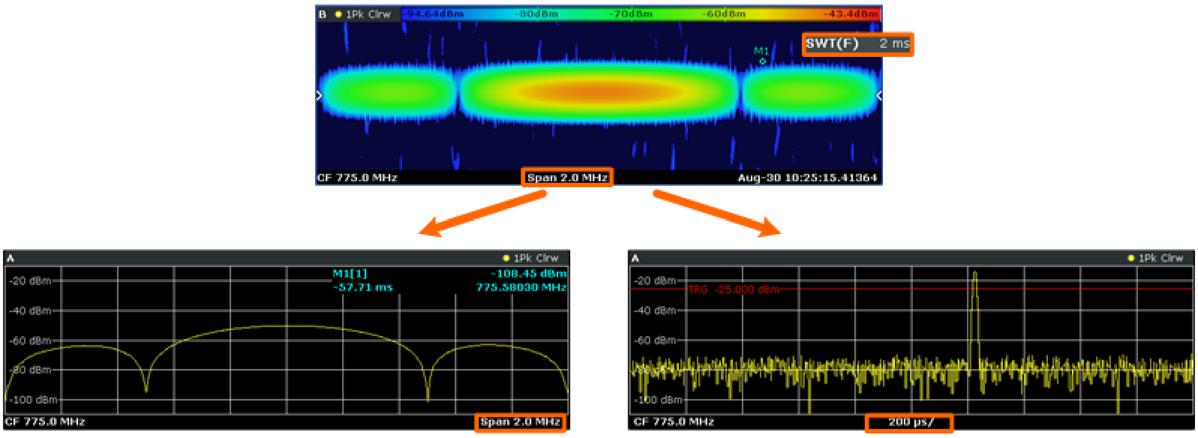


Figure 4-15: Effects of the Spectrogram zoom function on the Real-Time Spectrum displays

4.7 Understanding Persistence

Persistence describes the duration that past histogram traces remain visible in the display before fading away.

Historical term

The term persistence has its origins in cathode ray tube devices (CRTs). It describes the time period one point on the display stays illuminated after it has been lit by the cathode ray. The higher the persistence, the longer you could observe the illuminated point on the display.

Moving density

In the Persistence Spectrum result display, the persistence results from the moving 'density' (like a moving average) over a certain number of traces. The number of traces that are considered to calculate the density depends on the user-definable persistence duration. The longer the persistence, the more traces are part of the calculation and the deeper the history of displayed information gets. A spectral event that has occurred a single time is visible for up to 8 seconds. As densities get smaller at coordinates with signal parts that are not constantly there, the trace color changes. The rate of the color change is high with a low persistence and low with a high persistence.

Detecting changes over time

Note that a signal with constant frequency and level characteristics does not show the effects of persistence on the trace. As soon as the power or frequency of a signal change slightly, however, the effect of persistence becomes visible through color changes or changes in the shape of the trace.

You can remove persistence by setting its duration to 0 seconds.

Persistence Granularity

The amount of data that the R&S ESW uses to draw a single frame in the persistence spectrum is variable. By default, the data that was captured in 100 ms is used to calculate a frame. The time period in which data is captured and the mentioned density is calculated is referred to as the *persistence granularity*. The higher the granulation, i.e. the longer the data capturing time, the more data is included in each calculation.

A single histogram frame is calculated during the persistence granularity time. An initially empty matrix with 600 by 1001 elements, representing 600 discrete power levels and 1001 discrete frequency steps, is provided at the beginning of each histogram frame. After each newly calculated FFT, the matrix is updated according to the occurrence of each frequency/level pair. Every time the persistence granularity interval is completed, the matrix is reset to zero for each element and a new histogram frame is started.

Example: Calculating an individual persistence frame

Figure 4-16 demonstrates this process with a 6 by 8 elements matrix and a ratio of 2 for FFT time to granularity. Thus, two FFTs are calculated for each frame. Both FFTs contain the same signal and varying noise neighboring the signal. The FFTs are converted into a matrix of frequency/level pairs. The two matrices are summed up into the result matrix. The result matrix determines the color of the result trace in the histogram. In this example, red corresponds to a high count or probability, whereas the noise band is displayed in blue for a lower probability.

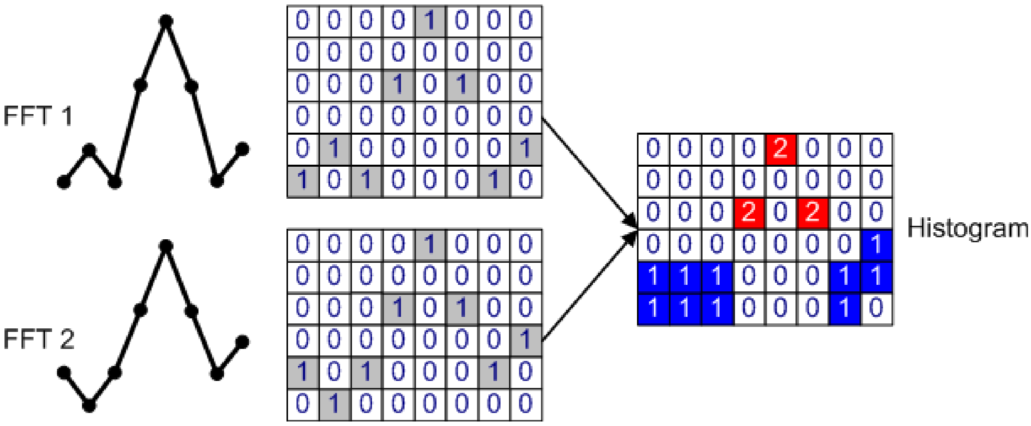


Figure 4-16: Schematic illustration of histogram calculation (dot style)

Persistence Spectrum and detectors

The Persistence Spectrum display calculates persistence and histogram information directly from the FFT results. There is no need to use detectors for data reduction as in the spectrogram, since the histogram algorithm already reduces data to a rate that can easily be displayed. For persistence spectrum results, the detector setting affects only the Max Hold values that can be plotted on top of the persistence spectrum (see Chapter 4.7.1, "Analyzing Maximum Density - Max Hold Function", on page 39).

Matrix style

The individual traces in the persistence spectrum can be displayed using vectors or dots.

The FFT matrices in Figure 4-16 contain only a single value per frequency column. This is the level value returned by the FFT. The example shows a matrix in dot style, i.e. the matrices are filled with dots only. Note that the resulting diagram may contain "holes" where signal levels for neighboring probabilities differ strongly.

In contrast, for vector style matrices, each element in the matrix with the value "1" is analyzed; if the neighboring frequency also has the value 1, regardless at which power level, the two frequency points are connected by additional (interpolated) value 1 elements. Thus, possible "holes" in the diagram are filled by interpolated values, resulting in a continuous trace. This is useful to detect discrete values with a high probability they may otherwise be overlooked. On the other hand, noise may be assigned a higher probability due to the interpolation values, increasing the displayed noise level (visible as more blue fields in the resulting histogram matrix in Figure 4-18).

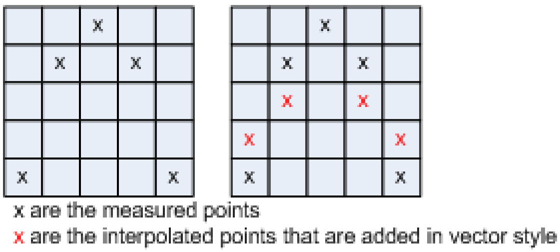


Figure 4-17: Dotted-style matrix vs. vector-style matrix

Example: Histogram for vector-style matrix

Figure 4-18 shows the vector-style representation for exactly the same example that was used in Figure 4-16 for dot style. To derive the vector-style matrices from the dot-style matrices, additional "1" elements are inserted to connect the "1" in column 4 to the neighboring "1" in columns 3 and 5.

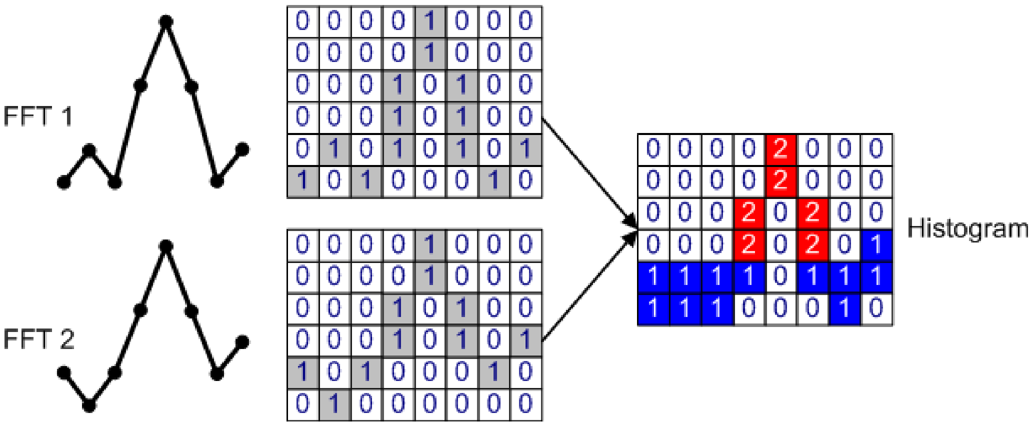


Figure 4-18: Histogram calculation using vector style

The additional "1" elements result in increased probability levels when changing from dot to vector mode. The increase is especially visible in areas with noise-like signals, that is, large level fluctuations.

Color mapping for different matrix styles

Color mapping for the persistence spectrum is identical to color mapping for the spectrogram or waterfall diagrams. The truncating function is especially useful to display only spectral components of a certain probability (see below).

Usually, you must adjust the color mapping value range after changing the persistence style from vector to dot or vice versa, as the resulting probabilities may vary significantly as explained above.

For details on color mapping see Chapter 4.6.3, "Color Maps", on page 29.

Truncating the persistence spectrum

By default, results outside the defined value range of the color map are displayed in the colors for the minimum or maximum values in the range.

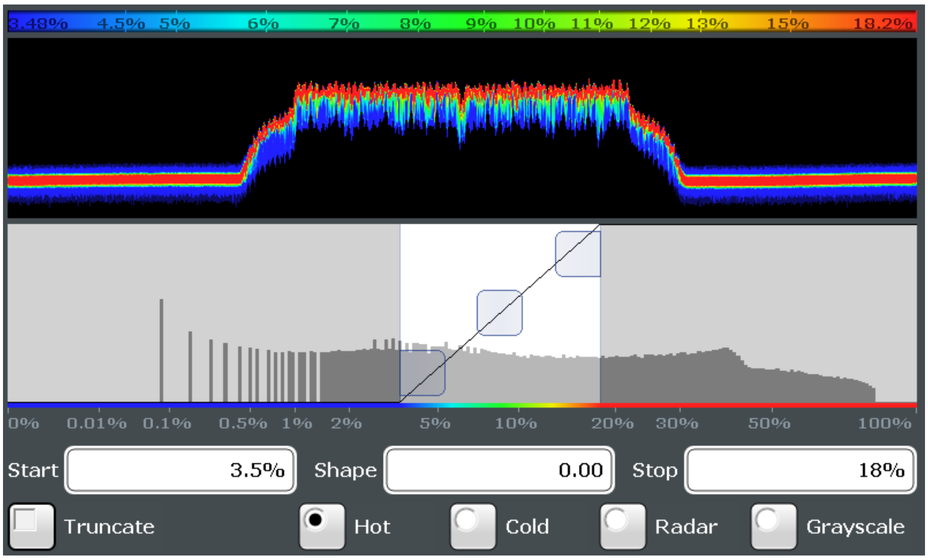


Figure 4-19: Default persistence spectrum coloring without truncating

Usually you restrict the value range displayed by the color map because only specific values are of interest. In that case, you can hide (or *truncate*) the results of the persistence spectrum outside the value range of the color map. This makes the display of the remaining - relevant - results clearer (see Figure 4-20), and allows you to eliminate the effects of noise, for example.

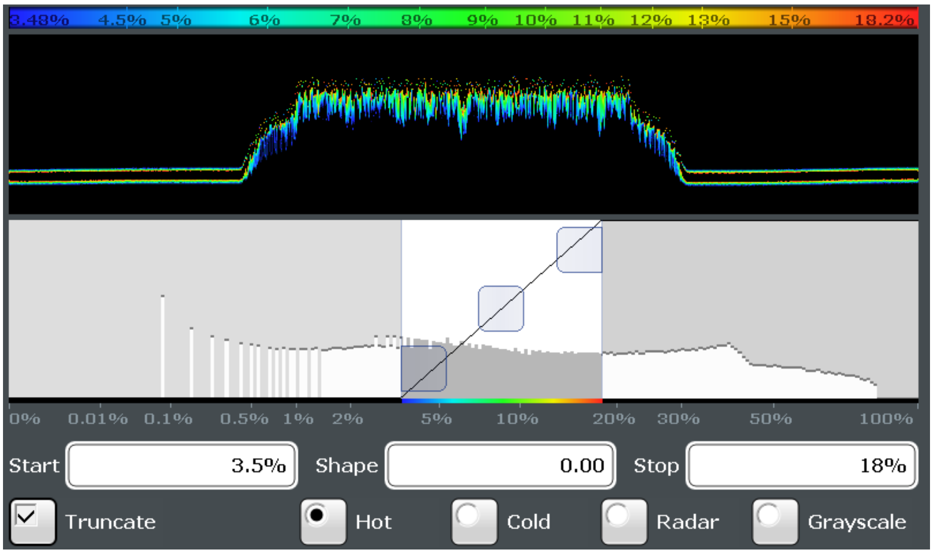


Figure 4-20: Persistence spectrum with truncated coloring

4.7.1 Analyzing Maximum Density - Max Hold Function

During analysis of a time-variant signal, level variations are usually of great interest; in particular, the ratio between the current signal and the maximum measured signal. The currently measured Real-Time Spectrum is displayed as a standard trace in clear/write mode with a peak detector in the Persistence Spectrum diagram.

An optional *Max Hold* function indicates the maximum probabilities ever measured during the entire measurement for each point in the diagram. It allows for a worst-case estimation of signal-to-noise-ratios (SNR), when talking about noise or interferers. For useful signals, it allows for an estimation of amplitude variation. The Persistence Spectrum display can display the Max Hold values on top of the persistence spectrum diagram. As mentioned above, the persistence colors fade out by reducing their intensity over time. The Max Hold values, on the other hand, are assigned a time-independent intensity value to allow you to distinguish the Max Hold values and the current persistence spectrum.

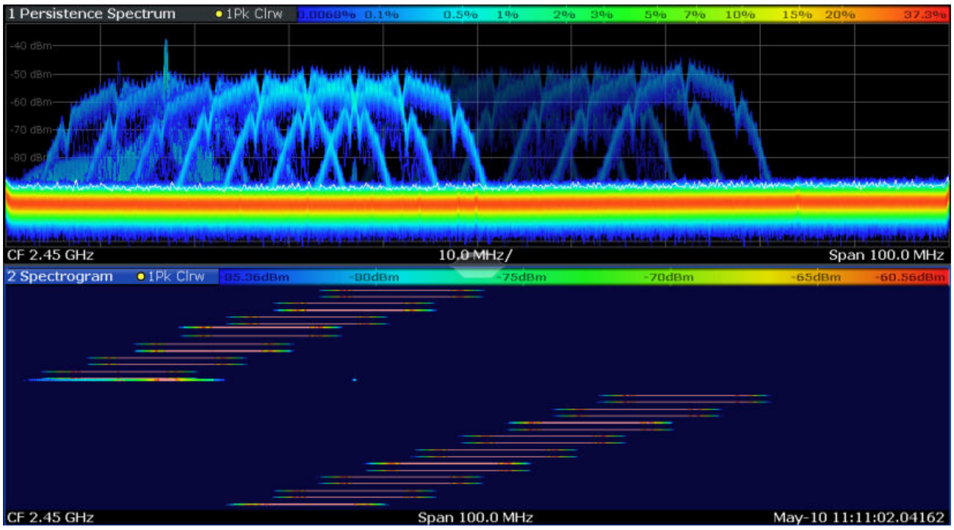


Figure 4-21: Persistence Spectrum with Max Hold trace and Spectrogram display

Changing the color intensity

By default, the Max Hold values are displayed. You can disable the function explicitly, or hide the values by reducing the color intensity to its minimum. The maximum intensity corresponds to one of the current Persistence Spectrum displays. Stored Max Hold values are cleared automatically after each new setting, and can be reset manually by the user.

For details on all settings concerning the Max Hold function and the Persistence Spectrum display in general see Chapter 6.2, "Persistence Spectrum Settings", on page 62.

5 Configuring the Real-Time Spectrum Application

Access: MODE > "Real-Time Spectrum"

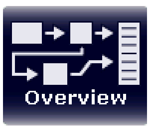
Real-Time Spectrum measurements on standard RF input require a special application on the R&S ESW.

When you activate a measurement channel for the R&S ESW Real-Time application, a Real-Time Spectrum measurement for the input signal is started automatically with the default configuration. The "Real-Time Config" menu is displayed and provides access to the most important configuration functions.

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

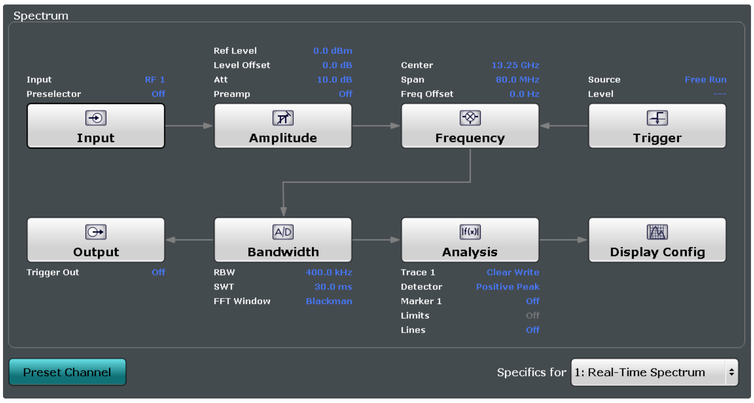
The R&S ESW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate before closing the dialog box.

5.1 Configuration Overview



Access: all menus

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



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

Multiple access paths to functionality

The easiest way to configure a measurement channel is via the "Overview" dialog box.

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

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

1. Input
   See Chapter 5.2, "Input and Output Settings", on page 43
2. Amplitude
   Amplitude: see Chapter 5.4, "Amplitude Settings", on page 46
   Scale: see Chapter 5.5, "Scale of the Y-Axis", on page 48
3. Frequency
   See Chapter 5.3, "Frequency and Span Settings", on page 44
4. (Optionally:) Trigger
   See Chapter 5.6, "Trigger Configuration", on page 49
5. Bandwidth
   See Chapter 5.7, "Bandwidth and Sweep Settings", on page 56
6. (Optionally:) Outputs
   See Chapter 5.2, "Input and Output Settings", on page 43
7. Analysis
   See Chapter 6, "Analysis", on page 62
8. Display Configuration
   See Chapter 6.1, "Display Configuration", on page 62

To configure settings

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

For step-by-step instructions on configuring Real-Time Spectrum measurements, see Chapter 8, "How to Perform Real-Time Spectrum Measurements", on page 89.

Preset Channel

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 106

Specifics for

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

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

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

5.2 Input and Output Settings

The input and output settings are the same as in the Receiver application.

For more information refer to the R&S ESW User Manual.

For more information about external generator control refer to the User Manual of the Spectrum application.

Input Selection

Selects the RF input you would like to use for a measurement.

Note that you cannot use both RF inputs simultaneously.

Remote command:
Global: `INPut<n>:TYPE` on page 107

Impedance

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

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

This value also affects the unit conversion.

Remote command:
`INPut:IMPedance` on page 107

Input Coupling
The RF input of the R&S ESW can be coupled by alternating current (AC) or direct current (DC).

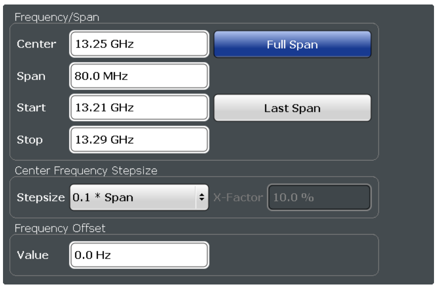
AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 107

5.3 Frequency and Span Settings

Access: "Overview" > "Frequency"



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

Remote command:
`[SENSe:]FREQuency:CENTer` on page 115

Span

Defines the frequency span. The center frequency is kept constant. The allowed range depends on the installed real-time option and is specified in the data sheet.

Remote command:
[SENSe:]FREQuency:SPAN on page 117

Start / Stop

Defines the start and stop frequencies.

Remote command:
[SENSe:]FREQuency:STARt on page 118
[SENSe:]FREQuency:STOP on page 118

Full Span

Sets the span to the full frequency range of the R&S ESW specified in the data sheet. This setting is useful for overview measurements.

Remote command:
[SENSe:]FREQuency:SPAN:FULL on page 117

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 117

Center Frequency Stepsize

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

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

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

"X * Span"	Sets the step size for the center frequency to a defined factor of the span. The "X-Factor" defines the percentage of the span. Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.
"= Center"	Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.
"= Marker"	This setting is only available if a marker is active. Sets the step size to the value of the current marker and removes the coupling of the step size to span. The used value is indicated in the "Value" field.
"Manual"	Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
[SENSe:]FREQuency:CENTer:STEP on page 116

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

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

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

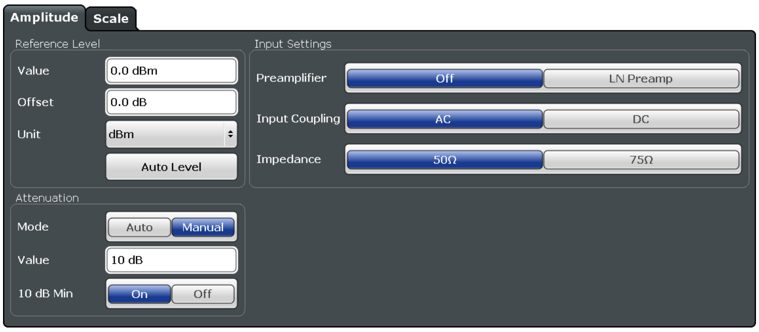
The allowed values range from -100 GHz to 100 GHz. The default setting is 0 Hz.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 117

5.4 Amplitude Settings

Access

- "Overview" > "Amplitude"



Functions to configure the amplitude described elsewhere:
- "Input Coupling" on page 44
- "Impedance" on page 43

Reference Level
Defines the expected maximum reference level. Signal levels above this value may not be measured correctly. This is indicated by an "IF OVLD" or "OVLD" status display.

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 110

Shifting the Display (Offset) ← Reference Level
Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis is changed accordingly.

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

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 111

Unit ← Reference Level
The R&S ESW measures the signal voltage at the RF input.

The following units are available and directly convertible:
- dBm
- dBmV
- dBμV

Remote command:
`CALCulate<n>:UNIT:POWer` on page 110

Attenuation
Defines the attenuation of the signal.

You can attenuate the signal in 1 dB steps. The range is specified in the datasheet. Attenuation of less than 10 dB is only possible if you turn off 10 dB Minimum Attenuation.

If you are using the preamplifier in frequency ranges above 8 GHz, the available attenuation may be reduced. For more information see Chapter 4.1.2, "Using the Preamplifier", on page 15.

Notice: For more information see Chapter 4.1, "Increasing Measurement Sensitivity (or Avoiding an Input Mixer Overload)", on page 13.

The R&S ESW also allows you to determine the best attenuation automatically.
- In the Receiver application, turn on the "Auto Ranging" feature.
- In the other applications, select attenuation "Mode" → "Auto"

Remote command:
Global: `INPut<n>:ATTenuation` on page 111
Attenuation mode: `INPut<n>:ATTenuation:AUTO` on page 111

10 dB Minimum Attenuation
Turns the availability of attenuation levels of less than 10 dB on and off.

When you turn the feature on, the attenuation level is always at least 10 dB to protect the input mixer and avoid accidental setting of 0 dB, especially if you measure DUTs with high RFI voltage.

When you turn it off, you can also select attenuation levels of less than 10 dB.

The setting applies to a manual selection of the attenuation as well as the automatic selection of the attenuation.

Remote command:
INPut<n>:ATTenuation:PROTection[:STATe] on page 112

Preamplifier
Configures the preamplifier.

In addition to the standard preamplifer, a low noise amplifier is available as an optional hardware component.

- **Off**
  Turns the preamplifier off.
- **LN Amplifier**
  Turns the optional low noise amplifier on.

Note that the real-time application only supports the optional low noise amplifier (because the normal preamplifier requires the preselector which is not supported).

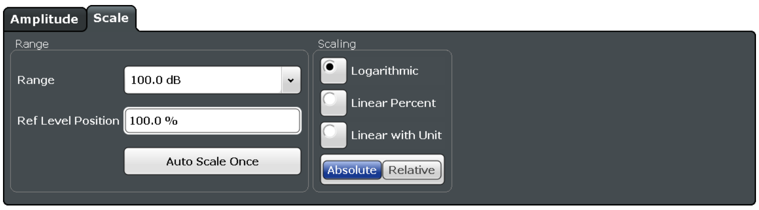
More information.

Remote command:
Preamplifier:
not supported
Low Noise preamplifier:
State (global): INPut<n>:GAIN:LNA:STATe on page 112

5.5 Scale of the Y-Axis

Access

- "Overview" > "Amplitude" > "Scale"



Range
Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] on page 113

Ref Level Position

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

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition on page 114

Auto Scale Once

Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE on page 113

Scaling

Defines the scaling method for the y-axis.

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

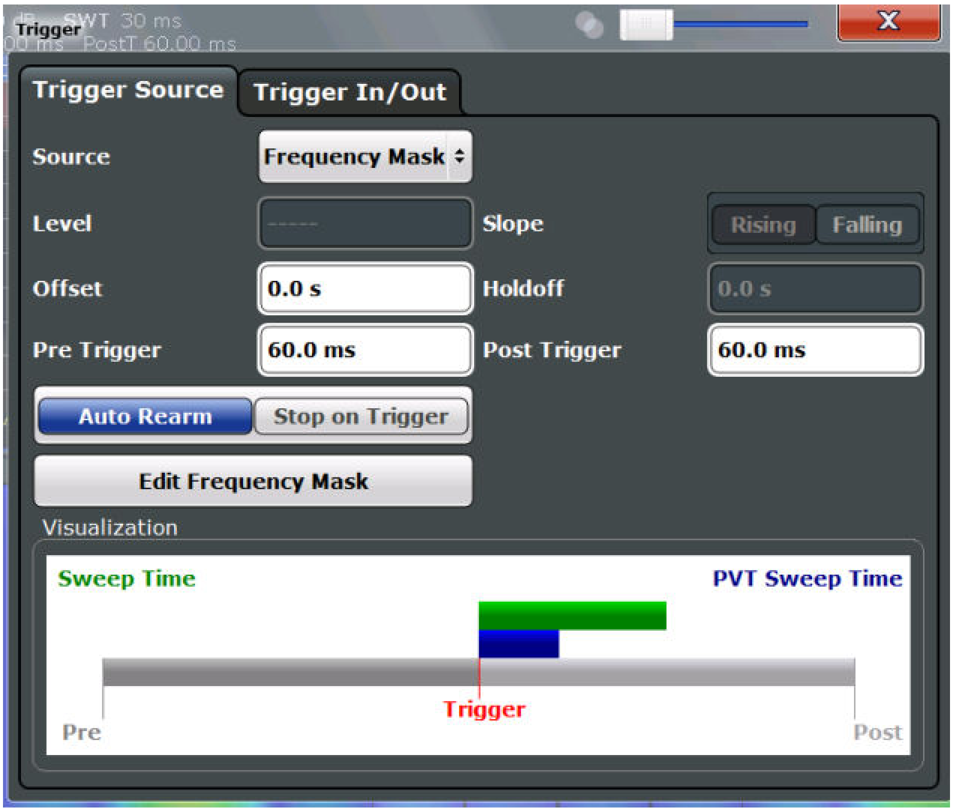
Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing on page 114
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE on page 114

5.6 Trigger Configuration

5.6.1 Trigger Source Settings

Access: "Overview" > "Trigger"

Trigger settings determine when the input signal is measured.



Trigger Source

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

Remote command:

`TRIGger<n>[:SEQuence]:SOURce` on page 124

Free Run ← Trigger Source

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

In its default state, the R&S ESW performs free run measurements.

Remote command:
TRIGger<n>[:SEQuence]:SOURce on page 124

Ext. Trigger 1/2 ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

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

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

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

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

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

Remote command:
TRIGger<n>[:SEQuence]:SOURce on page 124

Frequency Mask ← Trigger Source
Triggers when the measured signal violates the user-defined frequency mask.

For details see Chapter 4.5.1, "Frequency Mask Trigger", on page 20.

Remote command:
TRIGger<n>[:SEQuence]:SOURce on page 124

Time Domain ← Trigger Source
Triggers measurements if the signal exceeds a particular power level in the time domain.

Remote command:
TRIGger<n>[:SEQuence]:SOURce on page 124
TRIGger[:SEQuence]:TDTRigger:LEVel on page 125

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

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

Remote command:
TRIGger<n>[:SEQuence]:LEVel[:EXTernal<port>] on page 122
TRIGger[:SEQuence]:TDTRigger:LEVel on page 125

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

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

Remote command:
TRIGger<n>[:SEQuence]:HOLDoff[:TIME] on page 122

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

Remote command:
TRIGger<n>[:SEQuence]:SLOPe on page 123

Pretrigger capture time
Defines a time period *before* the actual trigger event in which data is also captured, in addition to the post-trigger time.

In this case, one or more additional frames will be available in the spectrogram/waterfall *beneath* the frame displayed in the Real-Time Spectrum or PVT diagram window by default.

Remote command:
TRIGger[:SEQuence]:PRETrigger[:TIME] on page 123

Posttrigger capture time
Defines a time period *after* the actual trigger event in which data is captured.

Posttrigger data after the sweep time are displayed as additional frames in the spectrogram/ PVT waterfall *above* the frame displayed in the Real-Time Spectrum or PVT diagram window by default.

Remote command:
TRIGger[:SEQuence]:POSTtrigger[:TIME] on page 123

Trigger mode (Auto Rearm/ Stop on Trigger)
By default, a trigger event causes the R&S ESW to start a measurement and to immediately rearm the trigger ("Auto Rearm"). In that case, measurements are continuously triggered and measurement results may become obsolete in a very short time. The pre- and posttrigger periods for each sweep time are displayed.

If "Stop on Trigger" is active, the trigger is not rearmed after the first trigger event has occurred; thus, the measurement stops after one sweep. The measurement results for that sweep remain on the display, including the pretrigger and posttrigger periods. Note, however, that if the trigger event occurs before the defined pretrigger time has elapsed, the period between measurement start and the trigger event is shorter than the defined pretrigger time.

Remote command:
TRIGger[:SEQuence]:MODE on page 121

Edit Frequency Mask
Opens the "Edit Frequency Mask" dialog, only available if the "Frequency Mask" trigger source is selected.

For details see Chapter 5.6.2, "Frequency Mask Trigger Configuration", on page 53.

5.6.2 Frequency Mask Trigger Configuration

Access: TRIG > "Edit Frequency Mask"

The Frequency Mask Trigger (FMT) is a mask in the frequency domain, which is checked with every calculated FFT. When a specific condition concerning this mask occurs during the measurement of the input signal, data capturing is triggered.

For details see Chapter 4.5.1, "Frequency Mask Trigger", on page 20.

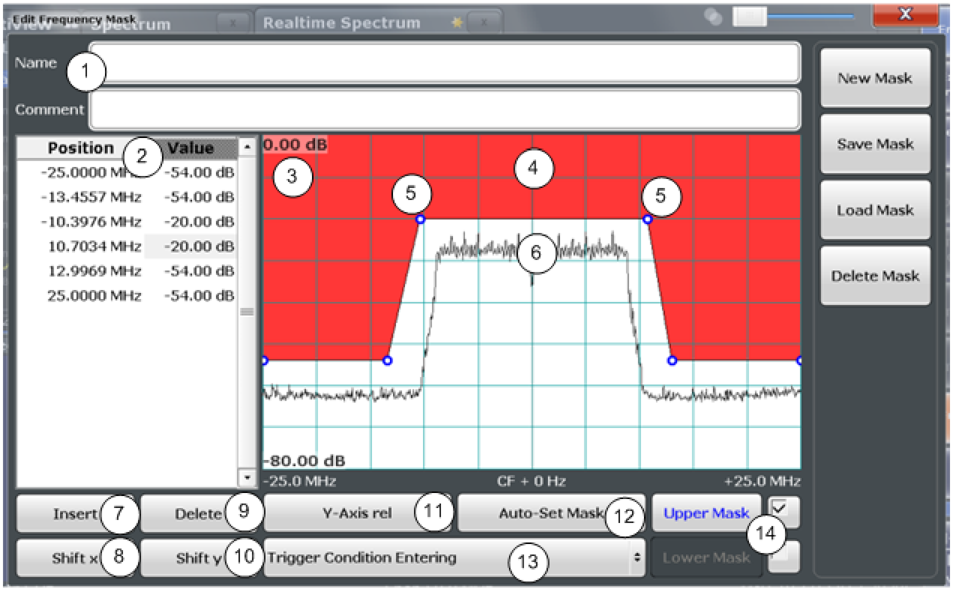


Figure 5-1: Edit Frequency Mask dialog box

1 = Name and description of the frequency mask
2 = Mask point table: list of position/value pairs defining mask coordinates
3 = Preview pane
4 = Frequency mask preview: the area the frequency mask currently covers is red
5 = Frequency mask mask points: define the shape of the frequency mask
6 = Preview of the current measurement trace; type and shape depend on currently selected measurement
7 = Insert: inserts a new mask point
8 = Shift X: shifts the complete frequency mask horizontally
9 = Delete: deletes an existing mask points
10 = Shift Y: shifts the complete frequency mask vertically
11 = Y-Axis Rel/Abs: switches between relative (dB) and absolute (dBm) amplitude values
12 = Auto Set Mask: creates a frequency mask automatically
13 = Trigger Condition selection: sets the trigger condition
14 = Upper Line/Lower Line: activates/deactivates the upper and lower frequency mask lines

5.6.2.1 Frequency Mask Management

Access: TRIG > "Edit Frequency Mask"

As frequency masks can have a very complex structure, they can be stored for later use with other signals. The masks are stored in a file with the extension `.FMT` in the `C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\freqmask` directory. By default, the mask name is used as the file name; however, it can be edited.

New Mask
Clears the current mask configuration to define a new frequency mask.

Remote command:
CALCulate<n>:MASK:NAME on page 128

Save Mask
Opens a file selection dialog box to save the current frequency mask configuration in a file.

By default, the mask name is used as the file name; however, it can be edited.

The mask is stored in a file with the extension .FMT in the C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\freqmask directory.

Remote command:
Path selection:
CALCulate<n>:MASK:CDIRectory on page 125
Define mask name:
CALCulate<n>:MASK:NAME on page 128

Load Mask
Opens a file selection dialog box to restore a saved frequency mask.

The dialog box contains all frequency masks with the extension .FMT in the C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\freqmask directory.

Select the required mask and confirm the selection with the "Load" button.

Remote command:
Path selection:
CALCulate<n>:MASK:CDIRectory on page 125
Load mask:
CALCulate<n>:MASK:NAME on page 128

Delete Mask
Opens a file selection dialog box to delete a previously saved frequency mask.

If confirmed, the file is deleted.

Remote command:
CALCulate<n>:MASK:DELete on page 126

5.6.2.2 Frequency Mask Definition

Access: TRIG > "Edit Frequency Mask"

The "Edit Frequency Mask" dialog box provides a basic structure of an upper frequency mask in the live preview window.

Name
Defines the name of the frequency mask. This name is used as the default file name for storage.

Remote command:
`CALCulate<n>:MASK:NAME` on page 128

Comment
An optional description of the frequency mask.

Remote command:
`CALCulate<n>:MASK:COMMent` on page 126

Mask points
Each mask is defined by a minimum of 2 and a maximum of 1001 mask points. Each mask point is defined by its position (x-axis) and value (y-value). Mask points must be defined in ascending order and have unique positions.

Remote command:
`CALCulate<n>:MASK:UPPer[:DATA]` on page 130
`CALCulate<n>:MASK:LOWer[:DATA]` on page 127

Inserting points
Inserts a mask point in the frequency mask above the selected one in the "Position/Value" list and the preview pane.

Remote command:
Redefine the list of data points:
`CALCulate<n>:MASK:UPPer[:DATA]` on page 130
`CALCulate<n>:MASK:LOWer[:DATA]` on page 127

Deleting points
Deletes the selected mask point in the "Position/Value" list and the preview pane.

Remote command:
Redefine the list of data points:
`CALCulate<n>:MASK:UPPer[:DATA]` on page 130
`CALCulate<n>:MASK:LOWer[:DATA]` on page 127

Shifting the mask position horizontally (Shift x)
Shifts the x-value (position) of each mask point horizontally by the defined shift width.

Remote command:
`CALCulate<n>:MASK:UPPer:SHIFt:X` on page 129
`CALCulate<n>:MASK:LOWer:SHIFt:X` on page 126

Shifting the mask vertically (Shift y)
Shifts the y-value of each mask point vertically by the defined shift height

Remote command:
`CALCulate<n>:MASK:UPPer:SHIFt:Y` on page 130
`CALCulate<n>:MASK:LOWer:SHIFt:Y` on page 127

Changing the y-axis scaling (Y-Axis rel /abs)
Switches between absolute scaling (in dBm) or relative scaling (in dB) for the mask (y-)values.

Remote command:
CALCulate<n>:MASK:MODE on page 128

Defining a mask automatically (Auto-Set Mask)
Defines a mask automatically according to the currently measured data. The mask is configured to follow the measurement trace with a specific distance to the power levels.

Remote command:
CALCulate<n>:MASK:UPPer:AUTO on page 129

Setting the trigger condition
Defines how the frequency mask is evaluated to control data acquisition.

For details see "Trigger conditions" on page 22.

"Entering"	Activates the trigger as soon as the signal enters the frequency mask. To arm the trigger, the signal initially has to be outside the frequency mask.
"Leaving"	Activates the trigger as soon as the signal leaves the frequency mask. To arm the trigger, the signal initially has to be inside the frequency mask.

Remote command:
TRIGger[:SEQuence]:MASK:CONDition on page 131

Activating/deactivating upper and lower masks
By default, the defined mask is activated as an upper mask, i.e. the mask is the area *above* the defined mask points. In addition or alternatively, a lower mask can be activated. In a lower mask, the mask is the area *below* the defined mask points.

The lower mask is defined in the same manner as the upper mask. However, it must be activated explicitly and cannot be configured automatically according to the currently measured values ("Auto-Set Mask").

Both upper and lower masks can be activated at the same time, in order to define a "corridor" of allowed values.

For details see "Upper and lower masks" on page 22

Remote command:
CALCulate<n>:MASK:LOWer:STATe on page 127
CALCulate<n>:MASK:UPPer:STATe on page 130

5.7 Bandwidth and Sweep Settings

Access: "Overview" > "Bandwidth"

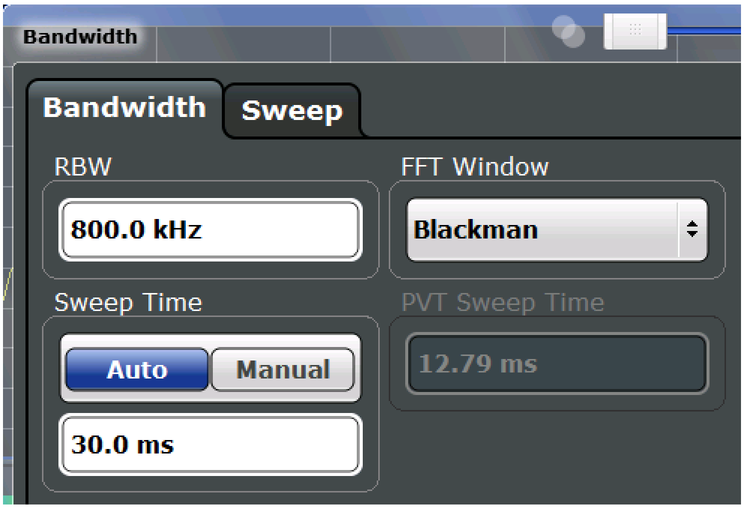


Figure 5-2: Bandwidth dialog box for High Resolution measurement

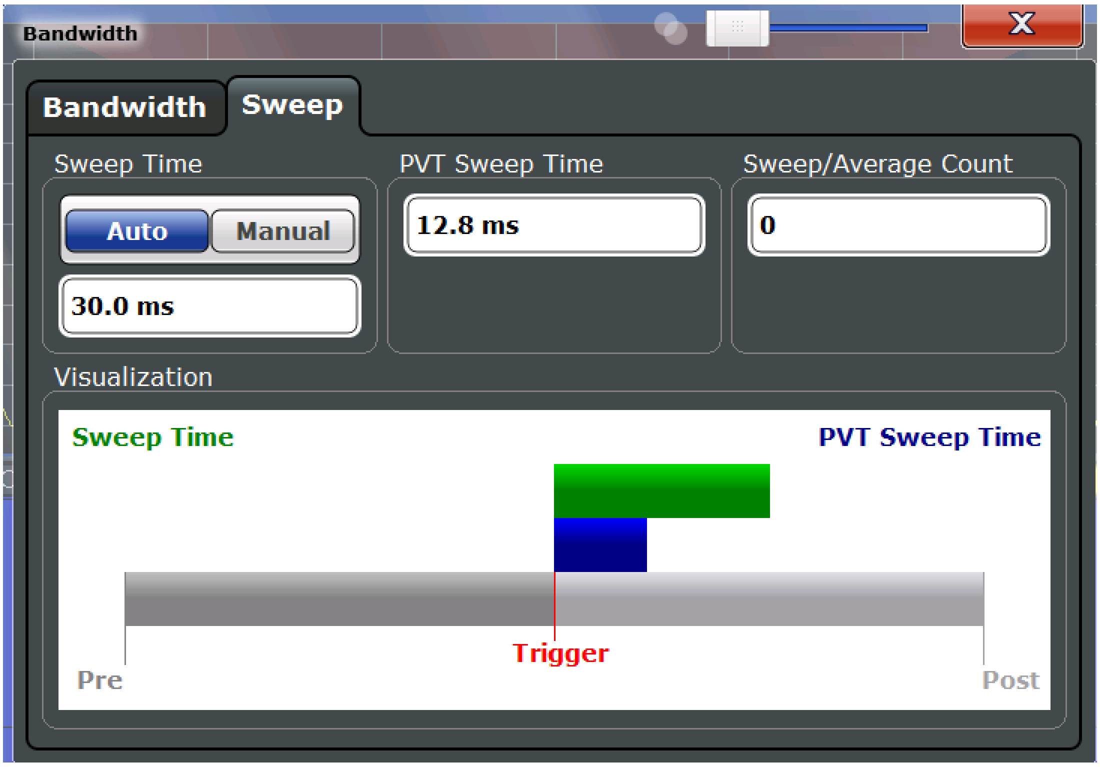


Figure 5-3: Sweep dialog box for Multi-Domain measurement

Functions to configure the sweep described elsewhere:

- Select Frame

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 according to the available Span/RBW coupling ratios.

Which coupling ratios are available depends on the selected FFT Window.

The RBW can be defined independently of the selected span.

For more information see Chapter 4.3, "Defining the Resolution Bandwidth", on page 19.

Remote command:
`[SENSe:]BANDwidth[:RESolution]` on page 119
`[SENSe:]BANDwidth[:RESolution]:RATio` on page 119

FFT Window

In the R&S ESW Real-Time application you can select one of several FFT window types. The window type is coupled to the resolution bandwidth.

The following window types are available:

- Blackman
- Flattop
- Gaussian
- Rectangle
- Hanning
- Hamming
- Kaiser

Remote command:
`[SENSe:]SWEep:FFT:WINDow:TYPE` on page 120

Sweep Time

Determines the amount of time used to sample data for one spectrum. The sweep time can be defined automatically or manually.

The allowed sweep times depend on the device model; refer to the data sheet.

For more information see Chapter 4.4, "Sweep Time and Detector", on page 20.

"Auto" The sweep time is coupled to the span and resolution bandwidth (RBW). If the span or resolution bandwidth is changed, the sweep time is automatically adjusted.

"Manual" Define the sweep time manually. Allowed values depend on the coupling ratio of span to RBW. 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 121
`[SENSe:]SWEep:TIME` on page 120

Continuous Sweep/RUN CONT
While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. Furthermore, the RUN CONT key controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 152
Measurement mode: `INITiate<n>:CONTinuous` on page 152
Run measurement: `INITiate<n>[:IMMediate]` on page 153

Single Sweep/ RUN SINGLE
RUN SINGLE initiates a single measurement. If no trigger is used, data is captured for the defined sweep time, resulting in one spectrogram frame. Otherwise, the measurement starts after triggering and the measurement time is defined by the post- and pre-trigger times. The result may be more than one frame.

While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. Furthermore, the RUN SINGLE key controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.
If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

Remote command:
Measurement mode: `INITiate<n>:CONTinuous` on page 152
Run measurement: `INITiate<n>[:IMMediate]` on page 153

Sweep Count
Defines the number of measurements to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one measurement is performed. The sweep count is applied to all the traces in all Real-Time Spectrum and Persistence Spectrum diagrams.

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

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

Remote command:
`[SENSe:]SWEep:COUNt` on page 119

Clear Spectrogram
Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:CLEar[:IMMediate]` on page 131

5.8 Adjusting Settings Automatically

Access: AUTO SET

Some settings can be adjusted by the R&S ESW automatically according to the current measurement settings. In order to do so, a measurement is performed. The duration of this measurement can be defined automatically or manually.

Adjusting settings automatically during triggered measurements

When you select an auto adjust function a measurement is performed to determine the optimal settings. If you select an auto adjust function for a triggered measurement, you are asked how the R&S ESW should behave:

- (default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger.
  The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored.

Remote command:

[SENSe:]ADJust:CONFigure:TRIG on page 143

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Frequency
- Auto Level

Remote command:
[SENSe:]ADJust:ALL on page 141

Adjusting the Center Frequency Automatically (Auto Freq)

The R&S ESW adjusts the center frequency automatically.

The optimum center frequency is the frequency with the highest S/N ratio in the frequency span. As this function uses the signal counter, it is intended for use with sinusoidal signals.

Remote command:
[SENSe:]ADJust:FREQuency on page 142

Setting the Reference Level Automatically (Auto Level)
Automatically determines a reference level which ensures that no overload occurs at the R&S ESW for the current input data. At the same time, the internal attenuators are adjusted so the signal-to-noise ratio is optimized, while signal compression and clipping are minimized.

To determine the required reference level, a level measurement is performed on the R&S ESW.

If necessary, you can optimize the reference level further by manually decreasing the attenuation level to the lowest possible value before an overload occurs, then decreasing the reference level in the same way.

Remote command:
`[SENSe:]ADJust:LEVel` on page 113

Resetting the Automatic Measurement Time (Meastime Auto)
Resets the measurement duration for automatic settings to the default value.

Remote command:
`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 142

Changing the Automatic Measurement Time (Meastime Manual)
This function allows you to change the measurement duration for automatic setting adjustments. Enter the value in seconds.

Remote command:
`[SENSe:]ADJust:CONFigure:DURation:MODE` on page 142
`[SENSe:]ADJust:CONFigure:DURation` on page 141

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

Remote command:
`[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer` on page 143

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

Remote command:
`[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer` on page 143

6 Analysis

Access: "Overview" > "Analysis"

Specific result configuration for persistence and spectrogram or waterfall displays, as well as general result analysis settings concerning the trace, markers, windows etc. can be configured.

6.1 Display Configuration

Access: MEAS

Or: "Overview" > "Display Config"

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the Real-Time Spectrum application are displayed in the evaluation bar in SmartGrid mode.

Up to 6 evaluation methods can be displayed simultaneously in separate windows. The real-Time evaluation methods are described in Chapter 3, "Measurements and Result Displays", on page 9.

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

6.2 Persistence Spectrum Settings

Access: "Overview" > "Analysis" > "Persistence" tab

Or: MEAS CONFIG > "Persistence Config"

The persistence spectrum is highly configurable. You can change the colors with which the densities are visualized, the persistence of the data, and the style of the displayed results.

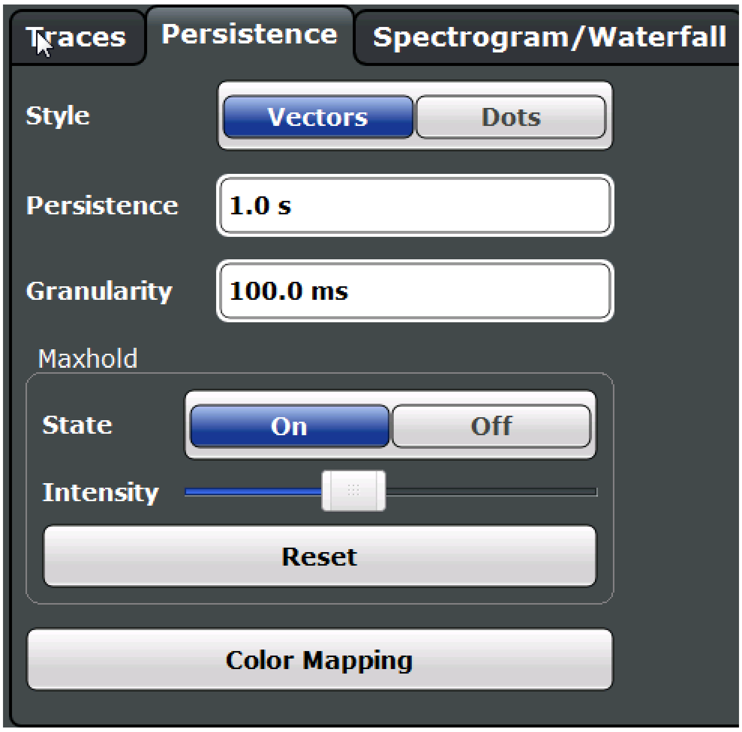


Diagram Style

The persistence spectrum can be displayed using vectors or dots.

For details see "Matrix style" on page 37.

"Vectors" Using vectors, the individual points - and thus the densities - are interpolated. The result is a persistence spectrum that contains no gaps between coordinates. Each point of the histogram is connected to the neighboring ones.

"Dots" Using dots, only those coordinates are displayed for which data has actually been measured. The result is a histogram made up out of individual points.

Remote command:

`DISPlay:WINDow:[SUBWindow:]TRACe:SYMBol` on page 136

Persistence

Persistence defines the duration that shadows of past histogram traces remain visible in the display before fading away.

The number of traces that are considered when calculating the density depends on this persistence length.

For low persistence values, the density colors change quickly in the persistence spectrogram.

For high persistence values, the colors change slowly.

A value of 0 seconds deactivates persistence.

For details see Chapter 4.7, "Understanding Persistence", on page 35.

Remote command:
`DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence:DURation` on page 135

Granularity
Defines the amount of data that the R&S ESW uses to draw a single frame in the persistence spectrum. By default, the moving density of the data that was captured in 100 ms is displayed for each frame.

For details see "Persistence Granularity" on page 36.

Remote command:
`DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence:GRANularity` on page 136

Configuring the Max Hold Function
The Max Hold function remembers and shows the maximum densities that have been measured at each point in the diagram.

If activated, the maximum values from all past sweeps are indicated in the persistence spectrum, together with the measured values from the current sweep.

Note: Setting the Intensity to 0 has the same effect as deactivating the Max Hold function.

For details see Chapter 4.7.1, "Analyzing Maximum Density - Max Hold Function", on page 39.

Remote command:
`DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold[:STATe]` on page 135

Intensity ← Configuring the Max Hold Function
The maximum values (that is, the Max Hold trace) are displayed in the defined intensity. The higher the intensity, the brighter the maximum values are displayed. With maximum intensity, the maximum values are displayed just as bright as the currently measured values.

Note: Setting the intensity to 0 has the same effect as deactivating the Max Hold function.

To change the intensity, move the slider to the left (weaker) or right (stronger).

Note that while the intensity of the Max Hold trace may differ to the currently measured trace, the color *mapping* is the same for both traces.

Remote command:
`DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold:INTensity` on page 134

Resetting the Max Hold Function ← Configuring the Max Hold Function
The previous results of the Max Hold function are cleared and the function starts determining new maximum values.

Remote command:
DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold:RESet on page 134

Color Mapping
Opens the "Color Map" dialog.

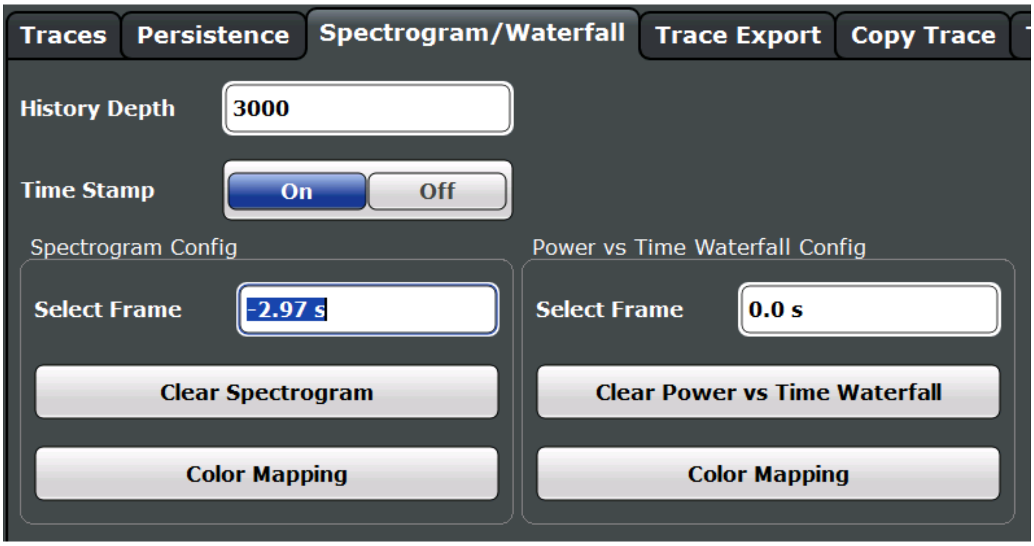
For details see Chapter 6.4, "Color Map Settings", on page 67.

6.3 Spectrogram Settings

Access: "Overview" > "Analysis" > "Spectrogram/Waterfall" tab

Or: MEAS CONFIG > "Spectrogram/Waterfall Config"

The individual settings available for spectrogram and waterfall displays are described here. For settings on color mapping, see Chapter 6.4, "Color Map Settings", on page 67.



History Depth
Sets the number of frames that the R&S ESW stores in its memory. The maximum history depth is 100.000 frames.

If the memory is full, the R&S ESW deletes the oldest frames stored in the memory and replaces them with the new data.

Remote command:
CALCulate<n>:SGRam|SPECtrogram:HDEPth on page 132

Time Stamp
Activates and deactivates the time stamp. If activated (default), the time stamp shows the system time while the measurement is running. In single sweep mode or if the sweep is stopped, the time stamp shows the time and date at the end of the sweep.

Individual frames are referred to by their time difference to the end of the sweep.

If deactivated, individual frames are referred to by their frame number in the spectrogram and waterfall diagrams.

For details see "Time stamps vs. frame index" on page 28.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:TSTamp[:STATe]` on page 133
`CALCulate<n>:SGRam|SPECtrogram:TSTamp:DATA?` on page 133

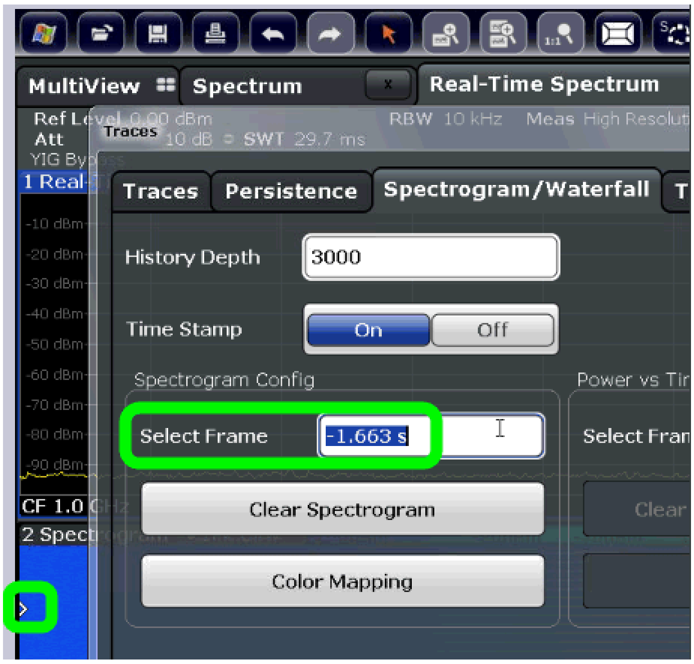
Selecting a frame to display
Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Real-Time Spectrum or Power vs. Time window. Different frames can be displayed in the Real-Time Spectrum and Power vs. Time windows.

This function is only available in single sweep mode or if the sweep is stopped.

The most recent frame is number 0, all previous frames have a negative number.

Note that activating a marker or changing the position of the active marker automatically selects the frame that belongs to that marker.

The selected frame is indicated by small white arrows on the left and right border of the spectrogram/PVT waterfall.



For more information see Chapter 4.6.1, "Time Frames", on page 26.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect` on page 132

Clear Spectrogram
Resets the spectrogram result display and clears the history buffer.

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SGRam|SPECtrogram:CLEar[:IMMediate]` on page 131

Color Mapping
Opens the "Color Map" dialog.

For details see Chapter 6.4, "Color Map Settings", on page 67.

6.4 Color Map Settings

Access: MEAS CONFIG > "Color Mapping"

The settings for color maps are available for spectrograms, persistence spectra, and waterfall displays.

For more information on color maps see Chapter 4.6.3, "Color Maps", on page 29.

For details on changing color map settings see Chapter 8.3, "How to Configure the Color Mapping", on page 91.

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 6-1: Color Mapping dialog box

1 = Color map: shows the current color distribution
2 = Preview pane: shows a preview of the diagram with any changes that you make to the color scheme
3 = Color curve pane: graphical representation of all settings available to customize the color scheme
4/5 = Color range start and stop sliders: define the range of the color map or amplitudes for the spectrogram
6 = Color curve slider: adjusts the focus of the color curve
7 = Histogram: shows the distribution of measured values
8 = Scale of the horizontal axis (value range)

Start / Stop

Defines the lower and upper boundaries of the value range of the diagram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer` on page 140
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer` on page 140
`DISPlay:WINDow:PSPectrum:COLor:LOWer` on page 137
`DISPlay:WINDow:PSPectrum:COLor:UPPer` on page 138

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 140
`DISPlay:WINDow:PSPectrum:COLor:SHAPe` on page 137

Truncate

This command is available for Persistence Spectrum only.

By default, results that are smaller than the start value of the color map range are displayed in the color for the minimum value. Results that are larger than the stop value of the color map range are displayed in the color for the maximum value.

If the "Truncate" function is activated, the results of the persistence spectrum outside the value range of the color map are truncated, that is, not displayed.

Remote command:
`DISPlay:WINDow:PSPectrum:COLor:TRUNcate` on page 138

Hot/Cold/Radar/Grayscale

Sets the color scheme for the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]` on page 139
`DISPlay:WINDow:PSPectrum:COLor[:STYLe]` on page 138

Auto

Defines the color range automatically according to the existing measured values for optimized display.

Set to Default

Sets the color map to the default settings.

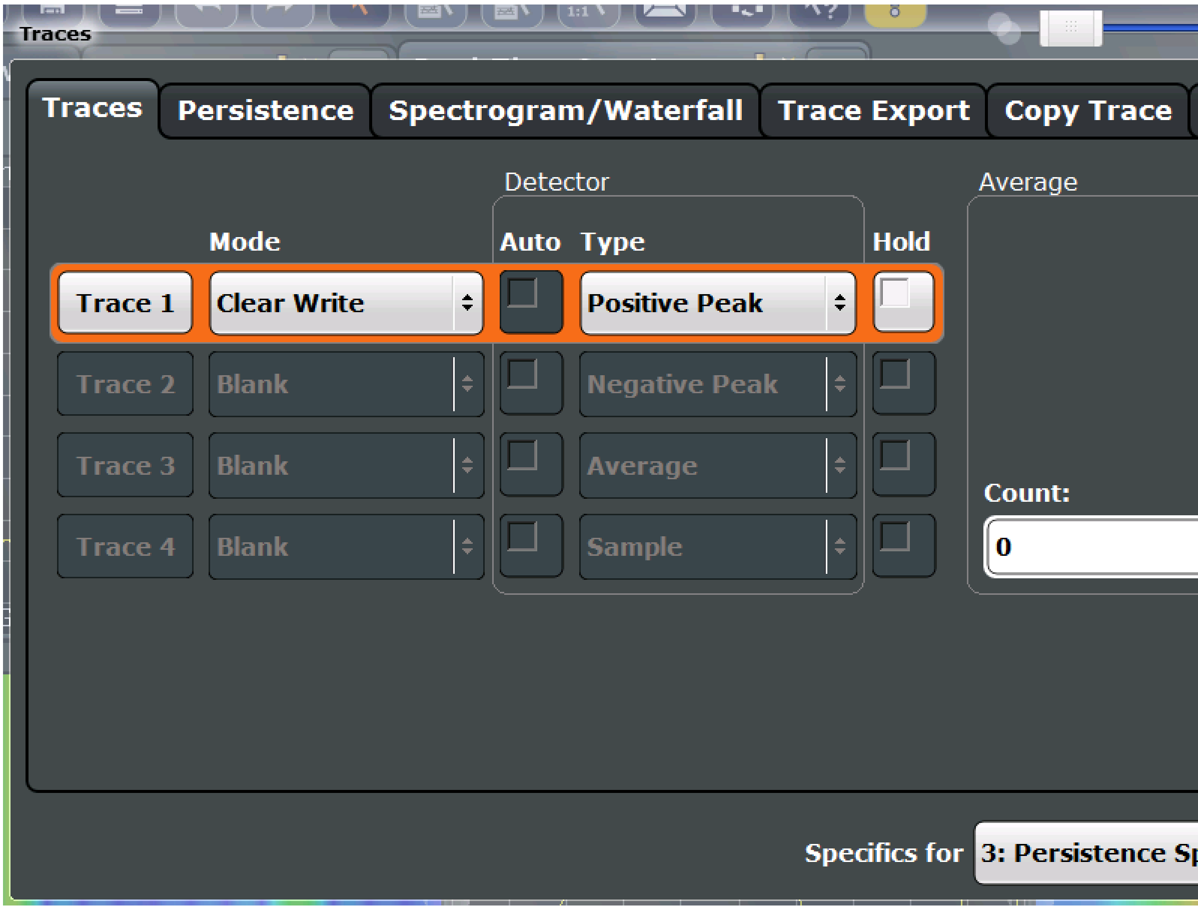
Remote command:
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault on page 140
DISPlay:WINDow:PSPectrum:COLor:DEFault on page 137

6.5 Trace Settings

Access: "Overview" > "Analysis" > "Traces" tab

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

Trace data can also be exported to an ASCII file for further analysis. For details see Chapter 6.6, "Trace / Data Export Configuration", on page 72.



Trace 1/Trace 2/Trace 3/Trace 4

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 170
Selected via numeric suffix of `TRACe<t>` commands

Mode

Defines the update mode for subsequent traces.

"Clear Write" Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

"Max Hold" The maximum value is determined over several sweeps and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.

"Min Hold" The minimum value is determined over several sweeps and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.

"View" The current contents of the trace memory are frozen and displayed.

"Blank" Removes the selected trace from the display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 168

Detector

Defines the trace detector to be used for trace analysis.

Detectors perform a data reduction from the swept values to the displayed trace points. The detector type determines which of the samples are displayed for each trace point.

Note: The detector activated for the specific trace is indicated in the corresponding trace information in the window title bar by an abbreviation.

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

"Positive Peak" Determines the largest of all positive peak values from the levels measured at the individual x-values which are displayed in one trace point

"Negative Peak" Determines the smallest of all negative peak values from the levels measured at the individual x-values which are displayed in one trace point

"Average" Calculates the linear average of all samples contained in a sweep point.
To this effect, R&S ESW uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). Each sweep point thus corresponds to the average of the measured values summed up in the sweep point.
The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).

"Sample" Selects the last measured value of the levels measured at the individual x-values which are displayed in one trace point; all other measured values for the x-axis range are ignored

Remote command:
`[SENSe:][WINDow:]DETector<t>[:FUNCtion]` on page 171

Hold

If activated, traces in "Min Hold", "Max Hold" and "Average" mode are not reset after specific parameter changes have been made.

Normally, the measurement is started again after parameter changes, before the measurement results are analyzed (e.g. using a marker). In all cases that require a new measurement after parameter changes, the trace is reset automatically to avoid false results (e.g. with span changes). For applications that require no reset after parameter changes, the automatic reset can be switched off.

The default setting is off.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous` on page 169

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

Remote command:
`[SENSe:]AVERage<n>:COUNt` on page 170

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 170

Copy Trace

Access: "Overview" > "Analysis" > "Traces" > "Copy Trace"

Copies trace data to another trace.

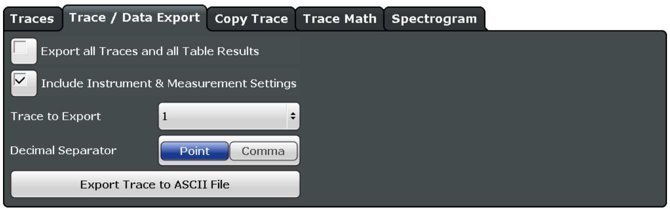
The first group of buttons (labeled "Trace 1" to "Trace 4") selects the source trace. The second group of buttons (labeled "Copy to Trace 1" to "Copy to Trace 4") selects the destination.

Remote command:
`TRACe<n>:COPY` on page 171

6.6 Trace / Data Export Configuration

Access: "Overview" > "Analysis" > "Traces" > "Trace/Data Export"

Or: "Overview" > "Analysis" > "Trace Export"



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 163

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

Remote command:
`FORMat:DEXPort:HEADer` on page 163

Trace to Export
Defines an individual trace that will be exported to a file.

This setting is not available if Export all Traces and all Table Results is selected.

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export files. Evaluation programs require different separators in different languages.

Remote command:
FORMat:DEXPort:DSEParator on page 163

Export Trace to ASCII File
Opens a file selection dialog box and saves the selected trace in ASCII format (**.dat**) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

If the spectrogram display is selected when you perform this function, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded. For large history buffers the export operation may take some time.

Remote command:
MMEMory:STORe<n>:TRACe on page 162

6.7 Trace Math

Access: TRACE > "Trace Math"

Trace Math Function
Defines which trace is subtracted from trace 1. The result is displayed in trace 1 and refers to the zero point defined with the Trace Math Position setting. The following subtractions can be performed:

"T1-T2 -> T1"	Subtracts trace 2 from trace 1.
"T1-T3 -> T1"	Subtracts trace 3 from trace 1
"T1-T4 -> T1"	Subtracts trace 4 from trace 1

To switch off the trace math, use the Trace Math Off button.

Remote command:
CALCulate<n>:MATH[:EXPression][:DEFine] on page 172
CALCulate<n>:MATH:STATe on page 173

Trace Math Off
Deactivates any previously selected trace math functions.

Remote command:
CALC:MATH:STAT OFF, see CALCulate<n>:MATH:STATe on page 173

Trace Math Position
Defines the zero point on the y-axis of the resulting trace in % of the diagram height. The range of values extends from -100 % to +200 %.

Remote command:
`CALCulate<n>:MATH:POSition` on page 173

Trace Math Mode

Defines the mode for the trace math calculations.

"Lin" 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.
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):

- 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" Activates logarithmic subtraction.
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.

"Power" Activates linear power subtraction.
The power level values are converted into unit Watt prior to subtraction. After the subtraction, the data is converted back into its original unit.
Unlike the linear mode, the subtraction is always done in W.

Remote command:
`CALCulate<n>:MATH:MODE` on page 172

6.8 Marker Settings

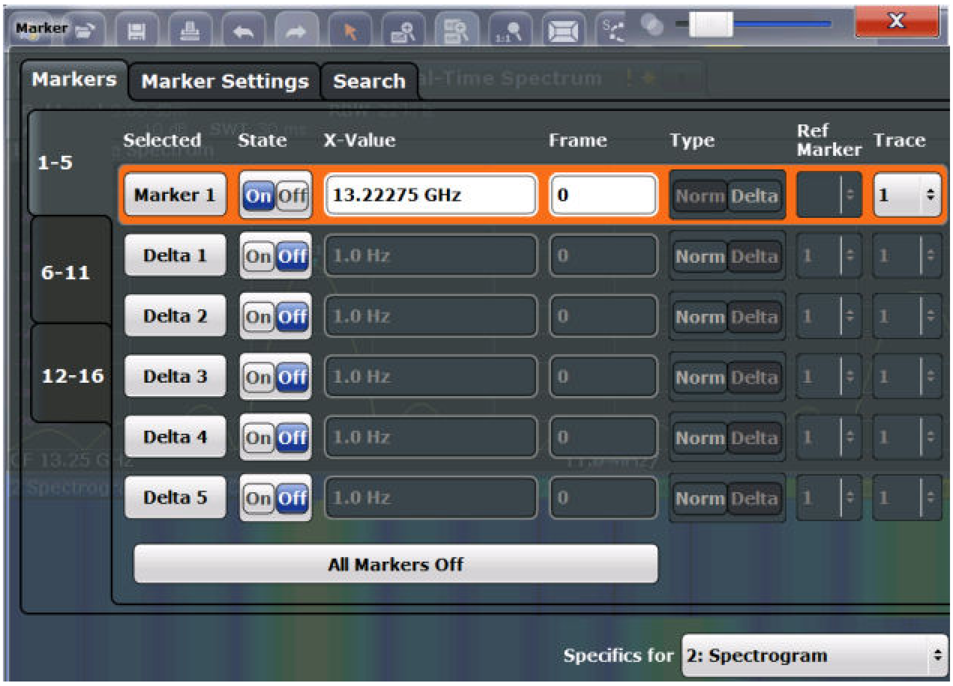
Access: "Overview" > "Analysis" > "Marker" tab

6.8.1 Individual Marker Setup

Access: "Overview" > "Analysis" > "Marker" tab > "Markers" tab

Or: MKR > "Marker Config"

Up to 17 markers or delta markers can be activated for each window simultaneously.



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

Selected Marker

Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State

Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 174
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 177

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 175
`CALCulate<n>:DELTamarker<m>:X` on page 178

Marker Level (Y-value)
Defines the level (y-value) of the marker in the Persistence Spectrum diagram.

Remote command:
`CALCulate<n>:MARKer<m>:Y?` on page 175
`CALCulate<n>:DELTamarker<m>:Y?` on page 178

Frame
Spectrogram frame number the marker is assigned to. The most recently swept frame is number 0, all previous frames have negative numbers.

The selected frame is indicated by small white arrows on the left and right border of the spectrogram/PVT waterfall.

Remote command:
`CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 191

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 174
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 177

Reference Marker
Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

If the reference marker is deactivated, the delta marker referring to it is also deactivated.

Remote command:
`CALCulate<n>:DELTamarker<m>:MREF` on page 177

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.

Note: Markers in the persistence spectrum. In the persistence spectrum result display, you can place each marker either on the **current** persistence trace or the **Max Hold** trace, if it is active.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 175

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 174
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 177

All Markers Off
Deactivates all markers in one step.

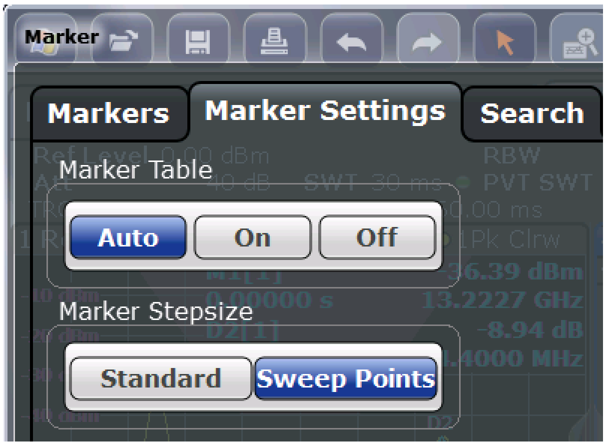
Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 174

6.8.2 General Marker Settings

Access: "Overview" > "Analysis" > "Marker" tab > "Marker Settings" tab

Or: MKR > "Marker Config" > "Marker Settings" tab

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



Marker Table Display

Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area. No separate marker table is displayed.

"Auto" (Default) Up to two markers are displayed in the diagram area. If more markers are active, the marker table is displayed automatically.

Remote command:

`DISPlay:MTABle` on page 180

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 measurement 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 179

6.8.3 Marker Search Settings

Access: "Overview" > "Analysis" > "Marker" tab > "Search" tab

Or: MKR -> > "Search Config"

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).

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:

`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 185
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 185
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 186
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 186
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 186
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 187

Search Mode for Next Peak in Y Direction

Selects the search mode for the next peak search within all frames at the current marker position.

This setting is only available for spectrogram displays.

"Up" Determines the next maximum/minimum above the current peak (in more recent frames).

"Absolute" Determines the next maximum/minimum above or below the current peak (in all frames).

"Down" Determines the next maximum/minimum below the current peak (in older frames).

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe on page 192
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe on page 197
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow on page 192
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow on page 197
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT on page 193
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT on page 198
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe on page 193
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe on page 198
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow on page 194
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow on page 199
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT on page 194
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT on page 199

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 marker position.

"XY-Search" Searches in all frames at all positions.

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK] on page 191
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK] on page 197
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK] on page 192
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK] on page 197
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK] on page 193
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK] on page 198
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK] on page 194
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK] on page 199

CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 185
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 188
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 186
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 189

Marker Search Area
Defines which frames the search is performed in.

This setting is only available for spectrogram displays.

"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 191
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea on page 196

Exclude LO
If activated, restricts the frequency range for the marker search functions.

"ON" The minimum frequency included in the peak search range is ≥ 5 × 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 180

Peak Excursion
Defines the minimum level value by which a signal must rise or fall so that it will be identified as a maximum or a minimum by the search functions.

Remote command:
CALCulate<n>:MARKer<m>:PEXCursion on page 181

Auto Max / Min Peak Search
If activated, a maximum or minimum peak search is performed automatically for marker 1 after each measurement.

For spectrogram displays, define which frame the peak is to be searched in.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:AUTO on page 181
CALCulate<n>:MARKer<m>:MINimum:AUTO on page 181

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.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 182
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 182
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT` on page 183

Search Threshold ← Search Limits
Defines an absolute threshold as an additional condition for the peak search. Only peaks that exceed the threshold are detected.

Remote command:
`CALCulate<n>:THReshold` on page 183

Deactivating All Search Limits ← Search Limits
Deactivates the search range limits.

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 182
`CALCulate<n>:THReshold:STATe` on page 184

6.8.4 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
Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 185
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 188

Search Next Peak
Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 185
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 186

CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 185
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 188
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 188
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 187

Search Minimum

Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 186
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 189

Search Next Minimum

Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 186
CALCulate<n>:MARKer<m>:MINimum:LEFT on page 186
CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 187
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 189
CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 188
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 189

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 184

Reference Level = Marker Level

Sets the reference level to the selected marker level.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:REFerence on page 110

Marker to Trigger

Sets the marker directly on the most recent trigger event.

This function is only available for spectrograms, and only if a trigger event already occurred.

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:Y:TRIGger on page 195

6.9 Display and Limit Lines

The display and limit line functionality is the same as in the Spectrum application.

For more information refer to the User Manual of the Spectrum application.

6.10 Zoom Functions

The zoom functions are only available from the toolbar.

For details on the zoom functions see Chapter 4.6.4, "Zooming into the Spectrogram", on page 32.

Single Zoom

Define the zoom area by drawing a rectangle on the touchscreen. When you draw the zoom area, its boundaries are shown as a dashed line. The R&S ESW stops the Real-Time measurement and recalculates the displays for the area you have selected. The definition of the color map remains the same.

Note: In Real-Time measurements, this function is only available for an active spectrogram.
The graphical zoom provided for other measurements on the R&S ESW is **not available** for Real-Time measurements.

For details and restrictions see Chapter 4.6.4, "Zooming into the Spectrogram", on page 32.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 201
`DISPlay[:WINDow<n>]:ZOOM:AREA` on page 200

Restore Original Display

Restores the original display, that is, the originally calculated displays for the entire capture buffer, and closes all zoom windows.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 201

Deactivating Zoom (Selection mode)
Deactivates any zoom mode.

Tapping the screen no longer invokes a zoom, but selects an object.

Remote command:
DISPlay[:WINDow<n>]:ZOOM:STATe on page 201

Replay Zoom
Switches between the zoomed displays and the original displays quickly for comparison.

If enabled, the zoomed displays are shown, that is, the recalculated displays for the selected zoom area.

If disabled, the original display is restored, that is, the originally calculated displays for the entire capture buffer.

This function is only available after a measurement has been performed.

For details see Chapter 4.6.4, "Zooming into the Spectrogram", on page 32.

7 I/Q Data Export

Baseband signals mostly occur as so-called complex baseband signals, i.e. a signal representation that consists of two channels; the in phase (I) and the quadrature (Q) channel. Such signals are referred to as I/Q signals. I/Q signals are useful because the specific RF or IF frequencies are not needed. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband.

Exporting I/Q signals is useful for example to capture and save I/Q signals with a signal analyzer to analyze them with another R&S ESW application or an external software tool (for example the R&S VSE software) later.

As opposed to storing trace data, which may be averaged or restricted to peak values, I/Q data is exported as it was captured, without further processing. The data is stored as complex values in 32-bit floating-point format.

For a detailed description see the R&S ESW I/Q Analyzer and I/Q Input User Manual.

7.1 Export Functions

The export functions are available in the "Save/Recall" menu which is displayed when you select the "Save" icon in the toolbar.

Some functions for particular data types are (also) available via softkeys or dialog boxes in the corresponding menus, e.g. trace data.

For a description of the other functions in the "Save/Recall" menu see the R&S ESW User Manual.

Trace Export Configuration
Opens the "Traces" dialog box to configure the trace and data export settings.

I/Q Export
Opens a file selection dialog box to define an export file name to which the I/Q data will be stored. This function is only available in single sweep mode.

For details see the description in the R&S ESW I/Q Analyzer User Manual ("Importing and Exporting I/Q Data").

Note: Storing large amounts of I/Q data (several Gigabytes) may exceed the available (internal) storage space on the R&S ESW. In this case, it may be necessary to use an external storage medium.

Note: Secure user mode.
In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

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

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

Remote command:
MMEMory:STORe<n>:IQ:STATe on page 167
MMEMory:STORe<n>:IQ:COMMent on page 167

7.2 How to Export I/Q Data

Capturing and exporting I/Q data

1. Configure the data acquisition.
2. Press the RUN SINGLE key to perform a single sweep measurement.
3. Select the "Save" icon in the toolbar.
4. Select "Export > I/Q Export".
5. In the file selection dialog box, select a storage location and enter a file name.
6. Select "Save".

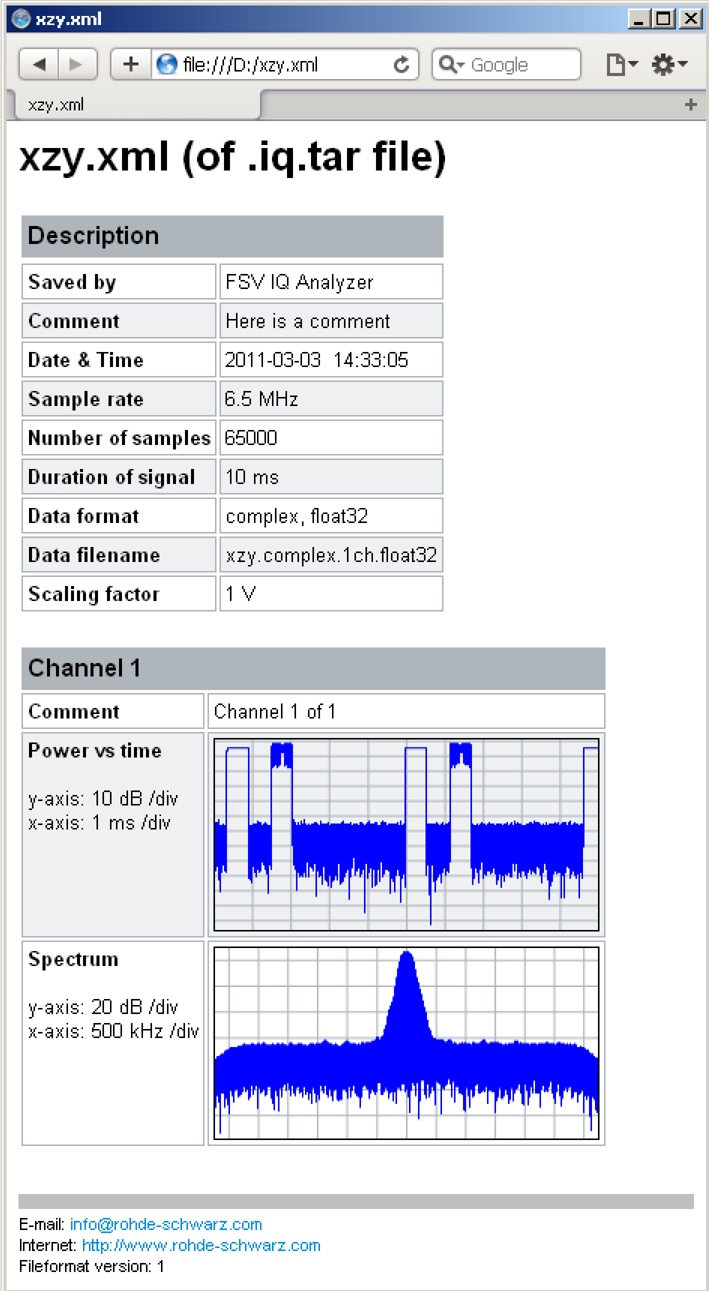
   The captured data is stored to a file with the extension .iq.tar.
   The length of the captured data is equal to the defined "Sweep Time" on page 58.

Previewing the I/Q data in a web browser

The iq-tar file format allows you to preview the I/Q data in a web browser.

1. Use an archive tool (e.g. WinZip® or PowerArchiver®) to unpack the iq-tar file into a folder.
2. Locate the folder using Windows Explorer.
3. Open your web browser.

4. Drag the I/Q parameter XML file, e.g. `example.xml`, into your web browser.



xzy.xml

file:///D:/xzy.xml

xzy.xml (of .iq.tar file)

Description	
Saved by	FSV IQ Analyzer
Comment	Here is a comment
Date & Time	2011-03-03 14:33:05
Sample rate	6.5 MHz
Number of samples	65000
Duration of signal	10 ms
Data format	complex, float32
Data filename	xzy.complex.1ch.float32
Scaling factor	1 V

Channel 1	
Comment	Channel 1 of 1
Power vs time y-axis: 10 dB /div x-axis: 1 ms /div	
Spectrum y-axis: 20 dB /div x-axis: 500 kHz /div	

E-mail: info@rohde-schwarz.com
Internet: http://www.rohde-schwarz.com
Fileformat version: 1

8 How to Perform Real-Time Spectrum Measurements

8.1 How to Perform a Basic Real-Time Spectrum Measurement

The following step-by-step instructions demonstrate how to perform a basic Real-Time Spectrum measurement with the R&S ESW Real-Time application.

1. Press the MODE key on the front panel and select the "Real-Time Spectrum" application.
2. Press the RUN CONT key to stop the default continuous measurement.
3. Select the "Overview" softkey to display the "Overview" for a Real-Time Spectrum measurement.
4. Select the "Amplitude" button to define the required reference level and configure the attenuation, if necessary.
5. Select the "Frequency" button to define the center frequency of the measurement.
6. Optionally, select the "Trigger" button to use an external trigger or to configure a frequency mask trigger for the measurement. For details on using a frequency mask trigger see Chapter 8.4, "How to Work with Frequency Mask Triggers", on page 93.
   To capture and analyze I/Q data for a specific time around a trigger event, define a pretrigger and posttrigger time in the "Trigger" settings.
7. Select the "Bandwidth" button to configure the FFT parameters.
   - "RBW": Define the resolution bandwidth in Hz
   - "FFT Window": Select the window function depending on the required characteristics
   - "Sweep Time": Define how long data is to be captured for one line in the spectrogram
8. Select the "Analysis" button and then the "Spectrogram/Waterfall" tab to configure the spectrogram.
   - "History Depth": number of lines (frames) to be stored in the spectrogram (possibly for several consecutive measurements).

- Optionally, deactivate the "Time Stamp" option to refer to the individual lines (frames) using an index number instead of the time they were captured.
- Optionally, select "Color Mapping" to change the colors with which the power levels are represented in the spectrogram. For details see Chapter 8.3, "How to Configure the Color Mapping", on page 91.
- Select "Clear Spectrogram" to start a new spectrogram display.

9. Press RUN SINGLE to start a sweep with the defined settings.

   When the sweep is finished, the Spectrogram displays all captured lines captured during the dwell time, and the Real-Time Spectrum displays the spectrum that starts with the trigger event (or the most recently captured spectrum for free-run measurements).

10. Scroll through the individual frames of the Spectrogram:
    a) Tap the Spectrogram window.
    b) Press the SWEEP key.
    c) Select the "Select Frame" softkey and change the index number (negative numbers from 0 downwards).

    The Real-Time Spectrum displays the stored spectrum for the selected frame.

11. Optionally, export the trace data of the spectrogram to a file.
    a) Select the "Analysis" button in the "Overview".
    b) In the "Traces" tab of the "Analysis" dialog box, switch to the "Trace Export" tab.
    c) From the "Specifics for" list, select the spectrogram display.
    d) Select "Export Trace to ASCII File".
    e) Define a file name and storage location and select "OK".

8.2 How to Analyze Persistency in Real-Time Spectrum Measurements

The following step-by-step instructions demonstrate how to analyze persistency in the R&S ESW Real-Time application.

1. Configure the R&S ESW Real-Time application to perform a Real-Time Spectrum measurement as described in Chapter 8.1, "How to Perform a Basic Real-Time Spectrum Measurement", on page 89.

2. Select the "Display Config" softkey and add a "Persistence Spectrum" window to the display.

3. Press ESC to exit the display configuration.

4. Select the "Persistence Config" softkey to configure the persistency.
   - "Persistence": Define how long each measured value is considered in the density calculation.

- "Granularity": Define the time frame used to calculate a single frame in the "Persistence Spectrum".
- Optionally, select "Dots" style to display only true values without interpolated data.
- Optionally, select "Color Mapping" to change the colors with which the density is represented in the "Persistence Spectrum". For details see Chapter 8.3, "How to Configure the Color Mapping", on page 91.
- Optionally, deactivate or change the intensity of the "Max Hold" trace that shows only the maximum density for all frequencies.
  Select "Reset" to start a new "Max Hold" trace.

5. Press RUN SINGLE to start a sweep with the defined persistency settings.

   When the sweep is finished, the "Persistence Spectrum" displays the density of all measured values, and the Real-Time Spectrum displays the spectrum that starts with the trigger event (or the most recently captured spectrum for free-run measurements).

   Now you can analyze the colors in the "Persistence Spectrum", which indicate the probability of a particular level in the spectrum.

8.3 How to Configure the Color Mapping

The color display is highly configurable to adapt the spectrogram to your needs.

The settings for color mapping are defined in the "Color Mapping" dialog box. To display this dialog box, do one of the following:

- Select the color map in the window title bar of the Spectrogram result display.
- Select the "Color Mapping" softkey in the "Real-Time Config" menu.

To select a color scheme

You can select which colors are assigned to the measured values.

► In the "Color Mapping" dialog box, select the option for the color scheme to be used.

Editing the value range of the color map

The distribution of the measured values is displayed as a histogram in the "Color Mapping" dialog box. To cover the entire measurement value range, make sure the first and last bar of the histogram are included.

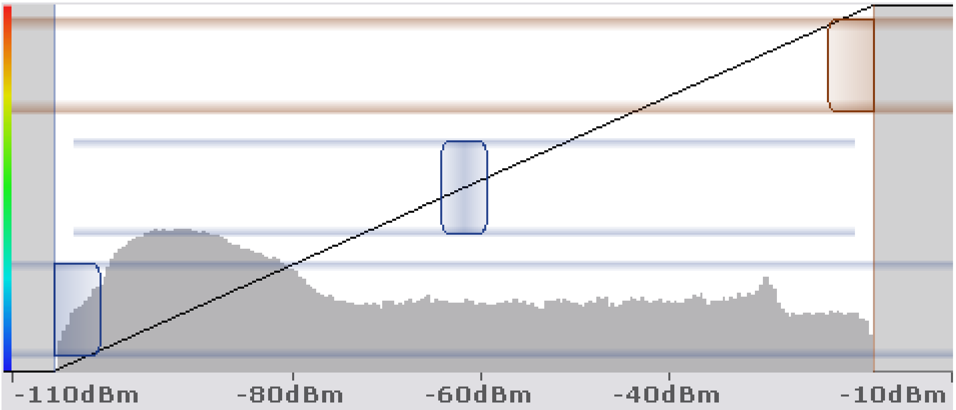
To ignore noise in a spectrogram, for example, exclude the lower power levels from the histogram.

The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram, that means, the difference between the start and stop values must be at least 10%.

The value range of the color map can be set numerically or graphically.

To set the value range graphically using the color range sliders

1. Select and drag the bottom color curve slider (indicated by a gray box at the left of the color curve pane) to the lowest value you want to include in the color mapping.
2. Select and drag the top color curve slider (indicated by a gray box at the right of the color curve pane) to the highest value you want to include in the color mapping.



To set the value range of the color map numerically

1. In the "Start" field, enter the percentage from the left border of the histogram that marks the beginning of the value range.
2. In the "Stop" field, enter the percentage from the right border of the histogram that marks the end of the value range.

Example:

The color map starts at -110 dBm and ends at -10 dBm (that is: a range of 100 dB). In order to suppress the noise, you only want the color map to start at -90 dBm. Thus, you enter *10%* in the "Start" field. The R&S ESW shifts the start point 10% to the right, to -90 dBm.

Adjusting the reference level and level range

Since the color map is configured using percentages of the total value range, changing the reference level and level range of the measurement (and thus the power value range) also affects the color mapping in the spectrogram.

Truncating persistence spectrum results

By default, results that are smaller than the start value of the color map range are displayed in the color for the minimum value. Results that are larger than the stop value of the color map range are displayed in the color for the maximum value.

In order to hide results outside the value range of the color map, use the "Truncate" function (see "Truncate" on page 68).

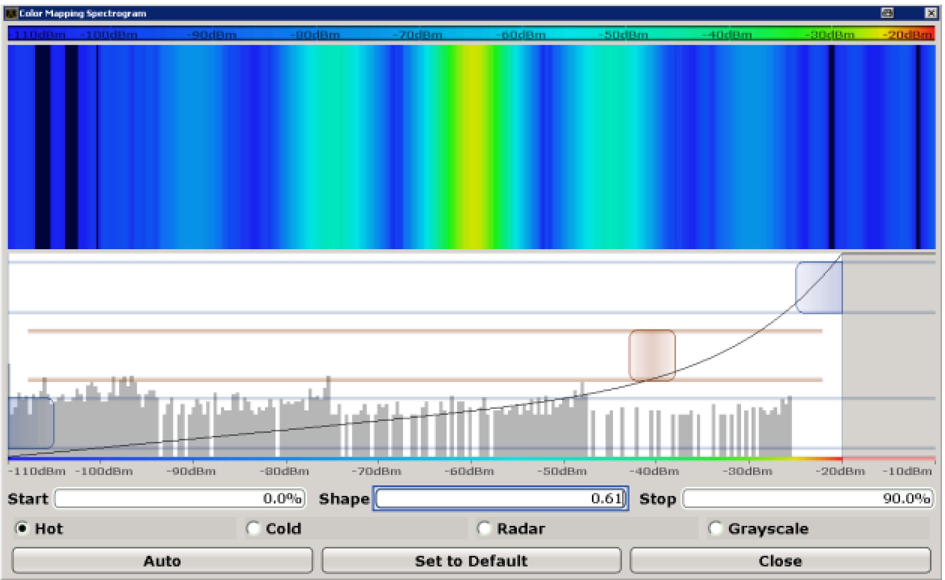
Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large number of results, while the other end distributes several colors over a relatively small result range.

The color curve shape can be set numerically or graphically.

To set the color curve shape graphically using the slider

► Select and drag the color curve shape slider (indicated by a gray box in the middle of the color curve) to the left or right. The area beneath the slider is focused, i.e. more colors are distributed there.



To set the color curve shape numerically

► In the "Shape" field, enter a value to change the shape of the curve:

- A negative value (-1 to <0) focuses the lower values
- 0 defines a linear distribution
- A positive value (>0 to 1) focuses the higher values

8.4 How to Work with Frequency Mask Triggers

The Frequency Mask Trigger (FMT) is a mask in the frequency domain, which is checked with every calculated FFT. When a specific condition concerning this mask occurs during the measurement of the input signal, I/Q data capturing is triggered.

For details see Chapter 4.5.1, "Frequency Mask Trigger", on page 20

8.4.1 How to Create a New Frequency Mask

The frequency mask is configured by a set of individual trace points which are connected to form a mask area. The frequency mask may have any shape, defined by up to 1001 points.

There are several ways to create a new mask:

- Automatically, according to the currently measured values
- Graphically, by adding and moving mask points on the touchscreen
- Numerically, by defining the x- and y-values of the mask points

You can combine the methods. For example, first you sketch the mask quickly on the touchscreen, and then modify the point coordinates with precise values. Or you create an upper mask automatically and then add a lower mask manually.

To create a mask automatically

1. Press the MEAS CONFIG key, then select the "Edit Frequency Mask" softkey.
   A default (upper) mask is displayed in the preview area of the "Edit Frequency Mask" dialog box.
2. Select "Auto-Set Mask".
   A mask in close proximity to the currently measured data is created.
3. If necessary, modify the mask or add a lower mask as described in "To create a mask manually" on page 94.

To create a mask manually

1. Press the MEAS CONFIG key, then select the "Edit Frequency Mask" softkey.
   A default (upper) mask with 4 points is displayed in the preview area of the "Edit Frequency Mask" dialog box.
2. If the mask you want to create is very different to the default mask, select "Delete Mask".
3. To define a lower mask, select the "Lower Mask" option.
   A default lower mask with 4 points is displayed in the preview area of the "Edit Frequency Mask" dialog box.
4. If only a lower mask is required, deselect the "Upper Mask" option.
5. For each mask, tap the corner points of the mask in the preview area and drag them to the required destination, or enter the position and value of each mask point in the list of coordinates to the left of the preview area.
6. If necessary, insert additional mask points to design a more complex shape:
   a) Tap an existing mask point in the preview area or in the list of coordinates before which you want to insert a new point.

b) Select the "Insert" button.
An additional point is inserted in the mask in the preview area and in the list of coordinates.
c) Drag the new point to the required destination, or define its coordinates.

7. To shift the entire mask (upper and lower) vertically or horizontally, for example to consider a frequency or reference level offset in the input signal, select the "Shift x" or "Shift y" button.

8. Repeat these steps until the required mask shape is displayed.

   For upper masks, the display region above the defined mask points is defined as the frequency mask and filled with red color. For lower masks, the display region below the mask points is defined as the frequency mask and also filled in red.

9. Define how the frequency mask is to be evaluated, depending on whether the mask area represents the relevant or irrelevant value range. See "Trigger conditions" on page 22 for detailed descriptions of the possible conditions.

10. Optionally, store the frequency mask configuration for later use:

    a) Provide a name and, optionally, a comment for the mask.
    b) Select "Save Mask".
    c) In the file selection dialog box, select the storage location for the file (default: `C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\freqmask`).
    By default, the mask name is used as the file name; however, it can be edited.
    d) Select "Save".

    The mask is stored in a file with the extension `.FMT` in the selected directory.

8.4.2 How to Use a Frequency Mask Trigger

1. Press the TRIG key, then select the "Frequency Mask" softkey to use a mask as the trigger source.

2. Press the MEAS CONFIG key, then select the "Edit Frequency Mask" softkey.

3. Define which frequency mask is to be used as a trigger source:

   - Create a new mask as defined in Chapter 8.4.1, "How to Create a New Frequency Mask", on page 94.

   Or:

   a) Select "Load Mask" to select a stored frequency mask.
   b) In the file selection dialog box, select the storage location of the file (default: `C:\Program Files (x86)\Rohde-Schwarz\ESW\<version>\freqmask`) with the extension `.FMT`.

c) If necessary, modify the mask as described in "To create a mask manually" on page 94.

The next Real-Time Spectrum measurement will be triggered when the specified event concerning the frequency mask occurs.

8.5 How to Output a Trigger Signal

Using the variable TRIGGER 2 INPUT / OUTPUT connector of the R&S ESW, the internal trigger signal can be output for use by other connected devices. For details on the connectors see the R&S ESW "Getting Started" manual.

To output a trigger to a connected device

1. In the "Trigger In/Out" tab of the "Trigger and Gate" dialog box, set the trigger to be used to "Output".
2. Define whether the trigger signal is to be output automatically ("Output Type" = "Device triggered" or "Trigger Armed") or whether you want to start output manually ("Output Type" = "User-defined").
3. For manual output: Specify the constant signal level and the length of the trigger pulse to be output. Note that the level of the trigger pulse is opposite to the constant output "Level" setting (compare the graphic on the "Send Trigger" button).
4. Connect a device that will receive the trigger signal to the configured TRIGGER 2 INPUT / OUTPUT connector.
5. Start a measurement and wait for an internal trigger, or select the "Send Trigger" button.

   The configured trigger is output to the connector.

9 Remote Commands to Perform Real-Time Measurements

The following commands are specific to performing measurements in the Real-Time Spectrum application in a remote environment.

It is assumed that the R&S ESW has already been set up for remote control in a network as described in the R&S ESW User Manual.

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S ESW User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers

The following tasks specific to Real-Time measurements are described here:

9.1 Introduction

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

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S ESW.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

9.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S ESW follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

9.1.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

SENSe:FREQuency:CENTer is the same as SENS:FREQ:CENT.

9.1.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

DISPlay[:WINDow<1...4>]:ZOOM:STATe enables the zoom in a particular measurement window, selected by the suffix at WINDow.

DISPlay:WINDow4:ZOOM:STATe ON refers to window 4.

9.1.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

[SENSe:]FREQuency:CENTer is the same as FREQuency:CENTer

With a numeric suffix in the optional keyword:

DISPlay[:WINDow<1...4>]:ZOOM:STATe

DISPlay:ZOOM:STATe ON enables the zoom in window 1 (no suffix).

DISPlay:WINDow4:ZOOM:STATe ON enables the zoom in window 4.

9.1.5 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`.

9.1.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

9.1.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

9.1.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

9.1.6.3 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 9.1.2, "Long and Short Form", on page 98.

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`

9.1.6.4 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'`

9.1.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

9.2 Common Suffixes

In the R&S ESW Real-Time application, the following common suffixes are used in remote commands:

Table 9-1: Common suffixes used in remote commands in the R&S ESW Real-Time application

Suffix	Value range	Description
<m>	1..16	Marker
<n>	1..6	Window (**in the currently selected measurement channel**)
<t>	1..4	Trace
<k>	irrelevant	Limit line
<i>	1..3	Output (1, 2 or Phones)
<k>	1..8 (Limit line) 1 | 2 (Display line)	Line

Selecting windows in multiple measurement channels

Note that the suffix <n> always refers to a window in the currently selected measurement channel.

9.3 Activating the Real-Time Spectrum Application

Real-Time measurements require a special application. A measurement is started immediately with the default settings.

INSTrument:CREate:DUPLicate

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

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

Example:
```
INST:SEL 'Receiver'
INST:CRE:DUPL
```
Duplicates the channel named 'Receiver' and creates a new measurement channel named 'Receiver 2'.

Usage: Event

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

This command adds an additional measurement channel.

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

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 104.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 104).

Example:
```
INST:CRE REC, 'Receiver 2'
```
Adds an additional Receiver channel named "Receiver 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 104.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 104).

Example: `INST:CRE:REPL 'Receiver',REC,'REC2'`
Replaces the channel named 'Receiver' by a new measurement channel of type 'Receiver' named 'REC2'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Receiver" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'Receiver'`
Deletes the channel with the name 'Receiver'.

Usage: Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 2 measurement channels:
`'REC','Receiver','REC','Receiver2'`

Usage: Query only

Table 9-2: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Receiver	RECEIVER	Receiver
CISPR APD	n/a Use `CALCulate:STATistics:CAPD[:STATe]`	CISPR APD
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Real-Time Spectrum	RTIM	Real-Time Spectrum
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you cannot assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'Receiver','REC'`
Renames the channel with the name 'Receiver' to 'REC'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

Selects the application (channel type) for the current channel.

See also `INSTrument:CREate[:NEW]` on page 103.

For a list of available channel types see Table 9-2.

Parameters:

<ChannelType> **RTIM**
Real-Time Spectrum application.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Usage: SCPI confirmed

SYSTem:PRESet:COMPatible <OpMode>

This command defines the operating mode that is activated when you switch on the R&S ESW or press the PRESET key.

Parameters:

<OpMode> **SANalyzer**
(Default:) Defines Signal and Spectrum Analyzer operating mode as the presetting.
RECeiver
Selects the Receiver application as the default application.

Usage: Event

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default <instrument> settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST:SEL 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 43

9.4 Configuring Real-Time Measurements

9.4.1 Configuring Input

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 44

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 43

INPut<n>:TYPE <Input>

The command selects the signal source.

Suffix:

<n> irrelevant

Parameters:

<Input> **INPUT1**
Selects RF input 1.

INPUT2
Selects RF input 2.

*RST: INPUT1

Example: `INP:TYPE INPUT1`
Selects RF input 1.

Manual operation: See "Input Selection" on page 43

9.4.2 Configuring Output

OUTPut:TRIGger<port>:DIRection <Direction>

This command selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:

<port> Selects the used trigger port.
2 = trigger port 2 (front panel)
3 = trigger port 3 (rear panel)

Parameters:

<Direction>

INPut
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the (TTL compatible) signal generated at the trigger output.

This command works only if you have selected a user defined output with `OUTPut:TRIGger<port>:OTYPe`.

Suffix:

<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<Level>

HIGH
5 V

LOW
0 V

*RST: LOW

Example: `OUTP:TRIG2:LEV HIGH`

OUTPut:TRIGger<port>:OTYPe <OutputType>

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

Suffix:

<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<OutputType>
DEVice
Sends a trigger signal when the R&S ESW has triggered internally.
TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.
UDEFined
Sends a user defined trigger signal. For more information see `OUTPut:TRIGger<port>:LEVel`.
*RST: DEVice

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:

<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Usage: Event

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

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

Suffix:

<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:

<Length> Pulse length in seconds.

Example: `OUTP:TRIG2:PULS:LENG 0.02`

9.4.3 Configuring Amplitude

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

This command matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Example: `CALC:MARK2:FUNC:REF`
Sets the reference level to the level of marker 2.

Usage: Event

Manual operation: See "Reference Level = Marker Level" on page 83

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all power-based measurement windows with absolute values.

Suffix:

<n> irrelevant

Parameters:

<Unit> *RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Unit" on page 47

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

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

Suffix:

<n>, <t> irrelevant

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

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 46

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

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

Suffix:
<n>, <t> irrelevant

Parameters:
<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 47

INPut<n>:ATTenuation <Attenuation>

This command defines the attenuation at the RF input.

To protect the input mixer, attenuation levels of 10 dB or less are possible only if you have turned the input protection off with `INPut<n>:ATTenuation:PROTection[:STATe]` on page 112.

Suffix:
<n> irrelevant

Parameters:
<Attenuation> numeric value

Range: 0 dB to 79 dB
*RST: 10 dB
Default unit: dB

Example: `INP:ATT 40dB`
Defines an attenuation level of 40 dB.

Manual operation: See "Attenuation" on page 47

INPut<n>:ATTenuation:AUTO <State>

This command turns automatic determination of the attenuation level on and off.

When you turn it on, the R&S ESW selects an attenuation that results in a good signal-to-noise ratio without overloading the RF input.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF

ON
Selects automatic attenuation mode.

ON
Selects manual attenuation mode.

*RST: ON

Example: `INP:ATT:AUTO ON`
Turns the auto ranging function on.

Manual operation: See "Attenuation" on page 47

INPut<n>:ATTenuation:PROTection[:STATe] <State>

This command turns the availability of attenuation levels of 10 dB or less on and off.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:ATT:PROT ON`

Manual operation: See "10 dB Minimum Attenuation" on page 47

INPut<n>:GAIN:LNA:AUTO <State>

This command includes and excludes the optional low noise amplifier from the auto ranging feature.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:LNA:STAT ON`
`INP:GAIN:LNA:AUTO OFF`
Allows you to turn the amplifier on and off manually.

Usage: SCPI confirmed

INPut<n>:GAIN:LNA:STATe <State>

This command turns the optional low noise amplifier on and off.

Note that it is not possible to use the low noise amplifier and the preamplifier at the same time.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:LNA:STAT ON`
Turns on the low noise amplifier.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 48

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S ESW or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 61

9.4.4 Configuring the Y-Axis

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

This command defines the display range of the y-axis (for all traces).

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Range> Range: 1 dB to 200 dB
*RST: 100 dB

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

Manual operation: See "Range" on page 48

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

Suffix:

<n> Window

<t> irrelevant

Usage: SCPI confirmed

Manual operation: See "Auto Scale Once" on page 49

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

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

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

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Mode> **ABSolute**
absolute scaling of the y-axis

RELative
relative scaling of the y-axis

*RST: ABSolute

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

Manual operation: See "Scaling" on page 49

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid (for all traces).

The R&S ESW adjusts the scaling of the y-axis accordingly.

Suffix:
<n> Window

<t> irrelevant

Example: `DISP:TRAC:Y:RPOS 50PCT`

Usage: SCPI confirmed

Manual operation: See "Ref Level Position" on page 49

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

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

Suffix:
<n> Window

<t> Trace

Parameters:

<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`
Selects linear scaling in %.

Usage: SCPI confirmed

Manual operation: See "Scaling" on page 49

9.4.5 Defining the Frequency and Span

The commands required to configure the frequency and span settings in a remote environment are described here.

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency>

The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*RST: fmax/2
Default unit: Hz

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

Usage: SCPI confirmed

Manual operation: See "Center frequency" on page 44

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

This command defines the center frequency step size.

Parameters:

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

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

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

Manual operation: See "Center Frequency Stepsize" on page 45

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

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

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example:
```
FREQ:CENT:STEP:AUTO ON
```
Activates the coupling of the step size to the span.

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

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

Parameters:

<CouplingType>

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

OFF
Decouples the step size.

*RST: SPAN

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

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

Parameters:

<Factor> 1 to 100 PCT

*RST: 10

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

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

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

Parameters:

<Offset> Range: -100 GHz to 100 GHz

*RST: 0 Hz

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual operation: See "Frequency Offset" on page 46

[SENSe:]FREQuency:SPAN <Span>

This command defines the frequency span.

Parameters:

<Span> Range: 1 kHz to 80 MHz

*RST: fmax

Usage: SCPI confirmed

Manual operation: See "Span" on page 45
See "Last Span" on page 45

[SENSe:]FREQuency:SPAN:FULL

This command restores the full span.

Usage: Event
SCPI confirmed

Manual operation: See "Full Span" on page 45

[SENSe:]FREQuency:STARt <Frequency>

Defines the start frequency for a Real-Time measurement. If you set a start frequency that would exceed the maximum span, the R&S ESW adjusts the stop frequency to stay within the maximum span.

Parameters:

<Frequency> 0 to (fmax - min span)

*RST: 0

Example: `FREQ:STAR 20MHz`

Usage: SCPI confirmed

Manual operation: See "Start / Stop" on page 45

[SENSe:]FREQuency:STOP <Frequency>

Defines the stop frequency for a Real-Time measurement. If you set a start frequency that would exceed the maximum span, the R&S ESW adjusts the start frequency to stay within the maximum span.

Parameters:

<Frequency> min span to fmax

*RST: fmax

Example: `FREQ:STOP 2000 MHz`

Usage: SCPI confirmed

Manual operation: See "Start / Stop" on page 45

9.4.6 Configuring Bandwidth and Sweep Settings

The commands required to configure the bandwidth, sweep and filter settings in a remote environment are described here. The tasks for manual operation are described in Chapter 5.7, "Bandwidth and Sweep Settings", on page 56.

Useful commands for configuring sweeps described elsewhere:

- `[SENSe:]AVERage<n>:COUNt` on page 170

Remote commands exclusive to configuring bandwidth and sweeps:

[SENSe:]BANDwidth[:RESolution] <Bandwidth>

This command defines the resolution bandwidth and decouples the resolution bandwidth from the span.

Parameters:
<Bandwidth> refer to data sheet

Example: `BAND 1 MHz`
Sets the resolution bandwidth to 1 MHz

Usage: SCPI confirmed

Manual operation: See "RBW" on page 58

[SENSe:]BANDwidth[:RESolution]:RATio <Ratio>

This command defines the ratio between the resolution bandwidth (Hz) and the span (Hz).

Note that the ratio defined with this remote command (RBW/span) is reciprocal to that of the coupling ratio (span/RBW).

Changing this ratio also affects the FFT length, which in turn affects the time resolution of the FFT. Furthermore, the ratio also affects the RBW value according to:

RBW = Span / Coupling ratio

Parameters:
<Ratio> Range: 0.0001 to 1

Example: `BAND:RAT 0.1`

Example: Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211

Usage: SCPI confirmed

Manual operation: See "RBW" on page 58

[SENSe:]SWEep:COUNt <SweepCount>

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

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

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

Suffix:
<n> Window

Example: `SWE:COUN 64`
Sets the number of measurements to 64.
`INIT:CONT OFF`
Switches to single measurement mode.
`INIT;*WAI`
Starts a measurement and waits for its end.

Usage: SCPI confirmed

Manual operation: See "Sweep Count" on page 59

[SENSe:]SWEep:FFT:WINDow:TYPE <FFTWindow>

This command selects the type of FFT window that you want to use in Real-Time mode.

Parameters:
<FFTWindow>
BLACkharris
FLATtop
GAUSsian
HAMMing
HANNing
KAISerbessel
RECTangular
*RST: BLACkharris

Example: `SWE:FFT:WIND:TYPE HANN`
Selects the Hanning FFT window.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "FFT Window" on page 58

[SENSe:]SWEep:TIME <Time>

Determines the amount of time used to sample data for one real-time spectrum.

For more information see Chapter 4.4, "Sweep Time and Detector", on page 20.

Parameters:
<Time> refer to data sheet

Example: `SWE:TIME 0.3`
Defines an acquisition time of 0.3 s.

Usage: SCPI confirmed

Manual operation: See "Sweep Time" on page 58

[SENSe:]SWEep:TIME:AUTO <State>

This command activates and deactivates automatic sweep time definition.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example: `SWE:TIME:AUTO ON`

Activates automatic sweep time.

Usage: SCPI confirmed

Manual operation: See "Sweep Time" on page 58

9.4.7 Triggering

The following remote commands are required to configure a triggered measurement in a remote environment.

*OPC should be used after requesting data. This will hold off any subsequent changes to the selected trigger source, until after the sweep is completed and the data is returned.

9.4.7.1 Configuring the Triggering Conditions

TRIGger[:SEQuence]:MODE <Mode>

This command turns continuous triggering on and off.

Parameters:

<Mode> **CONTinuous**

Continuous measurement

STOP

Measurement stops after the trigger event is done

*RST: CONTinuous

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Trigger mode (Auto Rearm/ Stop on Trigger)" on page 52

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

Defines the time offset between the trigger event and the start of the measurement (data capturing).

A negative offset is possible for time domain measurements.

For the trigger sources "External" or "IF Power", a common input signal is used for both trigger and gate. Therefore, changes to the gate delay will affect the trigger offset as well.

Suffix:

<n> irrelevant

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
For measurements in the time domain, the range is the negative sweep time to 30 s.

*RST: 0 s

Example: `TRIG:HOLD 500us`
Defines a trigger offset of 500 µs.

Manual operation: See "Trigger Offset" on page 51

TRIGger<n>[:SEQuence]:LEVel[:EXTernal<port>] <Level>

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

Note that the variable INPUT/OUTPUT connectors must be set for use as input using the `OUTPut:TRIGger<port>:DIRection` command.

Suffix:

<n> irrelevant

<port> Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)

Parameters:

<Level> Numeric value in V.

Example: `TRIG:SOUR EXT`
`TRIG:LEV 2V`
Defines a trigger level of 2 V for an external trigger source.

Manual operation: See "Trigger Level" on page 51

TRIGger[:SEQuence]:POSTtrigger[:TIME] <Time>

This command defines the length of the posttrigger.

Parameters:

<Time> Length of the posttrigger in seconds.
Note that the pre- and posttrigger combined may not be longer than 1 second.

Range: 0 s to 1 s
*RST: 60 ms

Example: `TRIG:POST 0.5s`
Selects a posttrigger time of 0.5 seconds.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Posttrigger capture time" on page 52

TRIGger[:SEQuence]:PRETrigger[:TIME] <Time>

This command defines the length of the pretrigger.

Parameters:

<Time> Length of the pretrigger in seconds.
Note that the pre- and posttrigger combined may not be longer than 1 second.

Range: 0 s to 1 s
*RST: 60 ms

Example: `TRIG:PRE 0.5s`
Selects a pretrigger time of 0.5 seconds.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Pretrigger capture time" on page 52

TRIGger<n>[:SEQuence]:SLOPe <Type>

This command selects the trigger slope.

Suffix:
<n> irrelevant

Parameters:
<Type>

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

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

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 52

TRIGger<n>[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

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

Suffix:
<n> irrelevant

Parameters:
<Source> See table below.

*RST: IMMediate

Example: `TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation: See "Trigger Source" on page 50
See "Free Run" on page 50
See "Ext. Trigger 1/2" on page 51
See "Frequency Mask" on page 51
See "Time Domain" on page 51

Table 9-3: Available trigger sources

SCPI parameter	Trigger source
EXTernal	Trigger signal from the TRIGGER INPUT connector.
EXT2 | EXT3	Trigger signal from the TRIGGER INPUT/OUTPUT connector. Note: Connector must be configured for "Input".
IMMediate	Free Run trigger.
MASK	Frequency mask trigger.
TDTRigger	Time domain trigger.

TRIGger[:SEQuence]:TDTRigger:LEVel <TriggerLevel>

This command sets the trigger level for the time domain trigger.

Parameters:

<TriggerLevel> Default unit: dBm

Example: `TRIG:TDTR:LEV 0`
Sets a trigger level of 0 dBm.

Manual operation: See "Time Domain" on page 51
See "Trigger Level" on page 51

9.4.7.2 Configuring a Frequency Mask Trigger

The Frequency Mask Trigger (FMT) is a mask in the frequency domain, which is checked with every calculated FFT. When a specific condition concerning this mask occurs during the measurement of the input signal, data capturing is triggered.

For details see Chapter 4.5.1, "Frequency Mask Trigger", on page 20.

CALCulate<n>:MASK:CDIRectory <Subdirectory>

This command selects the directory the R&S ESW stores frequency masks in.

Suffix:

<n> Window

Parameters:

<Subdirectory> String containing the path to the directory. The directory has to be a subdirectory of the default directory. Thus the path is always relative to the default directory (`C:\R_S\INSTR\freqmask`).
An empty string selects the default directory.

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "Save Mask" on page 54
See "Load Mask" on page 54

CALCulate<n>:MASK:COMMent <Comment>

This command defines a comment for the frequency mask that you have selected with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:
<n> Window

Parameters:
<Comment> String containing the comment for the frequency mask.

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Manual operation: See "Comment" on page 55

CALCulate<n>:MASK:DELete

This command deletes the currently selected frequency mask.

Before making any changes to a frequency mask, you have to select one by name with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:
<n> Window

Usage: Event

Manual operation: See "Delete Mask" on page 54

CALCulate<n>:MASK:LOWer:SHIFt:X <Frequency>

This command shifts the lower frequency mask horizontally by a specified distance. Positive values move the mask to the right, negative values shift the mask to the left.

Before making any changes to a frequency mask, you have to select one by name with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:
<n> Window

Parameters:
<Frequency> Defines the distance of the shift.

Default unit: Hz

Manual operation: See "Shifting the mask position horizontally (Shift x)" on page 55

CALCulate<n>:MASK:LOWer:SHIFt:Y <Level>

This command shifts the lower frequency mask vertically by a specified distance. Positive values move the mask upwards, negative values shift the mask downwards.

Before making any changes to a frequency mask, you have to select one by name with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:
<n> Window

Parameters:
<Level> Defines the distance of the shift. The shift is relative to the current position.
Default unit: dB

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Manual operation: See "Shifting the mask vertically (Shift y)" on page 55

CALCulate<n>:MASK:LOWer:STATe <State>

This command turns the lower frequency mask on and off.

Before making any changes to a frequency mask, you have to select one by name with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:
<n> Window

Parameters:
<State> **ON | OFF**

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Manual operation: See "Activating/deactivating upper and lower masks" on page 56

CALCulate<n>:MASK:LOWer[:DATA] <Frequency>,<Level>,...

This command defines the shape of the lower frequency mask.

Before making any changes to a frequency mask, you have to select one by name with `CALCulate<n>:MASK:NAME` on page 128.

The unit of the power levels depends on `CALCulate<n>:MASK:MODE` on page 128.

If you are using the command with the vector network analysis option (R&S ESW-K70), you can only use this command as a query.

Suffix:
<n> Window

Parameters:
<Frequency>, <Level>
[N] pairs of numerical values. [N] is the number of data points the mask consists of.
Each data point is defined by the frequency (in Hz) and the level (in dB or dBm). All values are separated by commas.
Note that the data points have to be inside the current span.

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Manual operation: See "Mask points" on page 55
See "Inserting points" on page 55
See "Deleting points" on page 55

CALCulate<n>:MASK:MODE <Mode>

This command defines the scaling of the level axis for frequency masks.

Suffix:
<n> Window

Parameters:
<Mode>
ABSolute
absolute scaling of the level axis.
RELative
relative scaling of the level axis.
*RST: RELative

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Manual operation: See "Changing the y-axis scaling (Y-Axis rel /abs)" on page 55

CALCulate<n>:MASK:NAME <Name>

This command creates or selects a frequency mask with the name that you specify by the parameter. When you use it as a query, the command returns the name of the mask currently in use.

Suffix:
<n> Window

Parameters:
<Name>
String containing the name of the mask.
Note that an empty string does not select a frequency mask.

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "New Mask" on page 54
See "Save Mask" on page 54
See "Load Mask" on page 54
See "Name" on page 54

CALCulate<n>:MASK:SPAN <Span>

This command defines the frequency span of the frequency mask.

Suffix:
<n> Window

Parameters:
<Span> Range: 1 kHz to 80 MHz
*RST: fmax

Example: `CALC:MASK:SPAN 10 MHz`
Defines a span of 10 MHz.

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

CALCulate<n>:MASK:UPPer:AUTO

This command automatically defines the shape of an upper frequency mask according to the spectrum that is currently measured.

Suffix:
<n> Window

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Usage: Event

Manual operation: See "Defining a mask automatically (Auto-Set Mask)" on page 56

CALCulate<n>:MASK:UPPer:SHIFt:X <Frequency>

This command shifts the lower frequency mask horizontally by a specified distance. Positive values move the mask to the right, negative values shift the mask to the left.

You have to select a mask before you can use this command with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:
<n> Window

Parameters:
<Frequency> Defines the distance of the shift.

Manual operation: See "Shifting the mask position horizontally (Shift x)" on page 55

CALCulate<n>:MASK:UPPer:SHIFt:Y <Level>

This command shifts the upper frequency mask vertically by a specified distance. Positive values move the mask upwards, negative values shift the mask downwards.

You have to select a mask before you can use this command with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:

<n> Window

Parameters:

<Level> Defines the distance of the shift. The shift is relative to the current position.

Default unit: dB

Manual operation: See "Shifting the mask vertically (Shift y)" on page 55

CALCulate<n>:MASK:UPPer:STATe <State>

This command turns the upper frequency mask on and off.

Before making any changes to a frequency mask, you have to select one by name with `CALCulate<n>:MASK:NAME` on page 128.

Suffix:

<n> Window

Parameters:

<State> **ON | OFF**

Manual operation: See "Activating/deactivating upper and lower masks" on page 56

CALCulate<n>:MASK:UPPer[:DATA] <Frequency>,<Level>,...

This command activates and defines the shape of the upper frequency mask trigger mask.

You have to select a mask before you can use this command with `CALCulate<n>:MASK:NAME` on page 128.

The unit of the power levels depends on `CALCulate<n>:MASK:MODE` on page 128.

Suffix:

<n> Window

Parameters:

<Frequency>, <Level> [N] pairs of numerical values. [N] is the number of data points the mask consists of.
Each data point is defined by the frequency (in Hz) and the amplitude (in dB or dBm). All values are separated by commas.
Note that the data points have to be inside the current span.

Example: See Chapter 9.10.1, "Example 1: Creating a Frequency Mask Trigger", on page 207.

Manual operation: See "Mask points" on page 55
See "Inserting points" on page 55
See "Deleting points" on page 55

TRIGger[:SEQuence]:MASK:CONDition <Condition>

This command sets the condition that activates the frequency mask trigger.

For details see Chapter 4.5.1, "Frequency Mask Trigger", on page 20.

Parameters:

<Condition> **ENTer**
Triggers on entering the frequency mask.

LEAVing
Triggers on leaving the frequency mask.

*RST: INSide

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Setting the trigger condition" on page 56

9.4.8 Configuring Spectrograms

The remote commands required for the individual settings available for spectrogram displays are described here. For color mapping commands, see Chapter 9.4.10, "Configuring Color Maps", on page 137.

The suffix <n> for CALCulate determines the window and thus which display the command is applied to.

CALCulate<n>:SGRam|SPECtrogram:CLEar[:IMMediate]

This command resets the spectrogram or PVT waterfall and clears the history buffer.

Suffix:

<n> 1 to 6
window

Example: `CALC:SGR:CLE`
Resets the result display and clears the memory.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Usage: Event

Manual operation: See "Clear Spectrogram" on page 59

CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect <Frame> | <Time>

This command selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:
<n> 1 to 6
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.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the distance to frame 0 (most recent frame) in seconds. The range depends on the history depth.

Example: `INIT:CONT OFF`
Stop the continuous sweep.
`CALC:SGR:FRAM:SEL -25`
Selects frame number -25.

Manual operation: See "Selecting a frame to display" on page 66

CALCulate<n>:SGRam|SPECtrogram:HDEPth <History>

This command defines the number of frames to be stored in the R&S ESW memory for the spectrogram or PVT waterfall result display.

Suffix:
<n> 1 to 6
window

Parameters:
<History> Range: 781 to 100000
Increment: 1
*RST: 3000

Example: `CALC:SGR:SPEC 1500`
Sets the history depth to 1500.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "History Depth" on page 65

CALCulate<n>:SGRam|SPECtrogram:TSTamp:DATA? <Frames>

This command queries the starting time of the frames.

The return values consist of four values for each frame. If the Spectrogram is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with `TRAC:DATA? SGR`

See `TRACe<n>[:DATA]?` on page 158

Suffix:

<n> 1 to 6
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 till the frame start

<Nanoseconds> Number of nanoseconds that have passed *in addition to the <Seconds>* since 01.01.1970 till the frame start.

<Reserved> The third and fourth value are reserved for future uses.

Example: `CALC:SGR:TST ON`
Activates the time stamp.
`CALC:SGR:TST:DATA? ALL`
Returns the starting times of all frames sorted in a descending order.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Usage: Query only

Manual operation: See "Time Stamp" on page 66

CALCulate<n>:SGRam|SPECtrogram:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- `CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe` on page 196
- `CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 191

- CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect on page 132

Suffix:
<n> 1 to 6
window

Parameters:
<State> ON | OFF
*RST: ON

Example: `CALC:SGR:TST OFF`
Deactivates the time stamp.

Manual operation: See "Time Stamp" on page 66

9.4.9 Configuring the Persistence Spectrum

You can customize the persistence spectrum in several ways. You can change the colors with which the densities are visualized, you can change the persistence of the data and change the style of the displayed results.

Compatibility with R&S FSVR

For compatiblity with the R&S FSVR, the following commands required to configure the persistence spectrum also accept the optional `SUBWindow` keyword (`DISPlay:WINDow[:SUBWindow]...`). However, this keyword is ignored and has no effect on remote control.

DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold:RESet

This command resets the maxhold trace in the persistence spectrum result display.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Usage: Event

Manual operation: See "Resetting the Max Hold Function" on page 64

DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold:INTensity <Intensity>

This command defines the color intensity of the maxhold persistence spectrum.

Note: Setting the intensity to 0 has the same effect as deactivating the Maxhold function (see `DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold[:STATe]` on page 135).

Parameters:

<Intensity> Sets the color intensity of the maxhold trace.

Range: 0 to 254
Increment: 1
*RST: 100

Example: `DISP:WIND:TRAC:MAXH:INT 120`
Sets the color intensity of the maxhold trace to 120.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Intensity" on page 64

DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold[:STATe] <State>

This command switches the maxhold trace in the persistence spectrum on and off.

Note: Setting the intensity to 0 has the same effect as deactivating the Maxhold function (see `DISPlay:WINDow:[SUBWindow:]TRACe:MAXHold:INTensity` on page 134).

Parameters:

<State> **ON | OFF**

*RST: On

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Configuring the Max Hold Function" on page 64

DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence:DURation <Persistence>

This command sets the duration of the persistence.

Setting the persistence to 0 turns it off and thus has the same effect as the command `DISP:WIND:TRAC:PERS OFF` (see `DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence[:STATe]` on page 136).

Parameters:

<Persistence> Persistance in seconds.

Range: 0 to 8
Increment: 0.001
*RST: 1 seconds
Default unit: seconds

Example: `DISP:WIND:TRAC:PERS:DUR 4.3`
Sets the persistence to 4.3 seconds.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Persistence" on page 63

DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence:GRANularity <Granularity>

Defines the duration that data is captured to build one persistence spectrum.

Parameters:

<Granularity> duration in seconds

*RST: 0.1s

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Granularity" on page 64

DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence[:STATe] <State>

This command switches persistence in the persistence spectrum on and off.

Note: Setting the persistence to 0 turns it off and thus has the same effect as this command (see `DISPlay:WINDow:[SUBWindow:]TRACe:PERSistence:DURation` on page 135).

Parameters:

<State> ON | OFF

*RST: On

DISPlay:WINDow:[SUBWindow:]TRACe:SYMBol <Style>

This command sets the display style of the persistence spectrum.

Parameters:

<Style> **DOTS**
Displays the data as dots. The result is a persistence spectrum made up out of dots.

VECTor
Interpolates the measurement points. The result is an uninterrupted persistence spectrum.

*RST: VECTor

Example: `DISP:WIND:TRAC:SYMB DOTS`
Displays the persistence spectrum as dots.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Diagram Style" on page 63

9.4.10 Configuring Color Maps

The color display used in spectrograms, persistence spectrums, and PVT waterfall diagrams is highly configurable to adapt the display to your needs.

For details see Chapter 4.6.3, "Color Maps", on page 29.

DISPlay:WINDow:PSPectrum:COLor:DEFault

This command sets the color settings for the persistence spectrum result display to its default state.

Usage: Event

Manual operation: See "Set to Default" on page 68

DISPlay:WINDow:PSPectrum:COLor:LOWer <Percentage>

This command sets the lower percentage boundary of the persistence spectrum.

Parameters:

<Percentage> Statistical frequency percentage.

Range: 0 to 65,6
*RST: 0
Default unit: %

Example: `DISP:WIND:HIST:COL:LOW 10`
Sets the start of the color map to 10%.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Start / Stop" on page 68

DISPlay:WINDow:PSPectrum:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the persistence spectrum result display.

Parameters:
<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Shape" on page 68

DISPlay:WINDow:PSPectrum:COLor:TRUNcate <State>

This command reduces the range of the color map of the persistence spectrum if there are no hits at the start or end of the value range.

Parameters:
<State> **ON**

OFF

*RST: OFF

Example: `DISP:WIND:PSP:COL:TRUN ON`
Activates truncation of the color map.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Truncate" on page 68

DISPlay:WINDow:PSPectrum:COLor:UPPer <Percentage>

This command sets the upper percentage boundary of the persistence spectrum.

Parameters:
<Percentage> Statistical frequency percentage.

Range: 0.01 to 100
*RST: 100
Default unit: %

Example: `DISP:WIND:HIST:COL:UPP 95`
Sets the upper boundary of the color map to 95%.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Start / Stop" on page 68

DISPlay:WINDow:PSPectrum:COLor[:STYLe] <ColorScheme>

This command sets the color scheme for the persistance spectrum.

Parameters:
<ColorScheme> **HOT**
COLD
RADar
GRAYscale
*RST: HOT

Example: `DISP:WIND:HIST:COL GRAY`
Changes the color scheme of the persistance spectrum to black and white.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Manual operation: See "Hot/Cold/Radar/Grayscale" on page 68

CALCulate<n>:SGRam|SPECtrogram:COLor <ColorScheme>
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Suffix:
<n> 1 .. 6
window; spectrograms and PVT waterfall displays can be selected

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.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "Hot/Cold/Radar/Grayscale" on page 68

DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

This command restores the original color map.

Suffix:
<n> Window

Usage: Event

Manual operation: See "Set to Default" on page 68

DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Suffix:
<n> Window

Parameters:
<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:LOW 10`
Sets the start of the color map to 10%.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "Start / Stop" on page 68

DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Suffix:
<n> Window

Parameters:
<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "Shape" on page 68

DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Suffix:
<n> Window

Parameters:
<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Manual operation: See "Start / Stop" on page 68

9.4.11 Adjusting Settings Automatically

The following remote commands are required to adjust settings automatically in a remote environment.

[SENSe:]ADJust:ALL

This command initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Center frequency
- Reference level

Example: `ADJ:ALL`

Usage: Event

Manual operation: See "Adjusting all Determinable Settings Automatically (Auto All)" on page 60

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

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

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

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

Manual operation: See "Changing the Automatic Measurement Time (Meastime Manual)" on page 61

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

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

Parameters:

<Mode>

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

MANual
The R&S ESW uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 141.

*RST: AUTO

Manual operation: See "Resetting the Automatic Measurement Time (Meastime Auto)" on page 61
See "Changing the Automatic Measurement Time (Meastime Manual)" on page 61

[SENSe:]ADJust:FREQuency

This command sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: `ADJ:FREQ`

Usage: Event

Manual operation: See "Adjusting the Center Frequency Automatically (Auto Freq)" on page 60

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

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

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation: See "Lower Level Hysteresis" on page 61

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

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

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

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

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

Manual operation: See "Upper Level Hysteresis" on page 61

[SENSe:]ADJust:CONFigure:TRIG <State>

Defines the behavior of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

Parameters:

<State>

ON | 1

The measurement for automatic adjustment waits for the trigger.

OFF | 0

The measurement for automatic adjustment is performed immediately, without waiting for a trigger.

*RST: 1

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S ESW or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 61

9.4.12 Configuring the Result Display

The following remote commands are required to configure the screen display in a remote environment. The tasks for manual operation are described in Chapter 3.1, "Real-Time Spectrum Result Displays", on page 9.

9.4.12.1 General Window Commands

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

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 148).

Suffix:

<n> Window

Parameters:

<Size>

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

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

*RST: SMALl

Example: `DISP:WIND2:SIZE LARG`

9.4.12.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See "Real-Time Spectrum" on page 9
See "Spectrogram" on page 10
See "Persistence Spectrum" on page 11
See "Marker Table" on page 12

For a detailed example see Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Table 9-4: <WindowType> parameter values for Real-Time measurements

Parameter value	Window type
'XFRequency:RFPower[:SPECtrum]' 'XFRequency[:SPECtrum]'	Real-Time Spectrum
'XFRequency:RFPower:SGRam' 'XFRequency:SGRam'	Spectrogram
'XFRequency:RFPower:PSPectrum' 'XFRequency:PSPectrum'	Persistence Spectrum
MTABle	Marker table

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 145 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 144 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

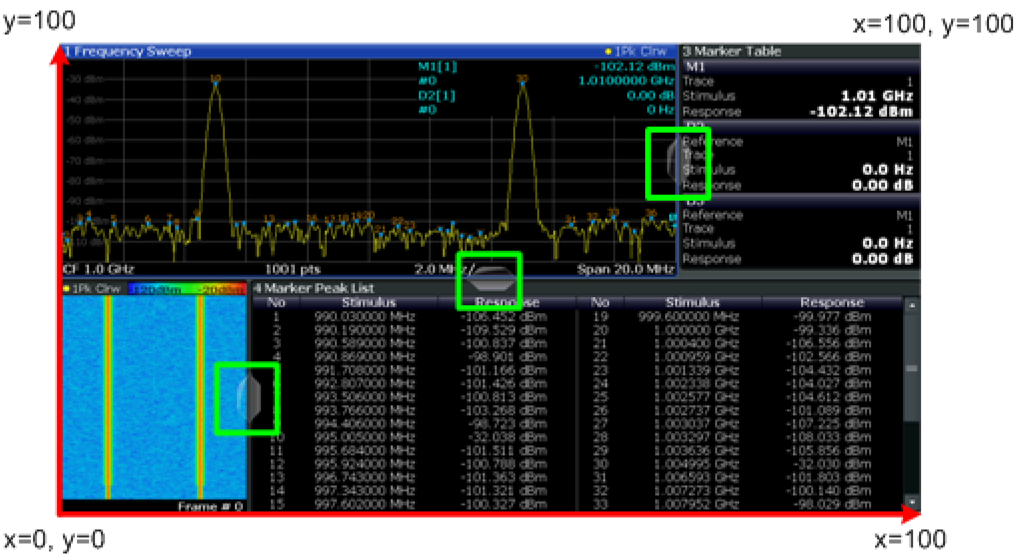


Figure 9-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 9-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:
<n> Window

Parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 145 for a list of available window types.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Suffix:
<n> Window

Parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 145 for a list of available window types.

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

9.5 Capturing Data and Performing Sweeps

When you activate a Real-Time Spectrum measurement channel, a measurement is started immediately with the default settings. However, you can start and stop new measurements at any time.

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S ESW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S ESW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single measurement mode.

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

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:CONTinuous <State>

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

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

Suffix:
<n> 1 | 2
INITiate1 selects single or continuous bargraph measurements.
INITiate2 selects single or continuous scans.

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

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

Manual operation: See "Continuous Sweep/RUN CONT" on page 59
See "Single Sweep/ RUN SINGLE" on page 59

INITiate<n>[:IMMediate]

The command initiates a new measurement.

In case of a single measurement, the R&S ESW stops measuring when it has reached the end frequency. When you start a continuous measurement, it stops only if you abort it deliberately.

If you are using trace modes MAXHold, MINHold and AVERage, previous results are reset when you restart the measurement.

- **Single measurements**
  Synchronization to the end of the measurement is possible with `*OPC`, `*OPC?` or `*WAI`.
- **Continuous measurements**
  Synchronization to the end of the measurement is not possible.
  It is thus recommended to use a single measurement for remote controlled measurements, because results like trace data or markers are only valid after synchronization.

Suffix:
<n> 1 | 2
INITiate1 initiates a bargraph measurement.
INITiate2 initiates a scan.

Example:
```
INIT2:CONT OFF
SWE:COUN 20
INIT2;*WAI
```
Starts a single scan (with a scan count = 20), and waits until the measurement is done.

Usage: Event

Manual operation: See "Continuous Sweep/RUN CONT" on page 59
See "Single Sweep/ RUN SINGLE" on page 59

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 154.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 155.

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 155).

Suffix:

<n> irrelevant

Example:
`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S ESW application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 155).

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

Suffix:

<n> irrelevant

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

9.6 Retrieving Results

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

9.6.1 Retrieving Marker Results

Useful commands for retrieving results described elsewhere:

- CALCulate<n>:DELTamarker<m>:X on page 178
- CALCulate<n>:DELTamarker<m>:Y? on page 178
- CALCulate<n>:MARKer<m>:X on page 175
- CALCulate<n>:MARKer<m>:Y? on page 175

Remote commands exclusive to retrieving marker results:

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:

<n> Window

<m> Marker

Return values:

<Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

CALCulate<n>:DELTamarker<m>:Z?

This command queries the z-axis value of the indicated delta marker in the persistence spectrum result display.

You can select whether to query the results of the persistence trace or the maxhold trace with CALCulate<n>:DELTamarker<m>:TRACe on page 178.

Suffix:

<n> Window

<m> Marker

Return values:

<percentage> The return value is the percentage of hits on the marker position.

Usage: Query only

Mode: RT

CALCulate<n>:MARKer<m>:Z?

This command queries the z-axis value of the indicated marker in the persistence spectrum result display.

You can select whether to query the results of the persistence trace or the maxhold trace with `CALCulate<n>:DELTamarker<m>:TRACe` on page 178.

Suffix:

<n>	Window
<m>	Marker

Return values:

<percentage>	The return value is the percentage of hits on the marker position.
Usage:	Query only

9.6.2 Retrieving Trace Results

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

Useful commands for retrieving results described elsewhere:

- `CALCulate<n>:SGRam|SPECtrogram:FRAMe:SELect` on page 132
- `CALCulate<n>:SGRam|SPECtrogram:TSTamp:DATA?` on page 133

Remote commands exclusive to retrieving trace results:

FORMat[:DATA] <Format>

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

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

Parameters:

<Format>

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

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
The format setting `REAL` is used for the binary transmission of trace data.
For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

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

This command queries current trace data and measurement results.

The data format depends on `FORMat[:DATA]`.

Query parameters:

<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6
Returns the measured power value for each of the 1001 trace points.
For **Spectrogram or PVT Waterfall** result displays, only the values for the currently selected frame are returned.
For **Persistence Spectrum** result displays, only the values for the most recently measured spectrum are returned.
The power level depends on the unit you have currently set.

SPECtrogram | SGRam
Returns the entire results of a **Spectrogram or PVT Waterfall** result display.
For each frame in the spectrogram/PVT waterfall, starting with the most recent frame, the command returns the 1001 measured power levels. The number of frames depends on the size of the history depth. The power level depends on the unit you have currently set.

PSPectrum
Returns the results of the **Persistence Spectrum** result display.
The command returns 1001*600 percentages, one for each pixel in the (current) histogram. The values are returned for each frequency for one power at a time, starting with the lowest frequency and highest power value and ending with the highest frequency and lowest power level; that is, from top left to bottom right (see Table 9-5).

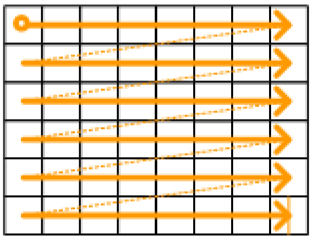
HMAXhold
Returns the results of the **maxhold trace** in the **Persistence Spectrum** result display.
The command returns 1001*600 percentages, one for each point in the maxhold trace. The values are returned for each frequency for one power at a time, starting with the lowest frequency and highest power value and ending with the highest frequency and lowest power level; that is, from top left to bottom right (see Table 9-5).

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

Usage: SCPI confirmed

Table 9-5: Order of trace data results for persistence spectrum and maxhold trace



TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

This command queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command is identical to `TRAC:DATA? TRACE1`

For details on the returned values see the TRAC:DATA? <TRACE...> command.

Suffix:

<n>	Window

Query parameters:

<Trace>	TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6
<OffsSwPoint>	The offset in sweep points related to the start of the measurement at which data retrieval is to start.
<NoOfSwPoints>	Number of sweep points to be retrieved from the trace.

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

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

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

Suffix:

<n>	Window

Query parameters:

<TraceNumber>	Trace number. **TRACE1 | ... | TRACE4**

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

9.6.3 Exporting Trace Results

Trace results can be exported to a file.

For more commands concerning data and results storage see the R&S ESW User Manual.

MMEMory:STORe<n>:PSPectrum <FileName>

This command exports persistence spectrum data to an ASCii file.

The file contains the most recently determined percentage value for each pixel in the persistence spectrum, that is, for 1001 frequency and 600 power values, followed by the 1001*600 maxhold percentages.

For details see Table A-2.

Note that, due to the large amount of data involved, 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:PSP 'C:\PersistentSpectrum'`
Copies the persistent spectrum data to a file.

Example: See Chapter 9.10.3, "Example 3: Analyzing Persistency", on page 211.

MMEMory:STORe<n>:SPECtrogram <FileName>

This command exports spectrogram data to an ASCII file.

The file contains the data for every frame in the history buffer. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Note that, depending on the size of the history buffer, the process of exporting the data can take a while.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

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

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

Suffix:
<n> Window

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:SGR 'Spectrogram'`
Copies the spectrogram data to a file.

Example: See Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

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

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

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

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

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

Suffix:
<n> Window

Parameters:
<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3,'C:\TEST.ASC'`
Stores trace 3 from window 1 in the file `TEST.ASC`.

Usage: SCPI confirmed

Manual operation: See "Export Trace to ASCII File" on page 73

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> **COMMa**
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 72

FORMat:DEXPort:HEADer <State>

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

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

Manual operation: See "Include Instrument Measurement Settings" on page 72

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 162).

Parameters:

<Selection> **SINGle**
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Usage: SCPI confirmed

Manual operation: See "Export all Traces and all Table Results" on page 72

9.6.4 Retrieving Trace I/Q Data

As opposed to retrieving only the y-values of a trace, the I/Q data of an evaluated trace can also be retrieved.

[SENSe:]IQ:FFT:LENGth?

Queries the number of frequency points determined by each FFT calculation. The more points are used, the higher the resolution in the spectrum becomes, but the longer the calculation takes.

Return values:

<NoOfBins> integer value

Range: 3 to 524288
*RST: 4096

Example:
```
IQ:FFT:LENG?
// 2048
```

Usage: Query only
SCPI confirmed

TRACe:IQ:BWIDth?

This command queries the bandwidth of the resampling filter.

Return values:

<Bandwidth> The bandwidth of the resampling filter depends on the sample rate and thus the used span.

Usage: Query only

TRACe:IQ:DATA?

This command queries the captured data from measurements with the I/Q Analyzer.

To get the results, the command also initiates a measurement with the current settings of the R&S ESW.

Return values:

<Results>
Measured voltage for I and Q component for each sample that has been captured during the measurement.
The data format depends on `TRACe:IQ:DATA:FORMat` on page 165.
Default unit: V

Example:
`TRAC:IQ:STAT ON`
Enables acquisition of I/Q data
`TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096`
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 0
Number of Samples = 4096
`FORMat REAL,32`
Selects format of response data
`TRAC:IQ:DATA?`
Starts measurement and reads results

Usage: Query only

TRACe:IQ:DATA:FORMat <Format>

This command selects the order of the I/Q data.

Parameters:

<Format>
COMPatible | IQBLock | IQPair

COMPatible
I and Q values are separated and collected in blocks: A block (512k) of I values is followed by a block (512k) of Q values, followed by a block of I values, followed by a block of Q values etc. (I,I,I,I,Q,Q,Q,Q,I,I,I,I,Q,Q,Q,Q...)

IQBLock
First all I-values are listed, then the Q-values
(I,I,I,I,I,I,...Q,Q,Q,Q,Q,Q)

IQPair
One pair of I/Q values after the other is listed
(I,Q,I,Q,I,Q...).

*RST: IQBL

TRACe:IQ:RLENgth?

This command queries the record length for the acquired I/Q data.

Return values:

<NoOfSamples>
Number of samples that were recorded.
If a trigger is used, the data for pretrigger+posttrigger time is stored.

Example: `TRAC:IQ:RLEN?`

Usage: Query only

TRACe:IQ:SRATe?

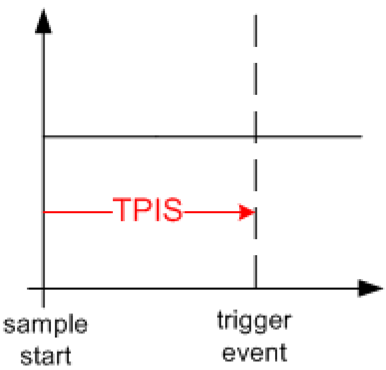
This command queries the final user sample rate for the acquired I/Q data.

Return values:
<SampleRate> The sample rate depends on the used span.

Usage: Query only

TRACe:IQ:TPISample?

This command queries the time offset between the sample start and the trigger event (trigger point in sample = TPIS). Since the R&S ESW usually samples with a much higher sample rate than the specific application actually requires, the trigger point determined internally is much more precise than the one determined from the (down-sampled) data in the application. Thus, the TPIS indicates the offset between the sample start and the actual trigger event.



This value can only be determined in triggered measurements using external or IFPower triggers, otherwise the value is 0.

Example: `TRAC:IQ:TPIS?`
Result for a sample rate of 1 MHz: between 0 and 1/1 MHz, i.e. between 0 and 1 µs (the duration of 1 sample).

Usage: Query only

9.6.5 Exporting (Raw) I/Q Data

For information on exporting I/Q data see Chapter 7, "I/Q Data Export", on page 86.

MMEMory:STORe<n>:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

Suffix:

<n> irrelevant

Parameters:

<Comment> String containing the comment.

Example: `MMEM:STOR:IQ:COMM 'Device test 1b'`
Creates a description for the export file.
`MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores I/Q data and the comment to the specified file.

Manual operation: See "I/Q Export" on page 86

MMEMory:STORe:IQ:FORMat? <Format>,<DataFormat>

This command queries the format of the I/Q data to be stored.

Parameters:

<Format> **FLOat32**
32-bit floating point format.
*RST: FLOat32

<DataFormat> **COMPlex**
Exports complex data.
*RST: COMPlex

Usage: Query only

MMEMory:STORe<n>:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Secure User Mode

In secure user mode, settings that are stored on the instrument are stored to volatile memory, which is restricted to 256 MB. Thus, a "Memory full" error can occur although the hard disk indicates that storage space is still available.

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

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

Suffix:

<n> irrelevant

Parameters:
1

<FileName> String containing the path and name of the target file.

Example:
```
MMEM:STOR:IQ:STAT 1, 'C:
\R_S\Instr\user\data.iq.tar'
```
Stores the captured I/Q data to the specified file.

Manual operation: See "I/Q Export" on page 86

9.7 Analyzing Results

The following remote commands are required to configure general result analysis settings concerning the trace, markers, lines etc. in a remote environment.

9.7.1 Configuring Traces

Useful commands for trace configuration described elsewhere

- DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing on page 114
- DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] on page 113
- Chapter 9.6.3, "Exporting Trace Results", on page 161

Remote commands exclusive to trace configuration

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

This command selects the trace mode.

Suffix:
<n> Window

<t> Trace

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S ESW saves the sweep result in the trace memory only if the new value is lower than the previous one.

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example:

`INIT:CONT OFF`
Switching to single sweep mode.
`SWE:COUN 16`
Sets the number of measurements to 16.
`DISP:TRAC3:MODE WRIT`
Selects clear/write mode for trace 3.
`INIT;*WAI`
Starts the measurement and waits for the end of the measurement.

Manual operation: See "Mode" on page 70

DISPlay[:WINDow<n>]:TRACe<t>:MODE:HCONtinuous <State>

This command turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Suffix:

<n> Window

<t> Trace

Parameters:

<State>

ON
The automatic reset is off.

OFF
The automatic reset is on.

*RST: OFF

Example: `DISP:WIND:TRAC3:MODE:HCON ON`
Switches off the reset function.

Manual operation: See "Hold" on page 71

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

This command turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> Window
Irrelevant in the Receiver application.

<t> Trace

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1 for TRACe1, 0 for TRACe 2 to 6

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4" on page 70
See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 71

[SENSe:]AVERage<n>:COUNt <AverageCount>

This command defines the number of measurements 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

Usage: SCPI confirmed

Manual operation: See "Average Count" on page 71

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

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

Suffix:

<n> Window

<t> Trace

Parameters:
<State> ON | OFF

Usage: SCPI confirmed

[SENSe:][WINDow:]DETector<t>[:FUNCtion] <Detector>

Defines the trace detector to be used for trace analysis.

For details see Chapter 4.4, "Sweep Time and Detector", on page 20.

Parameters:
<Detector>

NEGative
Negative peak

POSitive
Positive peak

SAMPle
First value detected per trace point

AVERage
Average

*RST: POS

Example: `DET POS`
Sets the detector to "positive peak".

Manual operation: See "Detector" on page 70

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Suffix:
<n> Window

Parameters:
<TraceNumber>, <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.

Usage: SCPI confirmed

Manual operation: See "Copy Trace" on page 71

9.7.2 Using Trace Mathematics

The following commands control trace mathematics.

CALCulate<n>:MATH[:EXPression][:DEFine] <Expression>

This command selects the mathematical expression for trace mathematics.

Before you can use the command, you have to turn trace mathematics on.

Suffix:

<n> Window

Parameters:

<Expression>

(TRACE1-TRACE2)
Subtracts trace 2 from trace 1.

(TRACE1-TRACE3)
Subtracts trace 3 from trace 1.

(TRACE1-TRACE4)
Subtracts trace 4 from trace 1.

Example:

`CALC:MATH:STAT ON`
Turns trace mathematics on.
`CALC:MATH:EXPR:DEF (TRACE1-TRACE3)`
Subtracts trace 3 from trace 1.

Usage: SCPI confirmed

Manual operation: See "Trace Math Function" on page 73

CALCulate<n>:MATH:MODE <Mode>

This command selects the way the R&S ESW calculates trace mathematics.

Suffix:

<n> Window

Parameters:

<Mode> For more information on the way each mode works see Trace Math Mode.

LINear
Linear calculation.

LOGarithmic
Logarithmic calculation.

POWer
Linear power calculation.

*RST: LOGarithmic

Example:

`CALC:MATH:MODE LIN`
Selects linear calculation.

Manual operation: See "Trace Math Mode" on page 74

CALCulate<n>:MATH:POSition <Position>

This command defines the position of the trace resulting from the mathematical operation.

Suffix:
<n> Window

Parameters:
<Position> Vertical position of the trace in % of the height of the diagram area.
100 PCT corresponds to the upper diagram border.
Range: -100 to 200
*RST: 50
Default unit: PCT

Example: `CALC:MATH:POS 100`
Moves the trace to the top of the diagram area.

Manual operation: See "Trace Math Position" on page 73

CALCulate<n>:MATH:STATe <State>

This command turns the trace mathematics on and off.

Suffix:
<n> Window

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MATH:STAT ON`
Turns on trace mathematics.

Usage: SCPI confirmed

Manual operation: See "Trace Math Function" on page 73
See "Trace Math Off" on page 73

9.7.3 Working with Markers Remotely

In the Real-Time Spectrum application, up to 16 markers or delta markers can be activated for each window simultaneously.

For more details see Chapter 4.6.2, "Markers in the Spectrogram", on page 28.

9.7.3.1 Setting Up Individual Markers

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

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Suffix:

<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual operation: See "All Markers Off" on page 77

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 75
See "Marker Type" on page 76
See "Select Marker" on page 77

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<Trace>

1 to 4
Trace number the marker is assigned to.

MAXHold
Marker is assigned to maxhold trace of persistent spectrum (only available in Persistent Spectrum window)

WRITe
Marker is assigned to clear/write trace of persistent spectrum (only available in Persistent Spectrum window)

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual operation: See "Assigning the Marker to a Trace" on page 77

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:

<m>	Marker (query: 1 to 16)
<n>	Window

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 12
See "Marker Position (X-value)" on page 76

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Suffix:

<n> Window

<m> Marker

Return values:

<Result> Result at the marker position.

Example:
`INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 12
See "Marker Level (Y-value)" on page 76

CALCulate<n>:DELTamarker<m>:AOFF

This command turns *all* delta markers off.

Suffix:

<n> Window

<m> irrelevant

Example:
`CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Suffix:

<n> Window

<m> Marker

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:DELT2:LINK ON`

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

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

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see CALCulate<n>:DELTamarker<m>:X on page 178)!

Suffix:
<n> Window

<m> irrelevant

Parameters:
<Mode> **ABSolute**
Delta marker position in absolute terms.
RELative
Delta marker position in relation to a reference marker.
*RST: RELative

Example: `CALC:DELT:MODE ABS`
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<Reference>

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 76

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 75
See "Marker Type" on page 76
See "Select Marker" on page 77

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> Window

<m> Marker

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:

<m> Marker

<n> Window

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker Position (X-value)" on page 76

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

The unit depends on the application of the command.

Suffix:

<m> Marker

<n> Window

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example:
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

Manual operation: See "Marker Level (Y-value)" on page 76

9.7.3.2 General Marker Settings

The following commands control general marker functionality.

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

This command selects the marker step size mode for *all* markers in *all* windows.

It therefore takes effect in manual operation only.

Suffix:

<n>, <m> irrelevant

Parameters:

<StepSize>

STANdard
the marker moves from one pixel to the next

POINts
the marker moves from one sweep point to the next

*RST: POINts

Example:
`CALC:MARK:X:SSIZ STAN`
Sets the marker step size to one pixel.

Manual operation: See "Marker Stepsize" on page 78

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode> **ON**
Turns the marker table on.
OFF
Turns the marker table off.
*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 78

9.7.3.3 Configuring and Performing a Marker Search

The following commands control the marker search.

CALCulate<n>:MARKer<m>:LOEXclude <State>

This command turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows).

Suffix:

<n>, <m> irrelevant

Parameters:

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

Example: `CALC:MARK:LOEX ON`

Manual operation: See "Exclude LO" on page 81

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

This command turns an automatic marker peak search for a trace maximum on and off. The R&S ESW performs the peak search after each sweep.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:MAX:AUTO ON`

Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Max / Min Peak Search" on page 81

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

This command turns an automatic marker peak search for a trace minimum on and off. The R&S ESW performs the peak search after each sweep.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:MIN:AUTO ON`

Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Max / Min Peak Search" on page 81

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Suffix:

<n>, <m> irrelevant

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: 6.0 dB

Manual operation: See "Peak Excursion" on page 81

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

This command turns marker search limits on and off for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n>, <m> irrelevant

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK:X:SLIM ON`
Switches on search limitation.

Manual operation: See "Search Limits (Left / Right)" on page 82
See "Deactivating All Search Limits" on page 82

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

This command defines the left limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n>, <m> irrelevant

Parameters:

<SearchLimit> The value range depends on the frequency range or measurement time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:LEFT 10MHz`
Sets the left limit of the search range to 10 MHz.

Manual operation: See "Search Limits (Left / Right)" on page 82

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHT <SearchLimit>

This command defines the right limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:

<n>, <m> irrelevant

Parameters:

<Limit> The value range depends on the frequency range or measurement time.
The unit is Hz for frequency domain measurements and s for time domain measurements.
*RST: right diagram border

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Search Limits (Left / Right)" on page 82

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

This command adjusts the marker search range to the zoom area for *all* markers in *all* windows.

Suffix:

<n>, <m> irrelevant

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

CALCulate<n>:THReshold <Level>

This command defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Suffix:

<n> irrelevant

Parameters:

<Level> Numeric value. The value range and unit are variable.
*RST: -120 dBm

Example: `CALC:THR -82DBM`
Sets the threshold value to -82 dBm.

Manual operation: See "Search Threshold" on page 82

CALCulate<n>:THReshold:STATe <State>

This command turns a threshold for the marker peak search on and off (for *all* markers in *all* windows).

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:THR:STAT ON`
Switches on the threshold line.

Manual operation: See "Deactivating All Search Limits" on page 82

9.7.3.4 Positioning the Marker

The following remote commands are required to position the marker on a trace.

Positioning Markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:FUNCtion:CENTer

This command matches the center frequency to the frequency of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK2:FUNC:CENT`
Sets the center frequency to the frequency of marker 2.

Usage: Event

Manual operation: See "Center Frequency = Marker Frequency" on page 83

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in X Direction" on page 79
See "Search Next Peak" on page 82

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in X Direction" on page 79
See "Search Next Peak" on page 82

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80
See "Peak Search" on page 82

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in X Direction" on page 79 See "Search Next Peak" on page 82

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in X Direction" on page 79 See "Search Next Minimum" on page 83

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in X Direction" on page 79 See "Search Next Minimum" on page 83

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n>	Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80
See "Search Minimum" on page 83

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in X Direction" on page 79
See "Search Next Minimum" on page 83

Positioning Delta Markers

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Peak" on page 82

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Next Peak" on page 82

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Marker Search Type" on page 80 See "Peak Search" on page 82

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Next Peak" on page 82

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

Suffix:

<n>	Window
<m>	Marker

Usage: Event

Manual operation: See "Search Next Minimum" on page 83

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Minimum" on page 83

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80
See "Search Minimum" on page 83

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Next Minimum" on page 83

9.7.3.5 Marker Search (Spectrograms)

The following commands automatically define the marker and delta marker position in the spectrogram.

The usage of these markers is demonstrated in Chapter 9.10.2, "Example 2: Performing a Basic Real-Time Measurement", on page 209.

Using Markers

The following commands control spectrogram markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the markers.

- `CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 185
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 185
- `CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 185
- `CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 186
- `CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 186
- `CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 186
- `CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 186
- `CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 187

Remote commands exclusive to spectrogram markers

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame> | <Time>
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the (negative) distance to frame 0 in seconds.
The range depends on the history depth.

Example: `CALC:MARK:SGR:FRAM -20`
Sets the marker on the 20th frame before the present.
`CALC:MARK2:SGR:FRAM -2s`
Sets second marker on the frame 2 seconds ago.

Manual operation: See "Frame" on page 76

CALCulate<n>:MARKer<m>:SGRam:SARea <SearchArea>
CALCulate<n>:MARKer<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for all spectrogram markers in the measurement channel.

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 81

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80

CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Marker Search Type" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:

<n> Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80

CALCulate<n>:MARKer<m>:SGRam:Y:TRIGger
CALCulate<n>:MARKer<m>:SPECtrogram:Y:TRIGger

This command positions a marker in the spectrogram on the most recent trigger event.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Marker to Trigger" on page 83

Using Delta Markers

The following commands control spectrogram delta markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the delta markers.

- `CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 187
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 188
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 188
- `CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 188
- `CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 188
- `CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 189
- `CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 189
- `CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 189

Remote commands exclusive to spectrogram markers

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe <Frame> | <Time>
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

<Time> Selects a frame via its time stamp. Valid if the time stamp is on.
The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:
`CALC:DELT4:SGR:FRAM -20`
Sets fourth deltamarker 20 frames below marker 1.
`CALC:DELT4:SGR:FRAM 2 s`
Sets fourth deltamarker 2 seconds above the position of marker 1.

CALCulate<n>:DELTamarker<m>:SGRam:SARea <SearchArea>
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for *all* spectrogram markers in the measurement channel.

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 81

CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Marker Search Type" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Marker Search Type" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker
Usage:	Event
Manual operation:	See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:
<n> Window

<m> Marker

Usage: Event

Manual operation: See "Marker Search Type" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:

<n>	Window
<m>	Marker

Usage: Event

Manual operation: See "Search Mode for Next Peak in Y Direction" on page 80

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Suffix:

<n> Window

<m> Marker

Usage: Event

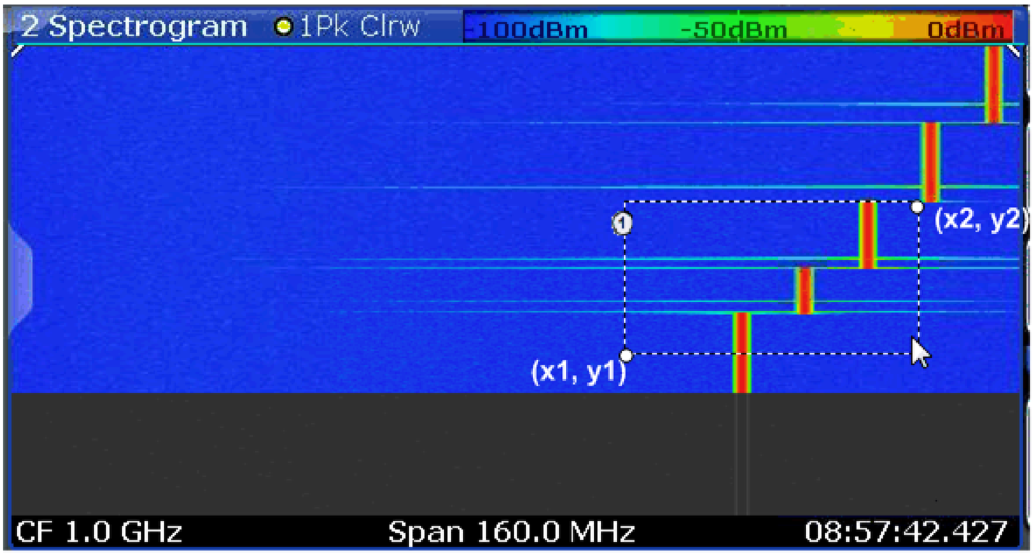
Manual operation: See "Marker Search Type" on page 80

9.7.4 Zooming into the Display

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area for the spectrogram (see Chapter 4.6.4, "Zooming into the Spectrogram", on page 32).

To define a zoom area, you first have to turn the zoom on (see `DISPlay[:WINDow<n>]:ZOOM:STATe` on page 201).



1 = zoom area (e.g. x1 = 1020 MHz, y1 = -80 ms, x2 = 1060 MHz, y2 = -40 ms)
(x1,y1) = zoom area start
(x2,y2) = zoom area end

Suffix:

<n> Window

Parameters:

<x1> Starting frequency for the zoom area. Left side of zoom area.

Range: CF - Span/2 to CF + Span/2
Default unit: Hz

<y1> Oldest time for zoom area. Bottom side of zoom area.

Range: starting time of spectrogram to 0
Default unit: s

<x2> Ending frequency for the zoom area. Right side of zoom area.
Range: CF - Span/2 to CF + Span/2
Default unit: Hz

<y2> Most recent time for zoom area. Top side of zoom area.
Range: starting time of spectrogram to 0
Default unit: s

Example: `DISPlay:WINDow2:ZOOM:AREA 1020 MHZ, -0.08 s, 1060 MHZ, -0.040 s;`

Manual operation: See "Single Zoom" on page 84

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Suffix:
<n> Window

Parameters:
<State> ON | OFF
*RST: OFF

Example: `DISP:ZOOM ON`
Activates the zoom mode.

Manual operation: See "Single Zoom" on page 84
See "Restore Original Display" on page 84
See " Deactivating Zoom (Selection mode)" on page 84

9.8 Querying the Status Registers

The Real-Time Spectrum application uses the standard status registers of the R&S ESW, as well as the `STATus:QUEStionable:TIME` register.

This register and the commands required to query its contents are described here.

For details on the common R&S ESW status registers refer to the description of remote control basics in the R&S ESW User Manual.

*RST does not influence the status registers.

9.8.1 STATus:OPERation Register

The STATus:OPERation register contains information on current activities of the R&S ESW. It also contains information on activities that have been executed since the last read out.

You can read out the register with STATus:OPERation:CONDition? on page 203 or STATus:OPERation[:EVENt]? on page 204.

Table 9-6: Meaning of the bits used in the STATus:OPERation register

Bit No.	Meaning
0	CALibrating This bit is set as long as the instrument is performing a calibration.
1-2	Not used
3	SWEeping Sweep is being performed in base unit (applications are not considered); identical to bit 4 Available in the Spectrum application.
4	MEASuring Measurement is being performed in base unit (applications are not considered); identical to bit 3 Available in the Spectrum application.
5	Waiting for TRIgger Instrument is ready to trigger and waiting for trigger signal. Available in the Spectrum application.
6-7	Not used
8	HardCOPy in progress This bit is set while the instrument is printing a hardcopy.
9	SCAN results available This bit is set when a block of scan results is available. Must be enabled by TRAC:FEED:CONT ALWays. Available in the Receiver application.
10	Range completed In the Spectrum application, this bit is set when a range in the sweep list has been completed if "Stop after Range" has been activated. In the Receiver application, this bit is set when the end of a scan range has been reached. To resume the scan, use INITiate:CONMeas.
11-12	Not used
13	Threshold signal active Available for the Receiver application.
14	Not used
15	This bit is always 0.

9.8.2 STATus:QUEStionable:TIMe Register

The STATus:QUEStionable:TIMe register contains information about possible time errors that may occur during operation of the R&S ESW. A separate time register exists for each active channel.

You can read out the register with STATus:QUEStionable:TIMe:CONDition? or STATus:QUEStionable:TIMe[:EVENt]?

Table 9-7: Meaning of the bits used in the STATus:QUEStionable:TIMe register

Bit No.	Meaning
0	Real-Time Data Loss This bit is set if the R&S ESW loses data during the measurement and measurements are no longer possible in Real-Time.
1 to 14	Unused
15	This bit is always 0.

9.8.3 Commands to Query the STATus:OPERation Register

The following commands are required to query the contents of the STATus:OPERation register.

STATus:OPERation:CONDition? <ChannelName>

This comand reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:ENABle? <SumBit>,<ChannelName>

This command controls the ENABle part of the register.

The ENABle part allows true conditions in the EVENt part of the status register to bereported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:NTRansition? <SumBit>,<ChannelName>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:PTRansition? <SumBit>,<ChannelName>

This command controls the Positive TRansition part of the register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation[:EVENt]? <ChannelName>

This command queries the contents of the EVENt section of the status register.

A query deletes the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Return values:

<RegisterContents>	Range:	0 to 32767

Usage: Query only

9.8.4 Commands to Query the STATus:QUEStionable:TIME Register

The following commands are required to query the contents of the `STATus:QUEStionable:TIME` register.

STATus:QUEStionable:TIMe:CONDition?

This command queries the contents of the "CONDition" section of the `STATus:QUEStionable:TIMe` register (see `STATus:QUEStionable:TIMe[:EVENt]?` on page 206). Readout does not delete the contents of the "CONDition" section.

Example: `STAT:QUES:TIM:COND?`

Usage: Query only

STATus:QUEStionable:TIMe:ENABle <BitDefinition>

This command sets the bits of the "ENABle" section of the `STATus:QUEStionable:TIMe` register. The "ENABle" register selectively enables the individual events of the associated "EVENt" section for the summary bit.

Parameters:
<BitDefinition> 0 to 65535

Example: `STAT:QUES:POW:ENAB 65535`

STATus:QUEStionable:TIMe:NTRansition <BitDefinition>

This command sets the edge detectors of all bits of the `STATus:QUEStionable:TIMe` register from 1 to 0 for the transitions of the "CONDition" bit.

Parameters:
<BitDefinition> 0 to 65535

Example: `STAT:QUE:POWS:NTR 65535`

STATus:QUEStionable:TIMe:PTRansition <BitDefinition>

This command sets the edge detectors of all bits of the `STATus:QUEStionable:TIMe` register from 0 to 1 for the transitions of the "CONDition" bit.

Parameters:

<BitDefinition> 0 to 65535

Example: `STAT:QUES:POW:PTR 65535`

STATus:QUEStionable:TIMe[:EVENt]?

This command queries the contents of the "EVENt" section of the `STATus:QUEStionable:TIMe` register. Readout deletes the contents of the "EVENt" section.

Example: `STAT:QUES:POW?`

Usage: Query only

9.9 Commands for Compatibility

Note that these commands are maintained for compatibility with the R&S FSVR only. Use the specified commands for new remote control programs.

DISPlay:WINDow[:SUBWindow] commands

For compatiblity with the R&S FSVR, the commands required to configure the persistence spectrum also accept the optional `SUBWindow` keyword (`DISPlay:WINDow[:SUBWindow]...`). However, this keyword is ignored and has no effect on remote control.

CALCulate<n>:FEED <ResultDisplay>

This command selects the result display in Real-Time mode.

Note that this command is maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see Chapter 9.4.12.2, "Working with Windows in the Display", on page 145).

Suffix:

<n> Window

Parameters:

<ResultDisplay> **'XFRequency:RFPower[:SPECtrum]'**

'XFRequency[:SPECtrum]'
Selects the Real-Time spectrum result display.

'XFRequency:RFPower:SGRam'

'XFRequency:SGRam'
Selects the spectrogram result display.

'XFRequency:RFPower:PSPectrum'

'XFRequency:PSPectrum'
Selects the persistence spectrum result display.

'XTIMe:RFPower[:TDOMain]'

'XTIMe[:TDOMain]'
Selects the power vs. time result display.

'XTIMe:RFPower:SGRam'

'XTIMe:SGRam'
Selects the power vs. time waterfall diagram.

*RST: SPECtrum

Example: `CALC:FEED 'XFR:PSP'`
Starts the persistence spectrum result display.

9.10 Programming Examples: Performing Real-Time Measurements

The following programming examples demonstrate how to perform Real-Time measurements in a remote environment.

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.

9.10.1 Example 1: Creating a Frequency Mask Trigger

In this example we will create a frequency mask trigger with an upper and lower mask. This trigger mask can be used in Example 2: Performing a Basic Real-Time Measurement.

```
//------------ Configuring a frequency mask trigger -----------------
//Store trigger mask as 'C:\R_S\INSTR\freqmask\myFMTS\NewFreqMaskTrigger'
//Note the 'myFMTS' subdirectory must be created under 'C:\R_S\INSTR\freqmask'
//beforehand.
```

```
CALC:MASK:CDIR 'myFMTS'
CALC:MASK:NAME 'NewFreqMaskTrigger'
CALC:MASK:COMM 'Upper and lower frequency mask'

//------------ Defining an upper frequency mask automatically ----------------
//Use relative scaling for the level axis
CALC:MASK:MODE REL
//Define a span of 20 MHz
CALC:MASK:SPAN 20000000
//Configure automatic upper mask according to measured spectrum
CALC:MASK:UPP:AUTO
//Query the mask points for the upper mask
CALC:MASK:UPP:DATA?
//Result: comma-separated list of value pairs (Frequency, level);
//one for each data point
//Example:
//-9.990009990E+006,-9.600020599E+001,-9.230769231E+006,-8.738758087E+001,
//-8.831168831E+006,-9.565835571E+001,-7.972027972E+006,-8.494093323E+001,
//...
//+8.171828172E+006,-8.577051544E+001,+8.631368631E+006,-9.534964752E+001,
//+9.530469530E+006,-8.848562622E+001,+9.990009990E+006,-9.600020599E+001

//------------ Configuring the lower frequency mask manually -------------------
//Configure lower mask 20 dB lower than upper mask;
//Use upper mask as basis, then shift all values by 20 dB
CALC:MASK:LOW:STAT ON
CALC:MASK:LOW:DATA -9.990009990E+006,-9.600020599E+001,-9.230769231E+006,-8.738758087E+001,
-8.831168831E+006,-9.565835571E+001,-7.972027972E+006,-8.494093323E+001,
-7.492507493E+006,-9.450020599E+001,-6.793206793E+006,-7.878201294E+001,
-6.693306693E+006,-7.925418091E+001,-6.213786214E+006,-9.578102112E+001,
-5.414585415E+006,-3.991313553E+001,-4.995004995E+006,-3.050031662E+001,
-4.575424575E+006,-3.975288010E+001,-3.776223776E+006,-9.574020386E+001,
-3.296703297E+006,-7.856089020E+001,-2.777222777E+006,-8.525804901E+001,
-2.497502498E+006,-9.450020599E+001,-1.878121878E+006,-8.315855408E+001,
-1.258741259E+006,-9.424127960E+001,-1.238761239E+006,-9.424189758E+001,
-1.058941058E+006,-8.987026215E+001,-4.995004995E+005,-9.452841949E+001,
-3.308057785E-006,-9.450020599E+001,+5.394605395E+005,-8.521303558E+001,
+1.238761239E+006,-9.425141144E+001,+1.258741259E+006,-9.425095367E+001,
+1.858141858E+006,-8.382637787E+001,+2.497502497E+006,-9.450020599E+001,
+2.817182817E+006,-8.492385864E+001,+3.356643357E+006,-8.088692474E+001,
+3.756243756E+006,-9.698367310E+001,+4.535464535E+006,-4.851605225E+001,
+4.995004995E+006,-3.950028992E+001,+5.454545455E+006,-4.873092270E+001,
+6.213786214E+006,-9.597808838E+001,+6.273726274E+006,-9.304232788E+001,
+6.773226773E+006,-8.045437622E+001,+7.492507493E+006,-9.450020599E+001,
+8.171828172E+006,-8.577051544E+001,+8.631368631E+006,-9.534964752E+001,
+9.530469530E+006,-8.848562622E+001,+9.990009990E+006,-9.600020599E+001
CALC:MASK:LOW:SHIFT:Y -20
```

9.10.2 Example 2: Performing a Basic Real-Time Measurement

The first measurement example performs a basic Real-Time measurement in the frequency domain with the default display configuration (Real-Time spectrum and spectrogram). It uses a frequency mask trigger stored as `C:\R_S\INSTR\freqmask\myFMTS\NewFreqMaskTrigger`, as described in Example 1: Creating a Frequency Mask Trigger.

To perform a basic Real-Time measurement without a frequency mask trigger, simply remove the section `Using a Frequency Mask Trigger` in the following example.

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST

//---------- Activating a Real-Time measurement channel -----------
//Activate a Real-Time measurement channel named "Real-Time"
INST:CRE:NEW RTIM,'Real-Time'

//Stop the current measurement
INIT:CONT OFF

//-------------- Configuring the Measurement -----
//Define the center frequency
FREQ:CENT 100MHz
//Set the span to 10 MHz on either side of the center frequency.
FREQ:SPAN 20MHz

//Set the reference level to 0 dBm
DISP:TRAC:Y:SCAL:RLEV 0

//Couple the RBW to the span, with RBW/span = 0.000625
BAND:RAT 0.000625
//Use a Gaussian FFT window function
SWE:FFT:WIND:TYPE GAUS
//Collect data for 20 ms for each spectrum
SWE:TIME 0.02

//----------- Using a Frequency Mask Trigger ------------------------
//Configure the use of an existing frequency mask (from Example 4) as a trigger
TRIG:SOUR MASK
//Select the mask to use
CALC:MASK:CDIR 'myFMTS'
CALC:MASK:NAME 'NewFreqMaskTrigger'
//Trigger on entering the frequency mask
TRIG:MASK:COND ENT

//Define a pretrigger period of 10 ms, posttrigger = 0.5 s
TRIG:PRET 0.001
```

```
TRIG:POST 0.5
//Use rearming trigger mode to perform continuous measurements
TRIG:MODE CONT

//-------------- Configuring the result displays -------------
//Clear the initial spectrogram results
CALC2:SPEC:CLE
//Store up to 1000 spectrogram frames
CALC2:SPEC:HDEP 1000

//-------------- Configuring spectrogram color mapping -----------------
//Use grayscale coloring
DISP:WIND2:SPEC:COL GRAY
//Configure a value range from 0.5% to 95%
DISP:WIND2:SPEC:COL:LOW 0.5
DISP:WIND2:SPEC:COL:UPP 95
//Change the shape of the color mapping function to distribute more colors among
//high values
DISP:WIND2:SPEC:COL:SHAP 0.35

//-------------- Performing the Measurement -----
//Initiate a new measurement
INIT:CONT ON
INIT:IMM
//Wait until some measurements have been performed.
INIT:CONT OFF

//--------------- Retrieving Results -------------
//Query the spectrogram results for the Real-Time measurement
CALC2:SPEC:TST:DATA? ALL
//Result: 4 values for each of the measured frames indicating the time passed
//since 01.01.1970 till the start of the frame, e.g.:
//1370524679,49559852,0,0,1370524679,18552034,0,0,
//1370524678,987161993,0,0,1370524678,971568114,0,0,
//...
//1370524670,79975615,0,0,1370524670,48813821,0,0
//First frame: 01.01.1970 + 1370524670 seconds
//Most recent frame: 01.01.1970 + 1370524679 seconds
//Measurement duration: 1370524679 s - 1370524670 s = 9 s

//Return the 1001 measured power levels for each of the measured frames
TRAC2:DATA? SPEC

//Store the spectrogram to a file
MMEM:STOR2:SPEC 'C:\temp\spectrogram'

//Query spectrum results for the most recent spectrum
CALC2:SPEC:FRAM:SEL 0
TRAC1:DATA:X? TRACE1
TRAC1:DATA? TRACE1
```

```
//Query spectrum results for the previous spectrum
CALC2:SPEC:TST OFF
//Use frame index instead of time stamp
CALC2:SPEC:FRAM:SEL -1
TRAC1:DATA:X? TRACE1
TRAC1:DATA? TRACE1
//Store these spectrum results to a file
MMEM:STOR1:TRAC 1,'C:\temp\FirstSpectrum'

//---------------- 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 -1 and query its position
CALC2:MARK2 ON
CALC2:MARK2:SGR:FRAM -1s
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 marker4 on the most recent trigger event in the spectrogram and query
//its position
CALC2:MARK4 ON
CALC2:MARK4:SPEC:Y:TRIG
CALC2:MARK4:X?
CALC2:MARK4:Y?
```

9.10.3 Example 3: Analyzing Persistency

This measurement example performs a basic Real-Time measurement in the frequency domain with an additional persistence spectrum window. It uses a frequency mask trigger stored as

`C:\R_S\INSTR\freqmask\myFMTS\NewFreqMaskTrigger`, as described in Example 1: Creating a Frequency Mask Trigger.

To perform a basic Real-Time measurement without a frequency mask trigger, simply remove the section `Using a Frequency Mask Trigger` in the following example.

```
//--------------Preparing the instrument -----------
//Reset the instrument
*RST

//---------- Activating a Real-Time measurement channel -----------
//Activate a Real-Time measurement channel named "Real-Time"
INST:CRE:NEW RTIM,'Real-Time'

//Stop the current measurement
INIT:CONT OFF

//-------------- Configuring the Measurement -----
//Define the center frequency
FREQ:CENT 100MHz
//Set the span to 10 MHz on either side of the center frequency.
FREQ:SPAN 20MHz

//Set the reference level to 0 dBm
DISP:TRAC:Y:SCAL:RLEV 0

//Couple the RBW to the span, with RBW/span = 0.000625
BAND:RAT 0.000625
//Use a Gaussian FFT window function
SWE:FFT:WIND:TYPE GAUS
//Collect data for 20 ms for each spectrum
SWE:TIME 0.02

//----------- Using a Frequency Mask Trigger ------------------------
//Configure the use of an existing frequency mask (from Example 4) as a trigger
TRIG:SOUR MASK
//Select the mask to use
CALC:MASK:CDIR 'myFMTS'
CALC:MASK:NAME 'NewFreqMaskTrigger'
//Trigger on entering the frequency mask
TRIG:MASK:COND ENT

//Define a pretrigger period of 10 ms, posttrigger = 0.5 s
TRIG:PRET 0.001
TRIG:POST 0.5
//Use rearming trigger mode to perform continuous measurements
TRIG:MODE CONT

//-------------- Configuring the result displays -------------
```

```
//Add a persistence spectrum result display
LAY:ADD? '1',RIGH,'XFRequency:PSPectrum'
//Result: '3'
//Clear the initial spectrogram results
CALC2:SPEC:CLE

//Configure vector-style trace for an uninterrupted (interpolated)
//persistence spectrum
DISP:WIND:TRAC:SYMB VECT

//Define a perstistence duration of 1.2 s
DISP:WIND:TRAC:PERS:DUR 1.2
//Use the data captured in 120 ms for a single frame (perstistence granularity)
DISP:WIND:TRAC:PERS:GRAN 0.12

//Activate the maxhold trace in the persistence spectrum display
DISP:WIND:TRAC:MAXH ON
//Define an intensity of 125 for the maxhold trace
DISP:WIND:TRAC:MAXH:INT 125
//Clear the maxhold trace
DISP:WIND:TRAC:MAXH:RES

//-------------- Configuring persistence color mapping -----------------
//Use greyscale coloring
DISP:WIND:PSP:COL GRAY
//Configure a value range from 0.5% to 95%
DISP:WIND:PSP:COL:LOW 0.5
DISP:WIND:PSP:COL:UPP 95
//Reduce the range of the color map if no hits are found at the value range edges
DISP:WIND:PSP:COL:TRUN ON
//Change the shape of the color mapping function to distribute more colors among
//high values
DISP:WIND:PSP:COL:SHAP 0.35

//-------------- Performing the Measurement -----
//Initiate a new measurement and wait until some measurements have been performed.
INIT:CONT ON
INIT:IMM
INIT:CONT OFF

//--------------- Retrieving Results -------------
//Query the persistence spectrum results
TRAC3:DATA? PSP
//Result: 1001*600 percentages, one for each pixel in the histogram

//Return the 1001 measured power levels for the most recent spectrum
TRAC3:DATA? TRACE1

//Return the 1001*600 maximum probabilities for the maxhold trace
TRAC3:DATA? HMAX
```

```
//Store the persistence spectrum to a file
MMEM:STOR3:PSP 'C:\temp\persistence'
```

Annex

A Reference: ASCII File Export Format

Trace data (for example Real-Time spectrum, persistence spectrum, or spectrogram) can be exported to a file in ASCII format for further evaluation in other applications.

The file consists of the header containing important measurement parameters and a data section containing the trace data.

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS-Excel. Different language versions of evaluation programs may require a different handling of the decimal point. Thus you can define the decimal separator to be used (decimal point or comma, see "Decimal Separator" on page 72).

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section contains the measured data in two columns, which are also separated by a semicolon.

The file contents vary depending on the result type.

Table A-1: ASCII file format for Spectrum trace export

File contents	Description
Header data	
Type;R&S ESW;	Instrument model
Version;1.80;	Firmware version
Date;20.Jul 2013;	Date of data set storage
Mode;Real-Time;	Channel type
Preamplifier;OFF;	Preamplifier state
Transducer;OFF;	Transducer state
Center Freq;1000000000.000000;Hz	Center frequency
Freq Offset;0.000000;Hz	Frequency offset
Start;920000000.000000;Hz	Start frequency
Stop;1080000000.000000;Hz	Stop frequency
Span;160000000.000000;Hz	Measured span
Ref Level;0.000000;dBm	Reference level
Level Offset;0.000000;dB	Reference level offset
Rf Att;10.000000;dB	Input attenuation
El Att;0.000000;dB	Electronic attentuation
RBW;800000.000000;Hz	Resolution bandwidth
SWT;0.030000;s	Sweep time

File contents	Description
Sweep Count;0;	Number of sweeps
Window;1;Real-Time Spectrum	Window containing the exported results
Ref Position;100.000000; %	Reference level position in percent
Level Range;100.000000;dB	Power level (y-axis) range
x-Axis;LIN;	x-axis scaling mode (linear, log.)
y-Axis;LOG;	y-axis scaling mode (linear, log.)
x-Unit;Hz;	x-axis unit
y-Unit;dBm;	y-axis unit
Data section	
Trace;1;	Trace number
Trace Mode;CLR/WRITE;	Trace mode
Detector;MAXPEAK;	Detector used for trace
Values; 1001;	Number of measured frequencies
13170000000;-100.50020599365234; 13170160000;-100.16989898681641; ...;...;	Measured values: <frequency>, <power level>

Table A-2: ASCII file format for persistence spectrum trace export

File contents	Description
Header data	
Type;R&S ESW;	Instrument model
Version;1.80;	Firmware version
Date;20.Jul 2013;	Date of data set storage
Mode;Real-Time;	Channel type
Preamplifier;OFF;	Preamplifier state
Transducer;OFF;	Transducer state
Center Freq;1000000000.000000;Hz	Center frequency
Freq Offset;0.000000;Hz	Frequency offset
Start;920000000.000000;Hz	Start frequency
Stop;1080000000.000000;Hz	Stop frequency
Span;160000000.000000;Hz	Measured span
Ref Level;0.000000;dBm	Reference level
Level Offset;0.000000;dB	Reference level offset
Rf Att;10.000000;dB	Input attenuation

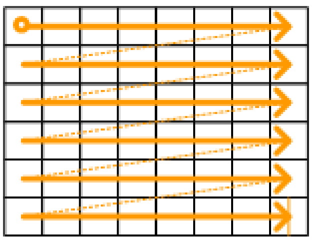
File contents	Description
El Att;0.000000;dB	Electronic attentuation
RBW;800000.000000;Hz	Resolution bandwidth
SWT;0.030000;s	Sweep time
Sweep Count;0;	Number of sweeps
Trace Mode;CLR/WRITE;MAXHOLD;	Display mode of traces: 1. CLR/WRITE; 2.MAXHOLD
Detector;PERSISTENCE;	Detector used for trace (none for persistence)
Data section	
Values; 1001;600;	Number of measurement points for x-axis (frequency) and y-axis (power)
920000000;920160000;920320000;920480000; ... 1079520000;1079680000;1079840000;1080000000	1001 frequency values used for histogram
-37.5;-37.583472454090149; ... -87.416527545909844;-87.5	600 power levels used for histogram
CLR/WRITE	Introduction for persistence spectrum data
0;0;0; 0.60534548759460449;0.37962344288825989	1000*600 most recently calculated percentage values in histogram from top left to bottom right, that is, starting with the lowest frequency and highest power value and ending with the highest frequency and lowest power level 
MAXHOLD	Introduction for MAXHOLD data
0;0;0; 0.90801829099655151;0.56943517923355103	1000*600 maximum percentage values for MAXHOLD trace from top left to bottom right, that is, starting with the lowest frequency and highest power value and ending with the highest frequency and lowest power level

Table A-3: ASCII file format for spectrogram trace export

File contents	Description
Header data	
Type;R&S ESW;	Instrument model
Version;1.80;	Firmware version

File contents	Description
Date;20.Jul 2013;	Date of data set storage
Mode;Real-Time;	Channel type
Preamplifier;OFF;	Preamplifier state
Transducer;OFF;	Transducer state
Center Freq;1000000000.000000;Hz	Center frequency
Freq Offset;0.000000;Hz	Frequency offset
Start;920000000.000000;Hz	Start frequency
Stop;1080000000.000000;Hz	Stop frequency
Span;160000000.000000;Hz	Measured span
Ref Level;0.000000;dBm	Reference level
Level Offset;0.000000;dB	Reference level offset
Rf Att;10.000000;dB	Input attenuation
El Att;0.000000;dB	Electronic attentuation
RBW;800000.000000;Hz	Resolution bandwidth
SWT;0.030000;s	Sweep time
Sweep Count;0;	Number of sweeps
Window;1;Real-Time Spectrum	Window containing the exported results
Ref Position;100.000000; %	Reference level position in percent
Level Range;100.000000;dB	Power level (y-axis) range
x-Axis;LIN;	x-axis scaling mode (linear, log.)
y-Axis;LOG;	y-axis scaling mode (linear, log.)
x-Unit;Hz;	x-axis unit
y-Unit;dBm;	y-axis unit
Data section	
Trace;1;	Trace number
Trace Mode;CLR/WRITE;	Trace mode
Detector;MAXPEAK;	Detector used for trace
Values; 1001;	Number of measured frequencies
Frames;130;	Number of exported frames
Data section for individual frame	
Frame;0;	Most recent frame number
Timestamp;29.Jul 13;08:51:19.355	Timestamp of this frame

File contents	Description
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <frequency>; <power value1>; <power value2>; <power value 2> only for AUTOPEAK detector; contains the minimum of the two measured values for each measurement point
Data section for individual frame	
Frame;-1;	Previous frame
Timestamp;29.Jul 13;08:51:19.278	Timestamp of this frame
...	

List of Remote Commands (Real-Time)

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