7 Common Analysis and Display Functions

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are performing a specific measurement task, using an operating mode other than Signal and Spectrum Analyzer mode, or an application other than the Spectrum application, be sure to check the specific application or mode description for settings and functions that may deviate from these common settings.

The analysis settings and functions are available via the "Analysis" dialog box, which is displayed when you select the "Analysis" button in the "Overview". Additional measurement-specific analysis functions may be available in separate tabs in the "Analysis" dialog box. These are described with the individual measurements.

See chapter 5, "Measurements", on page 101.

7.1 Result Display Configuration

Measurement results can be evaluated in many different ways, for example graphically, as spectrograms, as summary tables, statistical evaluations etc. Thus, the result display is highly configurable to suit your specific requirements and optimize analysis. Here you can find out how to optimize the display for your measurement results.

Basic operations concerning the R&S FSW display, for example how to use the SmartGrid, are described in the R&S FSW Getting Started manual.

General display settings that are usually configured during initial instrument setup, independantly of the current measurement, e.g. which items or colors are displayed on the screen, are described in chapter 9.4, "Display Settings", on page 535.

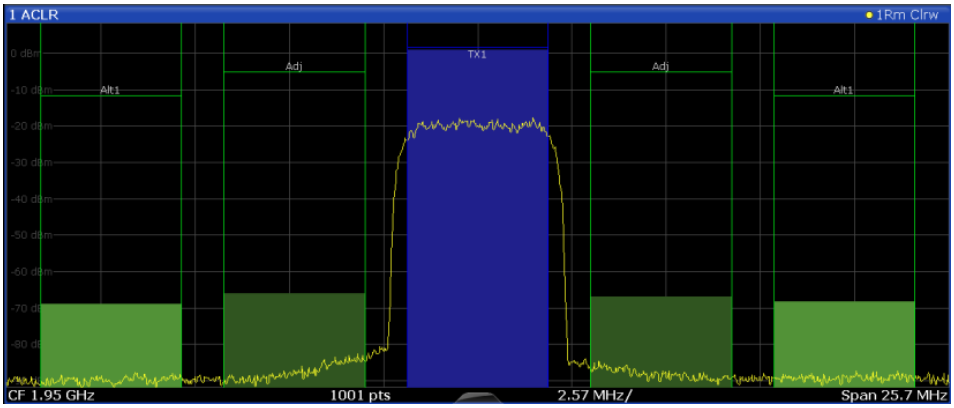
7.1.1 Basic Evaluation Methods

Measurement results can be displayed and evaluated using various different methods, also at the same time. Depending on the currently selected measurement, in particular when using optional firmware applications, not all evaluation methods are available.

The evaluation methods described here are available for most measurements in the Spectrum application.

Diagram
Displays a basic level vs. frequency or level vs. time diagram of the measured data to evaluate the results graphically. This is the default evaluation method. Which data is displayed in the diagram depends on the "Trace" settings. Scaling for the y-axis can be configured.

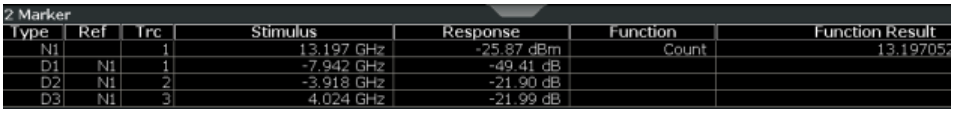
See chapter 7.3, "Trace Configuration", on page 405 and chapter 6.4.3, "Scaling the Y-Axis", on page 359.



Remote command:
`LAY:ADD? '1',RIGH, DIAG`, see `LAYout:ADD[:WINDow]?` on page 756

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

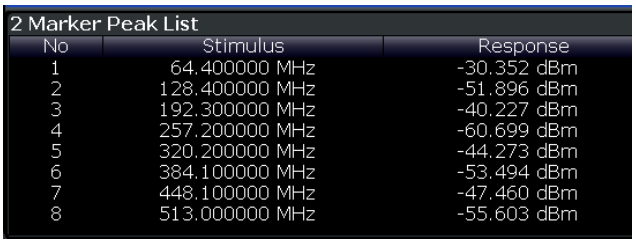
This table may be displayed automatically if configured accordingly (see "Marker Table Display" on page 449).



Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 756
Results:
`CALCulate<n>:MARKer<m>:X` on page 860
`CALCulate<n>:MARKer<m>:Y?` on page 871

Marker Peak List
The marker peak list determines the frequencies and levels of peaks in the spectrum or time domain. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

You can define search and sort criteria to influence the results of the analysis (see "Marker Search Settings" on page 450).


2 Marker Peak List

No	Stimulus	Response
1	64.400000 MHz	-30.352 dBm
2	128.400000 MHz	-51.896 dBm
3	192.300000 MHz	-40.227 dBm
4	257.200000 MHz	-60.699 dBm
5	320.200000 MHz	-44.273 dBm
6	384.100000 MHz	-53.494 dBm
7	448.100000 MHz	-47.460 dBm
8	513.000000 MHz	-55.603 dBm

Remote command:
`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 756
Results:
`CALCulate<n>:MARKer<m>:X` on page 860
`CALCulate<n>:MARKer<m>:Y?` on page 871

Result Summary
Result summaries provide the results of specific measurement functions in a table for numerical evaluation. The contents of the result summary vary depending on the selected measurement function. See the description of the individual measurement functions for details.


2 Result Summary

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	1.229 MHz		-0.86 dBm	
Tx Total			-0.86 dBm	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	30.000 kHz	750.000 kHz	-79.59 dB	-80.34 dB
Alt1	30.000 kHz	1.980 MHz	-85.04 dB	-83.85 dB

Remote command:
`LAY:ADD? '1',RIGH, RSUM`, see `LAYout:ADD[:WINDow]?` on page 756

Spectrogram
A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency or sweep time, the y-axis shows the measurement time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

The spectrogram display consists of two diagrams: the standard spectrum result display (upper diagram) and the spectrogram result display (lower diagram).

For details see chapter 7.3.1.6, "Spectrograms", on page 411.

Remote command:
`LAY:ADD? '1',RIGH, SGR`, see `LAYout:ADD[:WINDow]?` on page 756

7.1.2 How to Select an Evaluation Method

All evaluation methods available for the currently selected measurement are displayed in the evaluation bar in SmartGrid mode. The same evaluation method can be displayed in several windows simultaneously.

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

► To activate SmartGrid mode, do one of the following:

- Select the "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the configuration "Overview".
- Select the "Display Config" softkey from the MEAS CONFIG menu.

The Smartgrid functions and the evaluation bar are displayed.

To close the SmartGrid mode and restore the previous softkey menu select the "Close" icon in the righthand corner of the toolbar, or press any key on the front panel.

7.2 Zoomed Displays

You can zoom into the diagram to visualize the measurement results in greater detail. Using the touch screen or a mouse pointer you can easily define the area to be enlarged.

Zoom and the number of sweep points

Note that zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points!

You should increase the number of sweep points before zooming, as otherwise the function has no real effect (see chapter 6.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 366).

7.2.1 Single Zoom Versus Multiple Zoom

Two different zoom modes are available: single zoom and multiple zoom. A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible. In multiple zoom mode, you can enlarge up to four different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom areas can be moved and resized any time. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

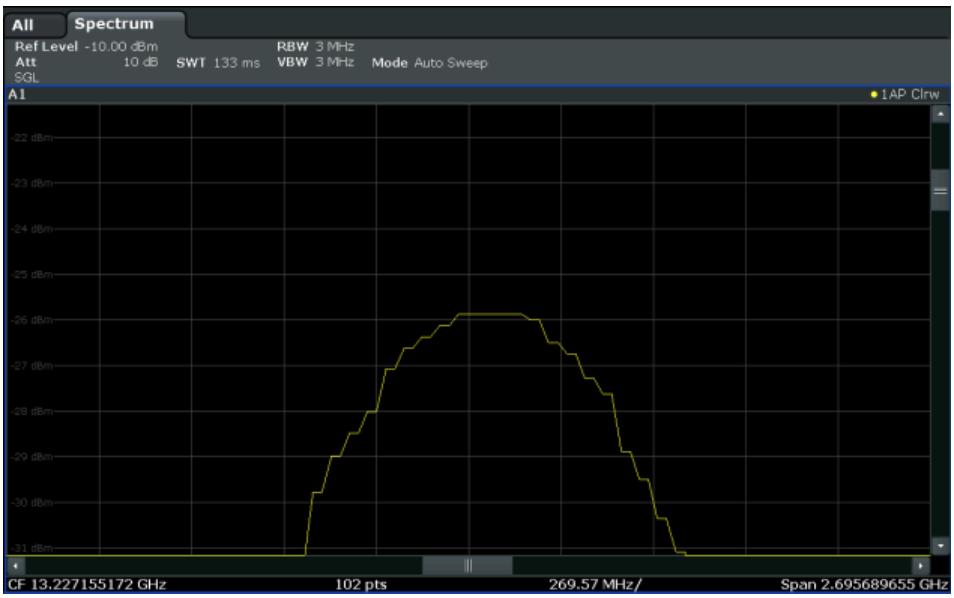


Fig. 7-1: Single zoom

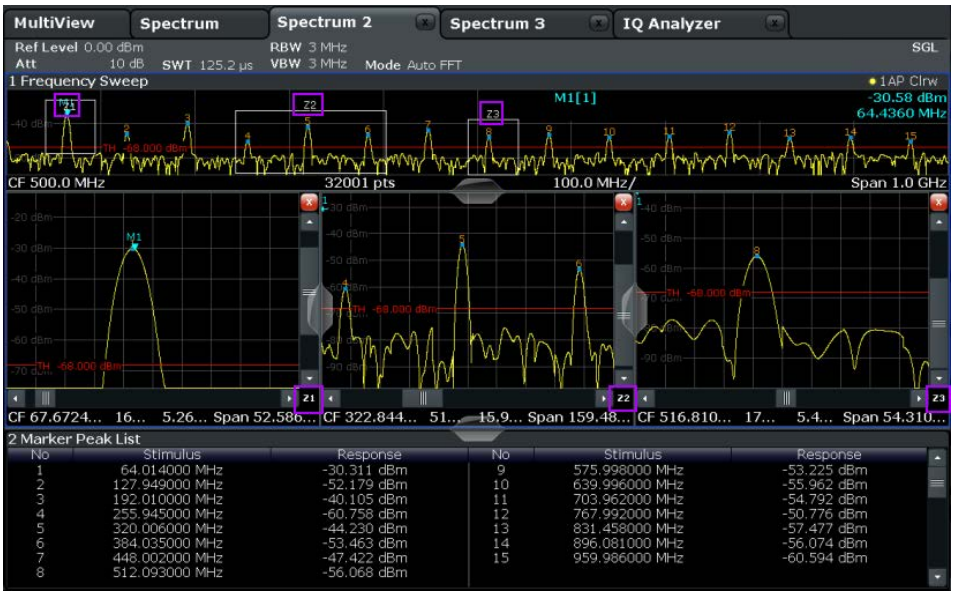


Fig. 7-2: Multiple zoom

Using the zoom area to restrict a peak search

The selected zoom area can be used to restrict the search range for a peak search, but only in single zoom mode (see "Using Zoom Limits" on page 453).

7.2.2 Zoom Functions

The zoom functions are only available from the toolbar.

Single Zoom

A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 838
`DISPlay[:WINDow<n>]:ZOOM:AREA` on page 838

Multiple Zoom

In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 839
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA` on page 839

Restore Original Display

Restores the original display and closes all zoom windows.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 838 (single zoom)
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 839 (for each multiple zoom window)

Deactivating Zoom (Selection mode)

Deactivates zoom mode; tapping the screen no longer invokes a zoom, but selects an object.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 838 (single zoom)
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 839 (for each multiple zoom window)

7.2.3 How to Zoom Into a Diagram

The remote commands required to zoom into a display are described in chapter 11.8.1, "Zooming into the Display", on page 838.

The following tasks are described here:

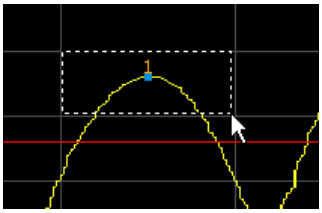
To zoom into the diagram at one position

1. 

   Click on the "Single Zoom" icon in the toolbar.

   Zoom mode is activated.

2. Select the area in the diagram to be enlarged on the touch screen. The selected area is indicated by a dotted rectangle.

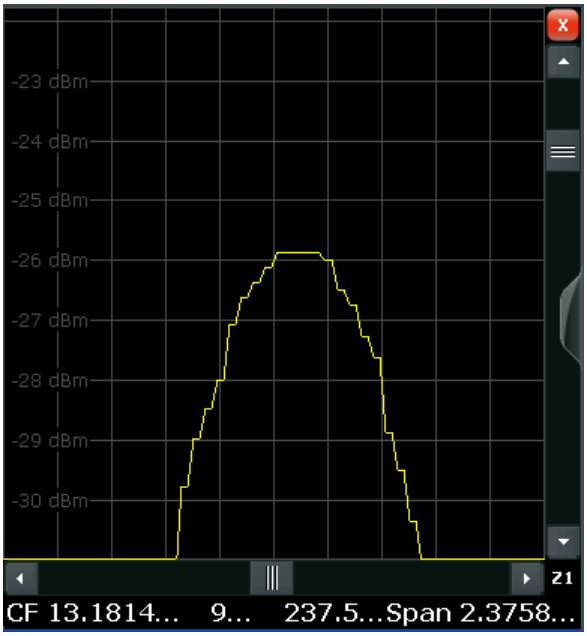
   

   When you leave the touch screen, the diagram is replaced by the zoomed trace area.

3. Repeat these steps, if necessary, to enlarge the diagram further.

Scrolling in the zoomed display

You can scroll the diagram area to display the entire diagram using the scrollbars at the right and at the bottom of the diagram.



To return to selection mode in the diagram

While you are in zoom mode, touching the screen changes the zoom area. In order to select or move a trace or marker, you must switch back to selection mode:

▶ 

Select the "Selection mode" icon in the toolbar.

To return to original display

▶ 

Click on the "Zoom Off" icon in the toolbar.

The original trace display is restored. Zoom mode remains active, however.
To switch off zoom mode and return to selection mode, select the "Selection mode" icon in the toolbar.

To zoom into multiple positions in the diagram

1. 

Click on the "Multiple Zoom" icon in the toolbar.

Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged on the touch screen. The selected area is indicated by a dotted rectangle.

   When you have completed your selection, the original trace is shown in an overview diagram with the selected area indicated by a dotted rectangle. The zoomed trace area is displayed in a separate window (see figure 7-2.

3. In the overview diagram, select the next area to be enlarged.

   The second zoom area is indicated in the overview diagram, and a second zoom window is displayed.

4. Repeat these steps, if necessary, to zoom into further trace areas (up to four).

To move or change zoom areas

In multiple zoom mode, you can change the size or position of the individual zoom areas easily at any time.

1. If necessary, switch off zoom mode and return to selection mode by selecting the "Selection mode" icon in the toolbar.
2. To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.
   To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.

   The contents of the zoom windows are adapted accordingly.

7.3 Trace Configuration

A trace is a collection of measured data points. The trace settings determine how the measured data is analyzed and displayed on the screen.

7.3.1 Basics on Setting up Traces

Some background knowledge on traces is provided here for a better understanding of the required configuration settings.

Each trace represents an analysis of the measured data. Up to 6 traces can be displayed in each window, and up to 16 windows can be displayed on the screen. So, in theory, you can analyze the data measured by the R&S FSW in almost 100 different ways simultaneously!

Trace settings are stored on the instrument for each window. So when you switch to a different window, the trace settings previously configured for that window are restored.

7.3.1.1 Mapping Samples to Sweep Points with the Trace Detector

A trace displays the power values measured at the sweep points. During a frequency sweep, the R&S FSW increments the first local oscillator in steps that are smaller than approximately 1/10 of the bandwidth. This ensures that the oscillator step speed is conform to the hardware settling times and does not affect the precision of the measured power. The number of samples taken during a sweep is independent of the number of oscillator steps and is much larger than the number of sweep points that are displayed in the measurement trace.

Example:

Assume the following measurement parameters:

- Sample rate: 32 MSamples / s
- Sweep points: 1000
- Sweep time: 100 ms
- Span: 5 GHz

During a single sweep, 3.2 * 10^6 samples are collected and distributed to 1000 sweep points, i.e. 3200 samples are collected per sweep point. For each sweep point, the measured data for a frequency span of 5 MHz (span/<sweep points>) is analyzed.

Note that if you increase the number of sweep points, the frequency span analyzed for each point in the trace decreases, making the result more stable. See also chapter 6.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 366.

Obviously, a data reduction must be performed to determine which of the samples are displayed for each sweep point. This is the trace detector's task.

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

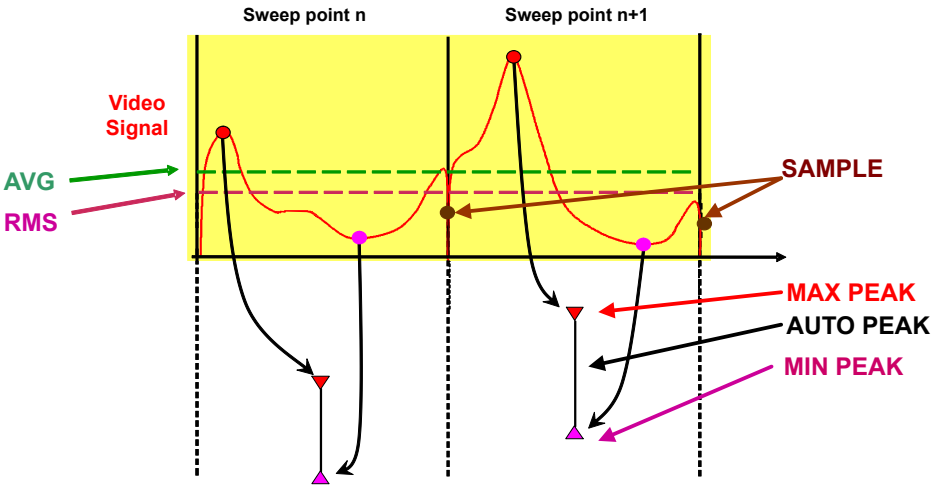
The detector activated for the specific trace is indicated in the corresponding trace information by an abbreviation.

Table 7-1: Detector types

Detector	Abbrev.	Description
Positive Peak	Pk	Determines the largest of all positive peak values of the levels measured at the individual frequencies which are displayed in one sample point
Negative Peak	Mi	Determines the smallest of all negative peak values of the levels measured at the individual frequencies which are displayed in one sample point

Detector	Abbrev.	Description
Auto Peak	Ap	Combines the peak detectors; determines the maximum and the minimum value of the levels measured at the individual frequencies which are displayed in one sample point (not available for SEM)
RMS	Rm	Calculates the root mean square of all samples contained in a sweep point. To this effect, R&S FSW uses the linear voltage after envelope detection. The sampled linear values are squared, summed and the sum is divided by the number of samples (= root mean square). For logarithmic display the logarithm is formed from the square sum. For linear display the root mean square value is displayed. Each sweep point thus corresponds to the power of the measured values summed up in the sweep point. The RMS detector supplies the power of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal). Correction factors as needed for other detectors to measure the power of the different signal classes are not required.
Average	Av	Calculates the linear average of all samples contained in a sweep point. To this effect, R&S FSW uses the linear voltage after envelope detection. The sampled linear values are summed up and the sum is divided by the number of samples (= linear average value). For logarithmic display the logarithm is formed from the average value. For linear display the average value is displayed. Each sweep point thus corresponds to the average of the measured values summed up in the sweep point. The average detector supplies the average value of the signal irrespective of the waveform (CW carrier, modulated carrier, white noise or impulsive signal).
Sample	Sa	Selects the last measured value of the levels measured at the individual frequencies which are displayed in one sample point; all other measured values for the frequency range are ignored
Quasi Peak	QP	Resembles the behavior of an analog voltmeter by analyzing the measured values for a sample point. The quasipeak detector is especially designed for the requirements of EMI measurements and is used for analyzing pulse-shaped spurious. This detector is only available if the R&S FSW EMI measurement option (K54) is installed.

The result obtained from the selected detector for a sweep point is displayed as the power value at this frequency point in the trace.



The trace detector for the individual traces can be selected manually by the user or set automatically by the R&S FSW.

The detectors of the R&S FSW are implemented as pure digital devices. All detectors work in parallel in the background, which means that the measurement speed is independent of the detector combination used for different traces.

RMS detector and VBW

If the RMS detector is selected, the video bandwidth in the hardware is bypassed. Thus, duplicate trace averaging with small VBWs and RMS detector no longer occurs. However, the VBW is still considered when calculating the sweep time. This leads to a longer sweep time for small VBW values. Thus, you can reduce the VBW value to achieve more stable trace curves even when using an RMS detector. Normally, if the RMS detector is used the sweep time should be increased to get more stable traces.

Auto detector

If the R&S FSW is set to define the appropriate detector automatically, the detector is set depending on the selected trace mode:

Trace mode	Detector
Clear Write	Auto Peak
Max Hold	Positive Peak
Min Hold	Negative Peak
Average	Sample Peak
View	–
Blank	–

7.3.1.2 Analyzing Several Traces - Trace Mode

If several sweeps are performed one after the other, or continuous sweeps are performed, the trace mode determines how the data for subsequent traces is processed. After each sweep, the trace mode determines whether:

- the data is frozen (View)
- the data is hidden (Blank)
- the data is replaced by new values (Clear Write)
- the data is replaced selectively (Max Hold, Min Hold, Average)

Each time the trace mode is changed, the selected trace memory is cleared.

The trace mode also determines the detector type if the detector is set automatically, see chapter 7.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 406.

The R&S FSW offers the following trace modes:

Table 7-2: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting. All available detectors can be selected.
Max Hold	The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one. This mode is especially useful with modulated or pulsed signals. The signal spectrum is filled up upon each sweep until all signal components are detected in a kind of envelope. This mode is not available for statistics measurements.
Min Hold	The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one. This mode is useful e.g. for making an unmodulated carrier in a composite signal visible. Noise, interference signals or modulated signals are suppressed, whereas a CW signal is recognized by its constant level. This mode is not available for statistics measurements.
Average	The average is formed over several sweeps. The Sweep/Average Count determines the number of averaging procedures. This mode is not available for statistics measurements.
View	The current contents of the trace memory are frozen and displayed.

If a trace is frozen ("View" mode), the instrument settings, apart from level range and reference level (see below), can be changed without impact on the displayed trace. The fact that the displayed trace no longer matches the current instrument setting is indicated by the ★ icon on the tab label.

If the level range or reference level is changed, the R&S FSW automatically adapts the trace data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

7.3.1.3 How Many Traces are Averaged - Sweep Count + Sweep Mode

In "Average" trace mode, the sweep count and sweep mode determine how many traces are averaged. The more traces are averaged, the smoother the trace is likely to become.

The algorithm for averaging traces depends on the sweep mode and sweep count.

- **sweep count = 0** (default)
  - In **"Continuous Sweep"** mode, a continuous average is calculated for 10 sweeps, according to the following formula:

$$Trace = \frac{9 * Trace_{old} + MeasValue}{10}$$

Fig. 7-3: Equation 1

Due to the weighting between the current trace and the average trace, past values have practically no influence on the displayed trace after about ten sweeps. With this setting, signal noise is effectively reduced without need for restarting the averaging process after a change of the signal.

– In **"Single Sweep"** mode, the current trace is averaged with the previously stored averaged trace. No averaging is carried out for the first sweep but the measured value is stored in the trace memory. The next time a sweep is performed, the trace average is calculated according to the following formula:

$$Trace = \frac{Trace_{old} + MeasValue}{2}$$

The averaged trace is then stored in the trace memory.

- **sweep count = 1**
  The currently measured trace is displayed and stored in the trace memory. No averaging is performed.
- **sweep count > 1**
  For both **"Single Sweep"** mode and **"Continuous Sweep"** mode, averaging takes place over the selected number of sweeps. In this case the displayed trace is determined during averaging according to the following formula:

$$Trace_n = \frac{1}{n} \cdot \left[\sum_{i=1}^{n-1} (T_i) + MeasValue_n \right]$$

Fig. 7-4: Equation 2

where n is the number of the current sweep (n = 2 ... Sweep Count).
No averaging is carried out for the first sweep but the measured value is stored in the trace memory. With increasing n, the displayed trace is increasingly smoothed since there are more individual sweeps for averaging.
After the selected number of sweeps the average trace is saved in the trace memory. Until this number of sweeps is reached, a preliminary average is displayed. When the averaging length defined by the "Sweep Count" is attained, averaging is continued in continuous sweep mode or for "Continue Single Sweep" according to the following formula:

$$Trace = \frac{(N-1) * Trace_{old} + MeasValue}{N}$$

where N is the sweep count

7.3.1.4 How Trace Data is Averaged - the Averaging Mode

When the trace is averaged over several sweeps (Trace mode: "Average"), different methods are available to determine the trace average.

With logarithmic averaging, the dB values of the display voltage are averaged or substracted from each other with trace mathematical functions.

With linear averaging, the level values in dB are converted into linear voltages or powers prior to averaging. Voltage or power values are averaged or offset against each other and reconverted into level values.

For stationary signals the two methods yield the same result.

Logarithmic averaging is recommended if sinewave signals are to be clearly visible against noise since with this type of averaging noise suppression is improved while the sinewave signals remain unchanged.

For noise or pseudo-noise signals the positive peak amplitudes are decreased in logarithmic averaging due to the characteristic involved and the negative peak values are increased relative to the average value. If the distorted amplitude distribution is averaged, a value is obtained that is smaller than the actual average value. The difference is -2.5 dB.

This low average value is usually corrected in noise power measurements by a 2.5 dB factor. Therefore the R&S FSW offers the selection of linear averaging. The trace data is linearized prior to averaging, then averaged and logarithmized again for display on the screen. The average value is always displayed correctly irrespective of the signal characteristic.

7.3.1.5 Combining Several Trace Results - Trace Math Evaluation

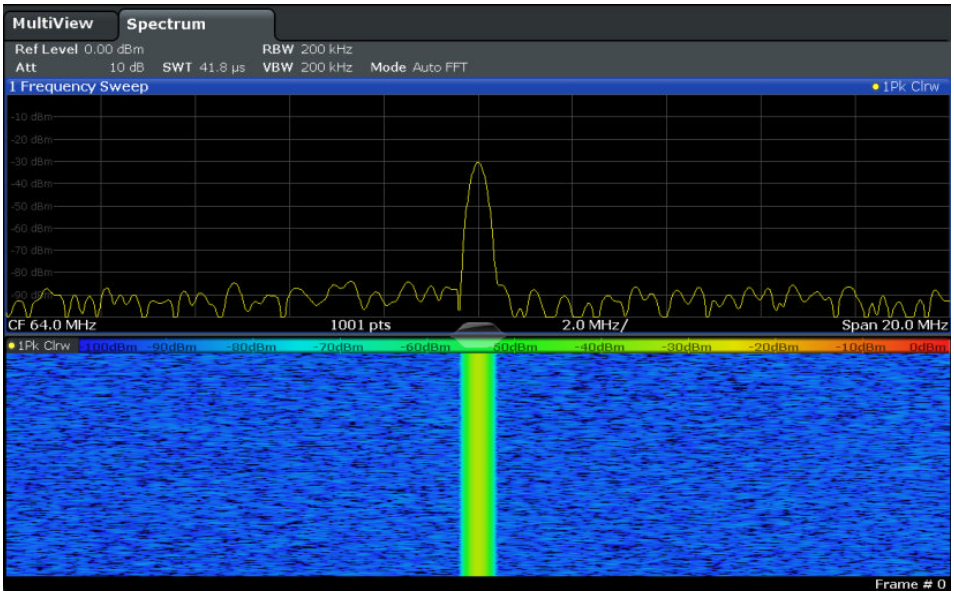
If you have several traces with different modes, for example an average trace and a maximum trace, it may be of interest to compare the results of both traces. In this example, you could analyze the maximum difference between the average and maximum values. To analyze the span of result values, you could subtract the minimum trace from the maximum trace. For such tasks, mathematical functions on trace results are provided.

7.3.1.6 Spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the R&S FSW also provides a spectrogram display of the measured data.

A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. A third dimension, the power level, is indicated by different colors. Thus you can see how the strength of the signal varies over time for different frequencies.

Example: Spectrogram for the calibration signal



In this example you see the spectrogram for the calibration signal of the R&S FSW, compared to the standard spectrum display. Since the signal does not change over time, the color of the frequency levels does not change over time, i.e. vertically. The legend above the spectrogram display describes the power levels the colors represent.

Result display

The spectrogram result can consist of the following elements:

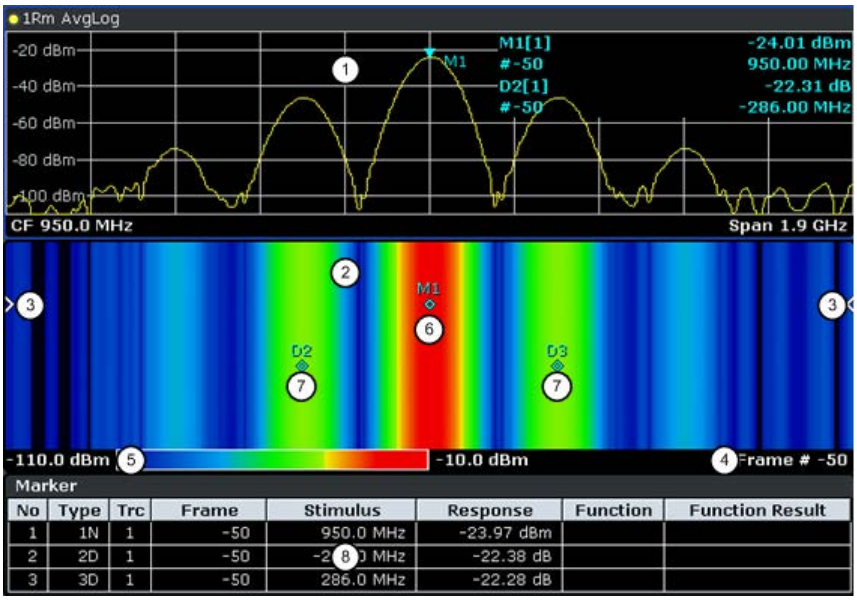


Fig. 7-5: Screen layout of the spectrogram result display

1 = Spectrum result display
2 = Spectrogram result display
3 = Current frame indicator
4 = Time stamp / frame number

5 = Color map
6 = Marker
7 = Delta marker
8 = Marker list

Time Frames

The time information in the spectrogram is displayed vertically, along the y-axis. Each line (or trace) of the y-axis represents one or more captured sweeps and is called a **time frame** or simply "frame". As with standard spectrum traces, several measured values are combined in one sweep point using the selected detector (see chapter 7.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 406).

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.

The maximum number of frames that you can capture is summarized in table 7-3.

Table 7-3: Correlation between number of sweep points and number of frames stored in the history buffer

Sweep Points	Max. History Depth
≤1250	20000
2001	12488
4001	6247
8.001	3124
16.001	1562
32.001	781

Frame analysis - Frame count vs. sweep count

As described for standard spectrum sweeps, the sweep count defines how many sweeps are analyzed to create a single trace. Thus, for a trace in "Average" mode, for example, a sweep count of 10 means that 10 sweeps are averaged to create a single trace, or frame.

The frame count, on the other hand, determines how many frames are plotted during a single sweep measurement (as opposed to a continuous sweep). For a frame count of 2, for example, 2 frames will be plotted during each single sweep. For continuous sweep mode, the frame count is irrelevant; one frame is plotted per sweep until the measurement is stopped.

If you combine the two settings, 20 sweeps will be performed for each single sweep measurement. The first 10 will be averaged to create the first frame, the next 10 will be averaged to create the second frame.

As you can see, increasing the sweep count increases the accuracy of the individual traces, while increasing the frame count increases the number of traces in the diagram.

Especially for "Average" or "Min hold" and "Max hold" trace modes, the number of sweeps that are analyzed to create a single trace has an effect on the accuracy of the results. Thus, you can also define whether the results from frames in previous traces are considered in the analysis for each new trace ("Continue frame").

Displaying individual frames

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. The spectrum diagram always displays the spectrum for the currently selected frame. The current frame number is indicated in the diagram footer, or alternatively a time stamp, if activated. The current frame, displayed at the top of the diagram, is frame number 0. Older frames further down in the diagram are indicated by a negative index, e.g."-10". You can display the spectrum diagram of a previous frame by changing the current frame number.

Color Maps

Spectrograms assign power levels to different colors in order to visualize them. The legend above the spectrogram display describes the power levels the colors represent.

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

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

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

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 amount 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:

Fig. 7-6: Linear color curve shape = 0; colors are distributed evenly over the complete result range

In the color map based on the linear color curve, the range from -105.5 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.

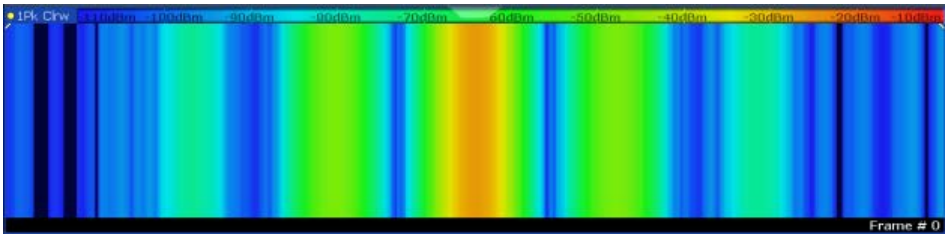


Fig. 7-7: Spectrogram with default color curve

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 -105.5 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.

Fig. 7-8: Non-linear color curve shape = -0.5

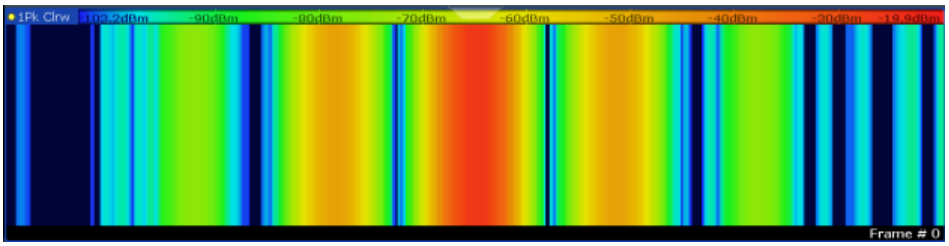
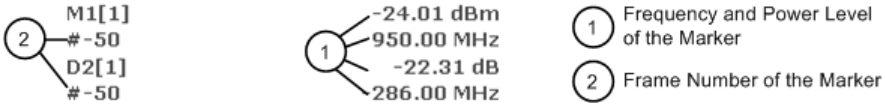


Fig. 7-9: Spectrogram with shifted color curve

Markers in the Spectrogram

Markers and delta markers are shaped like diamonds in the spectrogram. They are only displayed in the spectrogram if the marker position is inside the visible area of the spectrogram. If more than two markers are active, the marker values are displayed in a separate marker table.

In the spectrum result display, the markers and their frequency and level values (1) are displayed as usual. Additionally, the frame number is displayed to indicate the position of the marker in time (2).



In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame. Special search functions are provided for spectrogram markers.

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

7.3.2 Trace Configuration

Trace configuration includes the following settings and functions:

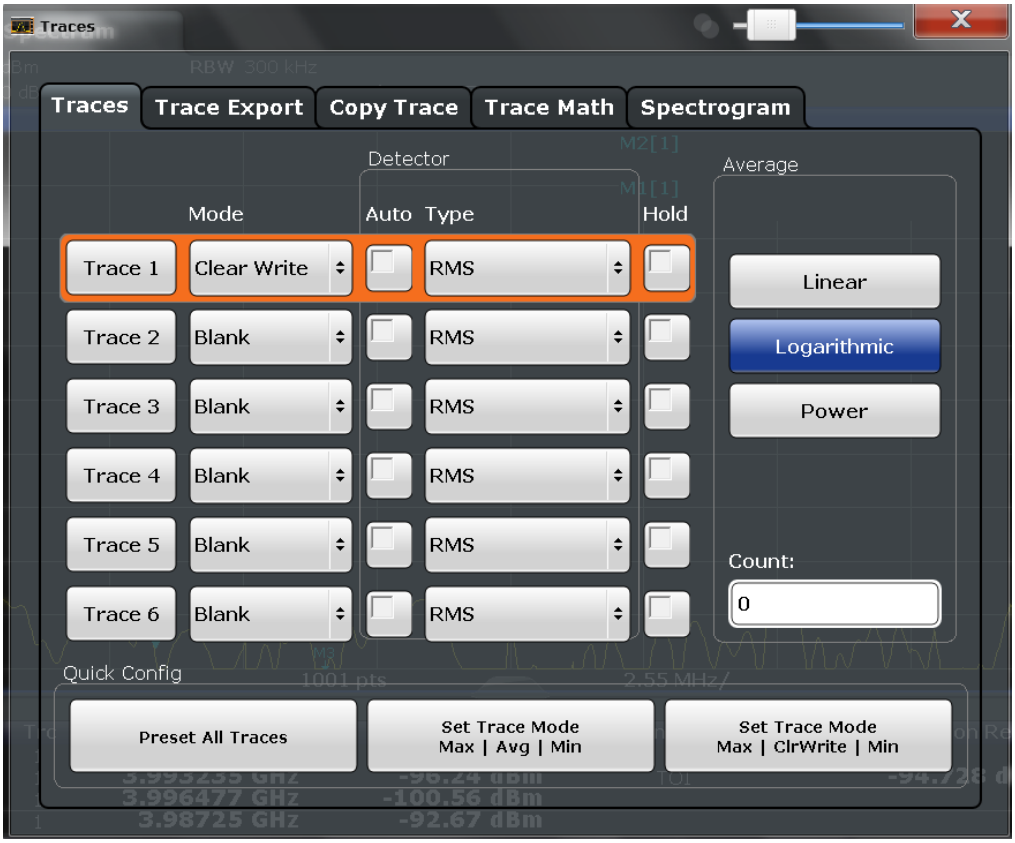
7.3.2.1 Trace Settings

You can configure the settings for up to 6 individual traces.

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

For settings on spectrograms, see chapter 7.3.2.4, "Spectrogram Settings", on page 425.

Trace data can also be exported to an ASCII file for further analysis. For details see chapter 7.3.2.3, "Trace Export Settings", on page 423.



Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6
Selects the corresponding trace for configuration. The currently selected trace is highlighted orange.

For details see chapter 7.3.3.1, "How to Configure a Standard Trace", on page 429.

Remote command:
Selected via numeric suffix of:`TRACe<1...6>` commands

Trace Mode
Defines the update mode for subsequent traces.

For details see chapter 7.3.1.2, "Analyzing Several Traces - Trace Mode", on page 408.

"Clear Write" Overwrite mode: the trace is overwritten by each sweep. This is the default setting.
The "Detector" is automatically set to "Auto Peak".

"Max Hold" The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.
The "Detector" is automatically set to "Positive Peak".
This mode is not available for statistics measurements.

"Min Hold" The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.
The "Detector" is automatically set to "Negative Peak".
This mode is not available for statistics measurements.

"Average" The average is formed over several sweeps.
The Sweep/Average Count determines the number of averaging procedures.
The "Detector" is automatically set to "Sample".
This mode is not available for statistics measurements.

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

"Blank" Removes the selected trace from the display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 841

Detector
Defines the trace detector to be used for trace analysis.

For details see chapter 7.3.1.1, "Mapping Samples to Sweep Points with the Trace Detector", on page 406.

Note: For EMI measurements, the trace detector is used for the initial peak search only, not for the final test. The detector for the final test is configured in the EMI marker settings, see chapter 5.13.4.1, "EMI Marker Configuration", on page 260.

"Auto" Selects the optimum detector for the selected trace and filter mode. This is the default setting.

"Type" Defines the selected detector type.

Note: If the EMI (R&S FSW-K54) measurement option is installed and the filter type "CISPR" is selected, additional detectors are available, even if EMI measurement is not active.
For details see chapter 5.13.3.2, "Detectors and Dwell Time", on page 252.

Remote command:
`[SENSe:][WINDow:]DETector<trace>[:FUNCtion]` on page 843
`[SENSe:][WINDow:]DETector<trace>[:FUNCtion]:AUTO` on page 844

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 anew 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 841

Average Mode
Defines the mode with which the trace is averaged over several sweeps. A different averaging mode can be defined for each trace.

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

How many sweeps are averaged is defined by the "Sweep/Average Count" on page 371.

For details see chapter 7.3.1.4, "How Trace Data is Averaged - the Averaging Mode", on page 410.

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

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

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

Remote command:
`[SENSe:]AVERage<n>:TYPE` on page 843

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

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

This value is identical to the Sweep/Average Count setting in the "Sweep" configuration.

Remote command:
`[SENSe:]AVERage:COUNt` on page 842

Predefined Trace Settings - Quick Config
Commonly required trace settings have been predefined and can be applied very quickly by selecting the appropriate button.

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write Auto Detector (Auto Peak)
	Traces 2-6:	Blank Auto Detector
Set Trace Mode Max | Avg | Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Average Auto Detector (Sample)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector
Set Trace Mode Max | ClrWrite | Min	Trace 1:	Max Hold Auto Detector (Positive Peak)
	Trace 2:	Clear Write Auto Detector (Auto Peak)
	Trace 3:	Min Hold Auto Detector (Negative Peak)
	Traces 4-6:	Blank Auto Detector

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)
Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

For details see chapter 7.3.3.1, "How to Configure a Standard Trace", on page 429.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 842

Copy Trace
The "Copy Trace" softkey opens the "Copy Trace" tab of the "Trace Configuration" dialog box.

The "Copy Trace" tab contains functionality to copy trace data to another trace.

The first group of buttons (labelled "Trace 1" to "Trace 6") select the source trace. The second group of buttons (labelled "Copy to Trace 1" to "Copy to Trace 6") select the destination.

Remote command:
`TRACe<n>:COPY` on page 844

7.3.2.2 Trace Math

Trace math settings can be configured via the TRACE key, in the "Trace Math" tab of the "Traces" dialog box.

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

"T1-T2 -> T1"	Subtracts trace 2 from trace 1.
"T1-T3 -> T1"	Subtracts trace 3 from trace 1
"T1-T4 -> T1"	Subtracts trace 4 from trace 1
"T1-T5 -> T1"	Subtracts trace 5 from trace 1
"T1-T6 -> T1"	Subtracts trace 6 from trace 1

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

Remote command:
`CALCulate<n>:MATH[:EXPression][:DEFine]` on page 850
`CALCulate<n>:MATH:STATe` on page 851

Trace Math Off
Deactivates any previously selected trace math functions.

Remote command:
`CALC:MATH:STAT OFF`, see `CALCulate<n>:MATH:STATe` on page 851

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 851

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.

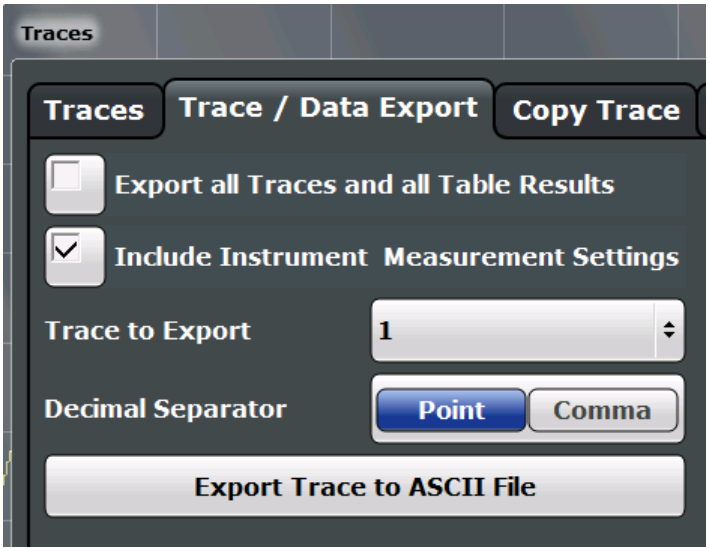
"Log" Activates logarithmic subtraction.
This subtraction method only takes effect if the grid is set to a logarithmic scale, i.e. the unit of the data is dBm. In this case the values are subtracted in dBm. Otherwise (i.e. with linear scaling) the behavior is the same as with linear subtraction.

"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 851

7.3.2.3 Trace Export Settings

Trace settings can be configured in the "Traces" dialog box or in the vertical "Traces" tab of the "Analysis" dialog box. Switch to the "Trace/Data Export" tab.



Export all Traces and all Table Results
Selects all displayed traces and result tables (e.g. Result Summary, marker peak list 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).

Remote command:
`FORMat:DEXPort:TRACes` on page 925

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

See chapter 8.3.4.1, "Reference: ASCII File Export Format", on page 503 for details.

Remote command:
`FORMat:DEXPort:HEADer` on page 925

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 906

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

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

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

For details on the file format see chapter 8.3.4.1, "Reference: ASCII File Export Format", on page 503.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 927
`MMEMory:STORe:SGRam` on page 926

7.3.2.4 Spectrogram Settings

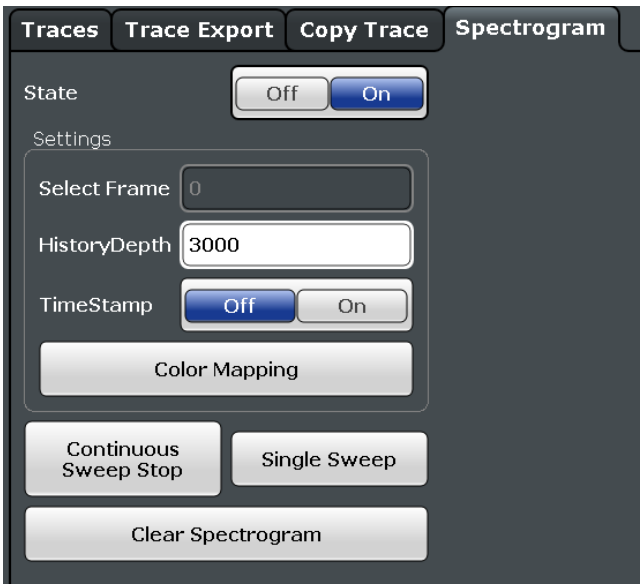
The individual settings available for spectrogram display are described here. For settings on color mapping, see "Color Map Settings" on page 428.

Settings concerning the frames and how they are handled during a sweep are provided as additional sweep settings for spectrogram display, see "Spectrogram Frames" on page 374.

Search functions for spectrogram markers are described in "Marker Search Settings for Spectrograms" on page 453.

General Spectrogram Settings

This section describes general settings for spectrogram display. They are available when you press the TRACE key and then select the "Spectrogram Config" softkey.



State
Activates and deactivates the spectrogram result display

Remote command:
`CALCulate:SGRam[:STATe]` on page 848
`CALCulate:SGRam:CONT` on page 845

Select frame
Selects a specific frame and loads the corresponding trace from the memory.

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

This function is 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.

For more information see "Time Frames" on page 413.

Remote command:
`CALCulate:SGRam:FRAMe:SELect` on page 846

History Depth
Sets the number of frames that the R&S FSW stores in its memory. The maximum number of frames depends on the Sweep Points.

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

For an overview of the maximum number of frames depending on the number of sweep points, see table 7-3.

Remote command:
CALCulate:SGRam:HDEPth on page 847

Time Stamp
Activates and deactivates the time stamp. 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 of the end of the sweep.

When active, the time stamp replaces the display of the frame number.

Remote command:
CALCulate:SGRam:TSTamp[:STATe] on page 848
CALCulate:SGRam:TSTamp:DATA? on page 847

Color Mapping
Opens the "Color Map" dialog.

For details see "Color Maps" on page 414.

Continuous Sweep Stop
Stops a continuous sweep measurement, e.g. in order to display the spectrum display for a previous frame.

Single Sweep/ RUN SINGLE
After triggering, starts the number of sweeps set in "Sweep Count". The measurement stops after the defined number of sweeps has been performed.

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.
Furthermore, the RUN SINGLE key on the front panel controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

For details on the Sequencer, see chapter 4.5.1, "The Sequencer Concept", on page 96.

Remote command:
INITiate[:IMMediate] on page 635

Clear Spectrogram

Resets the spectrogram result display and clears the history buffer.

Remote command:

`CALCulate:SGRam:CLEar[:IMMediate]` on page 845

Color Map Settings

The settings for color mapping are displayed in the "Color Mapping" dialog box that is displayed when you press the "Color Mapping" softkey in the "Spectrogram" menu, or tap the color map in the spectrogram display.

For more information on color maps see "Color Maps" on page 414.

For details on changing color mapping settings see "How to Configure the Color Mapping" on page 432.

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.

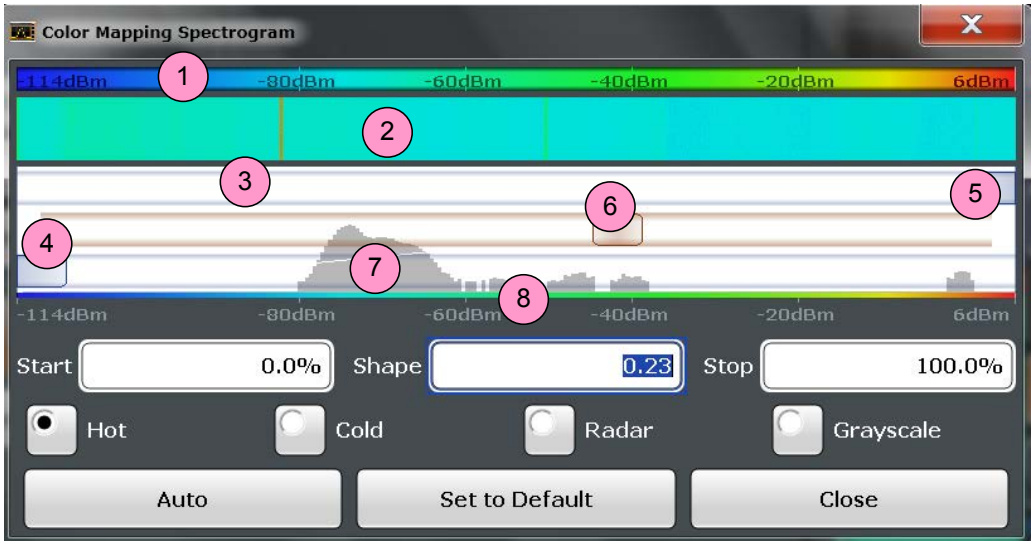


Fig. 7-10: Color Mapping dialog box

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

Start / Stop

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

Remote command:

`DISPlay:WINDow:SGRam:COLor:LOWer` on page 849
`DISPlay:WINDow:SGRam:COLor:UPPer` on page 849

Shape

Defines the shape and focus of the color curve for the spectrogram result display.

"-1 to <0"	More colors are distributed amoung the lower values
"0"	Colors are distributed linearly amoung the values
">0 to 1"	More colors are distributed amoung the higher values

Remote command:
`DISPlay:WINDow:SGRam:COLor:SHAPe` on page 849

Hot/Cold/Radar/Grayscale
Sets the color scheme for the spectrogram.

Remote command:
`DISPlay:WINDow:SGRam:COLor[:STYLe]` on page 849

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

Set to Default
Sets the color mapping to the default settings.

Remote command:
`DISPlay:WINDow:SGRam:COLor:DEFault` on page 848

7.3.3 How to Configure Traces

The following step-by-step procedures describe the following tasks:

7.3.3.1 How to Configure a Standard Trace

Step-by-step instructions on configuring the trace settings are provided here. For details on individual functions and settings see chapter 7.3.2.1, "Trace Settings", on page 417.

The remote commands required to perform these tasks are described in chapter 11.8.2, "Configuring the Trace Display and Retrieving Trace Data", on page 840.

Trace settings are configured in the "Traces" dialog box.

To display the "Traces" dialog box, do one of the following:

- Press the TRACE key and then select the "Trace Config" softkey.
- Select "Analysis" from the "Overview", then select the "Traces" tab.

1. For each trace, select the "Trace Mode" and "Trace Detector". Traces with the trace mode "Blank" are not displayed.
2. To configure several traces to predefined display modes in one step, press the button for the required function:
   - "Preset All Traces"

- "Set Trace Mode Avg | Max | Min"
- "Set Trace Mode Max | ClrWrite | Min"

For details see chapter 7.3.2.1, "Trace Settings", on page 417.

3. For "Average" trace mode, define the number of sweeps to be averaged in the "Sweep/Average Count" field of the "Sweep Config" dialog box.
(Press the SWEEP key and then select the "Sweep Config" softkey to display the "Sweep Config" dialog box.)
4. If linear scaling is used, select the "Average Mode: Linear".
5. To improve the trace stability, increase the number of "Sweep Points" or the "Sweep Time".

   All configured traces (not set to "Blank") are displayed after the next sweep.

How to Copy Traces

1. A trace copy function is provided in a separate tab of the "Traces" dialog box. To display this tab do one of the following:
   - Select the TRACE key and then the "Trace Copy" softkey.
   - Select "Analysis" from the "Overview", then select the "Trace Copy" tab.
2. Select the "Source" trace to be copied.
3. Select the "Copy to trace..." button for the trace to which the settings are to be applied.

   The settings from the source trace are applied to the destination trace. The newly configured trace (if not set to "Blank") is displayed after the next sweep.

7.3.3.2 How to Display and Configure a Spectrogram

Step-by-step instructions on how to display and configure a spectrogram are provided here. For details on individual functions and settings see chapter 7.3.2.4, "Spectrogram Settings", on page 425.

The remote commands required to perform these tasks are described in chapter 11.8.2.2, "Configuring Spectrograms", on page 845.

The following tasks are described here:

To display a spectrogram

1. In the "Overview", select "Display", then drag the evaluation type "Spectrogram" to the diagram area.
   Alternatively:
   a) Select the TRACE key and then the "Spectrogram Config" softkey.
   b) Toggle "Spectrogram" to "ON".
2. To clear an existing spectrogram display, select "Clear Spectrogram".
3. Start a new measurement using RUN SINGLE or RUN CONT.

   The spectrogram is updated continuously with each new sweep.
4. To display the spectrum diagram for a specific time frame:
   a) Stop the continuous measurement or wait until the single sweep is completed.
   b) Select the frame number in the diagram footer.
   c) Enter the required frame number in the edit dialog box.
   Note that the most recent sweep is frame number 0, all previous frames have negative numbers.

To remove the spectrogram display

1. Select the TRACE key and then the "Spectrogram Config" softkey.
2. Toggle "Spectrogram" to "OFF".

   The standard spectrum display is restored.

To set a marker in the spectrogram

1. While a spectrogram is displayed, select the MARKER key.
2. Select a "Marker" softkey.
3. Enter the frequency or time (x-value) of the marker or delta marker.
4. Enter the frame number for which the marker is to be set, for example *0* for the current frame, or *-2* for the second to last frame. Note that the frame number is always 0 or a negative value!
   The marker is only visible in the spectrum diagram if it is defined for the currently selected frame. In the spectrogram result display all markers are visible that are positioned on a visible frame.

To configure a spectrogram

1. Configure the spectrogram frames:
   a) Select the SWEEP key.
   b) Select the "Sweep Config" softkey.
   c) In the "Sweep/Average Count" field, define how many sweeps are to be analyzed to create a single frame.
   d) In the "Frame Count" field, define how many frames are to be plotted during a single sweep measurement.

e) To include frames from previous sweeps in the analysis of the new frame (for "Max Hold", "Min Hold" and "Average" trace modes only), select "Continue Frame" = "ON".

2. Define how many frames are to be stored in total:
   a) Select the TRACE key and then the "Spectrogram Config" softkey.
   b) Select the "History Depth" softkey.
   c) Enter the maximum number of frames to store.
3. Optionally, replace the frame number by a time stamp by toggling the "Timestamp" softkey to "On".
4. If necessary, adapt the color mapping for the spectrogram to a different value range or color scheme as described in "How to Configure the Color Mapping" on page 432.

How to Configure the Color Mapping

The color display is highly configurable to adapt the spectrograms 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:

- Tap the color map in the spectrogram display.
- Press the "Color Mapping" softkey in the "Spectrogram" menu.

To select a color scheme

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

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

Editing the value range of the color map

The distribution of the measured values is displayed as a histogram in the "Color Mapping" dialog box (see "Color Map Settings" on page 428). To cover the entire measurement value range, make sure the first and last bar of the histogram are included. To remove noise from the display, exclude the bottom 10 or 20 dB of the histogram.

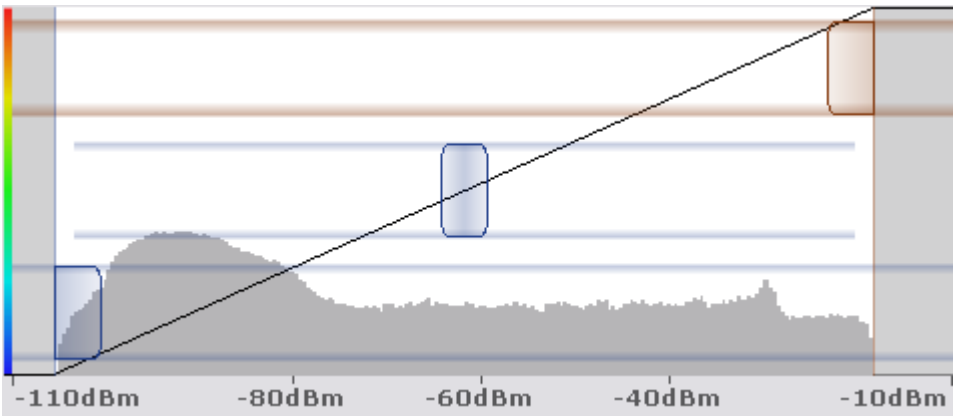
The value range of the color map must cover at least 10% of the value range on the horizontal axis of the diagram.

The value range 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 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 -100 dBm and ends at 0 dBm (i.e. 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 FSW shifts the start point 10% to the right, to -90 dBm.

Adjusting the reference level and level range

Note that changing the reference level and level range of the measurement also affects the color mapping in the spectrogram.

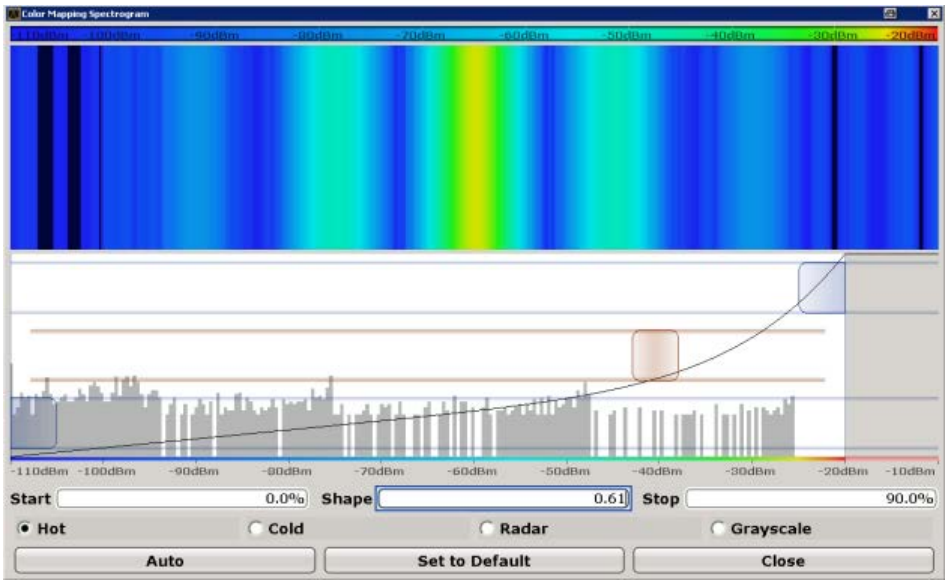
Editing the shape of the color curve

The color curve is a tool to shift the focus of the color distribution on the color map. By default, the color curve is linear, i.e. the colors on the color map are distributed evenly. If you shift the curve to the left or right, the distribution becomes non-linear. The slope of the color curve increases or decreases. One end of the color palette then covers a large amount 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 focussed, 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) focusses the lower values
- 0 defines a linear distribution
- A positive value (>0 to 1) focusses the higher values

7.3.3.3 How to Copy Traces

You can copy the trace settings from one trace to another in the "Copy Trace" tab of the "Traces" dialog box.

► Select the "Source" trace and then the button for the "Copy to" trace.

Remote command:

`TRACe<n>:COPY` on page 844

7.4 Marker Usage

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display both in the time and frequency domain. In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

Markers in Spectrogram Displays

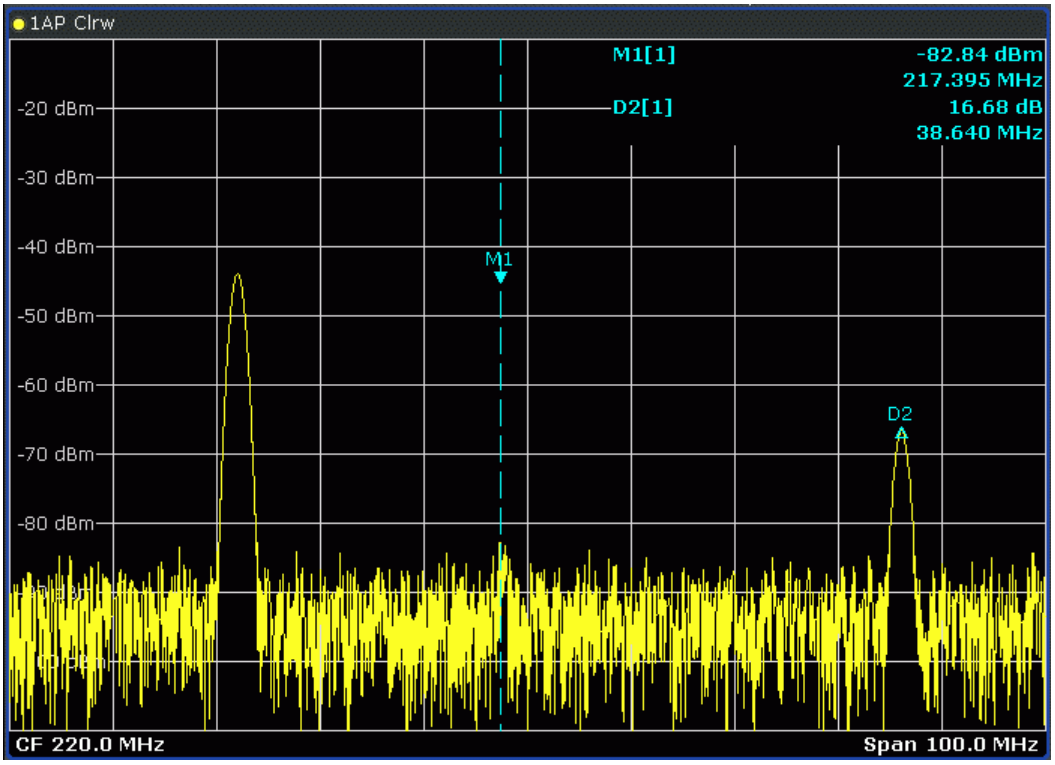
In the spectrogram result display, you can activate up to 16 markers or delta markers at the same time. Each marker can be assigned to a different frame. Therefore, in addition to the frequency you also define the frame number when activating a new marker. If no frame number is specified, the marker is positioned on the currently selected frame. All markers are visible that are positioned on a visible frame.

7.4.1 Basics on Markers and Marker Functions

Some background knowledge on marker settings and functions is provided here for a better understanding of the required configuration settings.

Markers are used to mark points on traces, to read out measurement results and to select a display section quickly. R&S FSW provides 16 markers per display window. In the Spectrum application, the same markers are displayed in all windows.

- The easiest way to work with markers is using the touch screen. Simply drag the marker and drop it at the required position. When a marker label is selected, a vertical line is displayed which indicates the marker's current x-value.



- Alternatively, change the position of the selected marker using the rotary knob. By default, the marker is moved from one pixel to the next. If you need to position the marker more precisely, change the step size to move from one sweep point to the next (General Marker Setting).
- You can also set an active marker to a new position by defining its x-position numerically. When you select the softkey for a marker, an edit dialog box is displayed.
- The most commonly required marker settings and functions are also available as softkeys or via the context menu. Tap the marker on the touch screen and hold your finger for about 2 seconds until the context menu is opened, then select the required entry.
- Softkeys for active markers (displayed on the screen) are highlighted blue. The softkey for the currently selected marker (for which functions are performed) is highlighted orange.
- To set individual markers very quickly, use the softkeys in the "Marker" menu.
- To set up several markers at once, use the "Marker" dialog box.
- To position the selected marker to a special value, use the softkeys in the "Marker To" menu.
- To determine more sophisticated marker results, use the special functions in the "Marker Function" dialog box.

7.4.1.1 Marker Types

All markers can be used either as normal markers or delta markers. A normal marker indicates the absolute signal value at the defined position in the diagram. A delta marker indicates the value of the marker relative to the specified reference marker (by default marker 1).

In addition, special functions can be assigned to the individual markers. The availability of special marker functions depends on whether the measurement is performed in the frequency or time domain.

Temporary markers are used in addition to the markers and delta markers to analyze the measurement results for special marker functions. They disappear when the associated function is deactivated.

7.4.1.2 Activating Markers

Only active markers are displayed in the diagram and in the marker table. Active markers are indicated by a highlighted softkey.

By default, marker 1 is active and positioned on the maximum value (peak) of trace 1 as a normal marker. If several traces are displayed, the marker is set to the maximum value of the trace which has the lowest number and is not frozen (View mode). The next marker to be activated is set to the frequency of the next lower level (next peak) as a delta marker; its value is indicated as an offset to marker 1.

A marker can only be activated when at least one trace in the corresponding window is visible. If a trace is switched off, the corresponding markers and marker functions are also deactivated. If the trace is switched on again, the markers along with coupled functions are restored to their original positions, provided the markers have not been used on another trace.

7.4.1.3 Marker Results

Normal markers point to a sweep point on the time or frequency axis and display the associated numeric value for that sweep point. delta markers indicate an offset between the level at the delta marker position and the level at the position of the assigned reference marker, in dB. Signal count markers determine the frequency of a signal at the marker position very accurately.

The results can be displayed directly within the diagram area or in a separate table. By default, the first two active markers are displayed in the diagram area. If more markers are activated, the results are displayed in a marker table.

Marker information in diagram area

By default, the results of the last two markers or delta markers that were activated are displayed in the diagram area.

The following information is displayed there:

- The marker type (M for normal, D for delta, or special function name)
- The marker number (1 to 16)
- The assigned trace number in square brackets [ ]
- The marker value on the y-axis, or the result of the marker function
- The marker position on the x-axis

For n dB down markers, additional information is displayed, see "Measuring Characteristic Bandwidths (n dB Down Marker)" on page 443.

Marker information in marker table

In addition to the marker information displayed within the diagram area, a separate marker table may be displayed beneath the diagram. This table provides the following information for all active markers:

Type	Marker type: N (normal), D (delta), T (temporary, internal) and number
Dgr	Diagram number
Ref	Reference marker for delta markers
Trc	Trace to which the marker is assigned
X-value	X-value of the marker
Y-value	Y-value of the marker
Function	Activated marker or measurement function
Function Result	Result of the active marker or measurement function

7.4.1.4 Searching for Signal Peaks

A common task in spectrum analysis is determining peak values, i.e. maximum or minimum signal levels. The R&S FSW provides various peak search functions and applications:

- Setting a marker to a peak value once (Peak Search)
- Searching for a peak value within a restricted search area (Search Limits)
- Creating a marker table with all or a defined number of peak values for one sweep (Marker Peak List)
- Updating the marker position to the current peak value automatically after each sweep (Auto Peak Search)
- Creating a fixed reference marker at the current peak value of a trace (Peak Search)

Peak search limits

The peak search can be restricted to a search area. The search area is defined by limit lines which are also indicated in the diagram. In addition, a minimum value (threshold) can be defined as a further search condition.

When is a peak a peak? - Peak excursion

During a peak search, for example when a marker peak table is displayed, noise values may be detected as a peak if the signal is very flat or does not contain many peaks. Therefore, you can define a relative threshold ("Peak excursion"). The signal level must increase by the threshold value before falling again before a peak is detected. To avoid identifying noise peaks as maxima or minima, enter a peak excursion value that is higher than the difference between the highest and the lowest value measured for the displayed inherent noise.

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

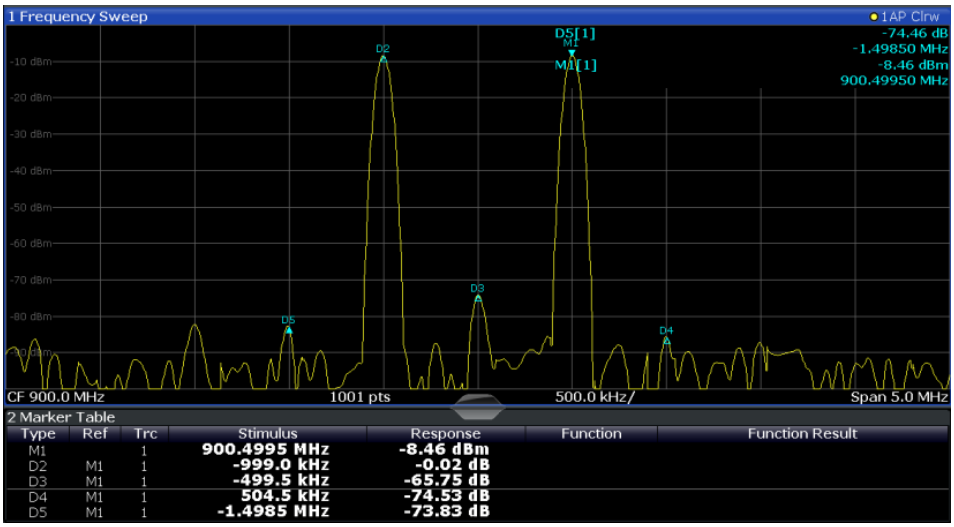


Fig. 7-11: Trace example

The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	30 dB
2	29.85 dB
3	20 dB
4	10 dB
5	18 dB

In order to eliminate the smaller peaks M3,M4 and M5 in the example above, a peak excursion of at least 20 dB is required. In this case, the amplitude must rise at least 20 dB before falling again before a peak is detected.

Marker peak list

The marker peak list determines the frequencies and levels of peaks in the spectrum. It is updated automatically after each sweep. How many peaks are displayed can be defined, as well as the sort order. In addition, the detected peaks can be indicated in the diagram. The peak list can also be exported to a file for analysis in an external application.

Automatic peak search

A peak search can be repeated automatically after each sweep in order to keep the maximum value as the reference point for a phase noise measurement. This is useful to track a drifting source. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting.

Using a peak as a fixed reference marker

Some results are analyzed in relation to a peak value, for example a carrier frequency level. In this case, the maximum level can be determined by an initial peak search and then be used as a reference point for further measurement results.

7.4.1.5 Special Marker Functions

In addition to basic markers, sophisticated marker functions are provided for special results such as noise or demodulation.

Performing a Highly Accurate Frequency Measurement (Signal Count)

A normal marker determines the position of the point on the trace and indicates the signal frequency at this position. The trace, however, contains only a limited number of points. Depending on the selected span, each trace point may contain many measurement values. Thus, the frequency resolution of each trace point is limited (see also chapter 6.5.1.8, "How Much Data is Measured: Sweep Points and Sweep Count", on page 366). Frequency resolution is further restricted by the RBW and sweep time settings.

In order to determine the frequency of a signal point accurately without changing the sweep settings, the R&S FSW is equipped with a signal counter. The signal counter sets the RF to the current marker position, then counts the zero crossings of the IF (thus the term signal *counter*) and derives the precise frequency value.

Signal counting can be performed explicitely at the current marker position ("Signal Count" marker function), or implicitely by the R&S FSW for certain functions.

Signal counting is only possible while the instrument is not sweeping. Thus, to perform a signal count for a marker, the sweep is stopped at the marker position. The frequency is determined with the desired resolution and then the sweep is allowed to continue.

Measuring Noise Density

Using the noise measurement marker function, the noise power density is measured at the position of the marker. In the time domain mode, all points of the trace are used to determine the noise power density. When measurements are performed in the frequency domain, two points to the right and left of the marker are used for the measurement to obtain a stable result.

Noise density is the noise referred to a bandwidth of 1 Hz. With logarithmic amplitude units (dBm, dBmV, dBmµV, dBµA), the noise power density is output in dBm/Hz, i.e. as level in 1 Hz bandwidth with reference to 1 mW. With linear amplitude units (V, A, W), the noise voltage density is analyzed in µV/Hz, the noise current density in µA/Hz or the noise power density in µW/Hz. The result is indicated as the noise marker value.

Prerequisite settings

The following settings have to be made to obtain correct values:

- Detector: Sample or RMS
- Video bandwidth:
  ≤ 0.1 resolution bandwidth with sample detector
  ≥ 3 x resolution bandwidth with RMS detector
- Trace averaging:
  In the default setting, the R&S FSW uses the sample detector for the noise function. With the sample detector, the trace can additionally be set to "Average" mode to stabilize the measured values. When the RMS detector is used, trace averaging should not be used since in this case it produces too low noise levels which cannot be corrected. Instead, the sweep time can be increased to obtain stable measurement results.

Correction factors

The R&S FSW uses the following correction factors to analyze the noise density from the marker level:

- Since the noise power is indicated with reference to 1 Hz bandwidth, the bandwidth correction value is deducted from the marker level. It is 10 x lg (1 Hz/BWNoise), where BWNoise is the noise or power bandwidth of the set resolution filter (RBW).
- RMS detector: With the exception of bandwidth correction, no further corrections are required since this detector already indicates the power for each point of the trace.
- Sample detector: As a result of video filter averaging and trace averaging, 1.05 dB is added to the marker level. This is the difference between the average value and the RMS value of white noise. With a logarithmic level axis, 1.45 dB is added additionally. Logarithmic averaging is thus fully taken into account which yields a value that is 1.45 dB lower than that of linear averaging.

- To allow a more stable noise display the adjacent (symmetric to the measurement frequency) points of the trace are averaged.
- For span > 0, the measured values are averaged versus time (after a sweep).

The R&S FSW noise figure can be calculated from the measured power density level. It is calculated by deducting the set RF attenuation (RF Att) from the displayed noise level and adding 174 to the result.

Measuring Phase Noise

Phase noise is unintentional modulation of a carrier; it creates frequencies next to the carrier frequency. A phase noise measurement consists of noise density measurements at defined offsets from the carrier; the results are given in relation to the carrier level (dBc). The phase noise marker function measures the noise power at the delta markers referred to 1 Hz bandwidth. Marker 1 is used as the reference for the phase noise measurement. By default, the current frequency and level of marker 1 are used as the fixed reference marker. However, a peak search can be started to use the current signal peak as the reference point, or a reference point can be defined manually.

Since the reference point is fixed, the reference level or the center frequency can be set so that the carrier is outside the displayed frequency range after phase noise measurement is started. Or a notch filter can be switched on to suppress the carrier.

Alternatively, the reference point can be determined automatically by a peak search after each sweep. This function can be used to track a drifting source during a phase noise measurement. The delta marker 2, which shows the phase noise measurement result, keeps the delta frequency value. Therefore the phase noise measurement leads to reliable results in a certain offset although the source is drifting. Only if the marker 2 reaches the border of the span, the delta marker value is adjusted to be within the span. In these cases, select a larger span.

The result of the phase noise measurement is the difference in level between the reference point and the noise power density. It is indicated as the function result of the phase noise marker.

The sample detector is automatically used and the video bandwidth set to 0.1 times the resolution bandwidth (RBW). The two settings are taken into account in the correction values used for the noise power measurement. To obtain stable results, two pixels on the right and the left of the delta marker position are taken for the measurement. The procedure for determining the noise power is identical to the method used for the noise power measurement (see "Measuring Noise Density" on page 441).

Using logarithmic scaling for the frequency axis allows for a large frequency range with fine resolution close to the carrier.

Defining a Fixed Reference Marker

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once posi-

tioned, the reference marker does not move during subsequent sweeps unless you explicitely move it manually.

Measuring Characteristic Bandwidths (n dB Down Marker)

When characterizing the shape of a signal, the bandwidth at a specified offset from its peak level is often of interest. The offset is specified as a relative decrease in amplitude of n dB. In order to measure this bandwidth, you could use several markers and delta markers and determine the bandwidth manually. However, using the n dB down marker function makes the task very simple and quick.

The n dB down marker function uses the current value of marker 1 as the reference point. It activates two temporary markers T1 and T2 located on the signal, whose level is n dB below the level of the reference point. Marker T1 is placed to the left and marker T2 to the right of the reference marker. The default setting for n is 3 dB, but it can be changed.

If a positive offset is entered, the markers T1 and T2 are placed below the active reference point. If a negative value is entered (for example for notch filter measurements), the markers T1 and T2 are placed above the active reference point.

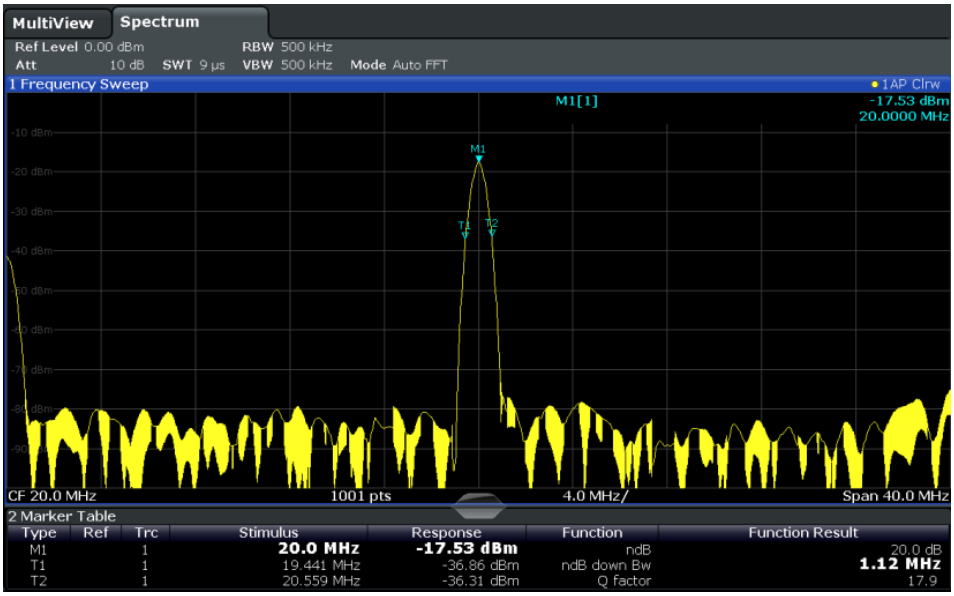


Fig. 7-12: n dB down marker function

The following marker function results are displayed:

Table 7-4: n dB down marker function results

Label	Description
M1	Current position and level of marker 1
ndB	Offset value (n dB down)
ndB down Bw / PWid	Determined bandwidth or pulse width (zero span) at the offset
Q-factor	Quality factor of the determined bandwidth (characteristic of damping or resonance)
T1, T2	Current position and level of the temporary markers

If the required position for the temporary markers cannot be determined uniquely, for example due to noise, dashes are displayed as a result.

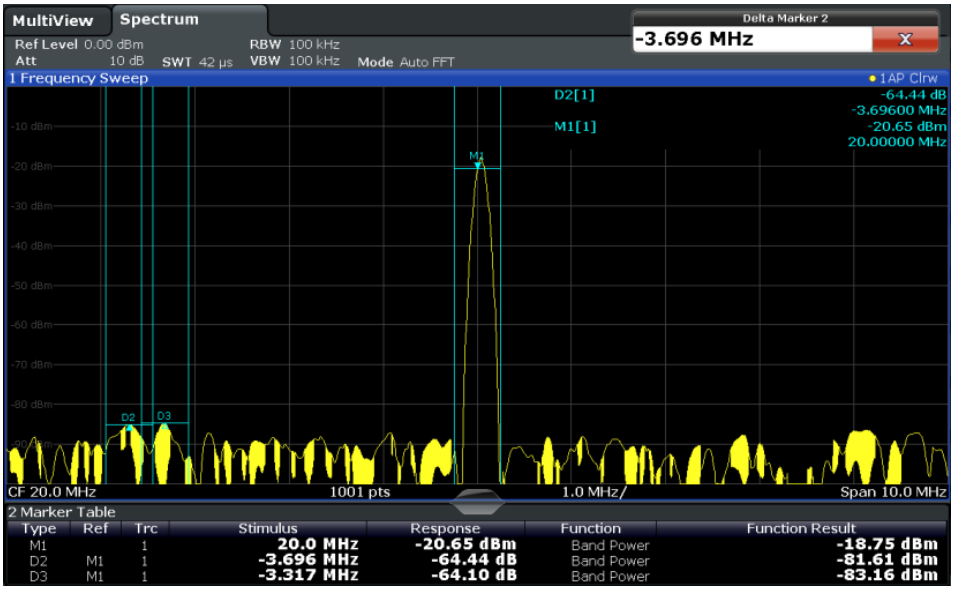
Measuring the Power in a Channel (Band)

When you want to determine the noise power in a transmission channel, you could use a noise marker and multiply the result with the channel bandwidth. However, the results would only be accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the marker table for each band power marker.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- - -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



All markers can be defined as band power markers, each with a different span. When a band power marker is activated, if no marker is active yet, marker 1 is activated. Otherwise, the currently active marker is used as a band power marker (all other marker functions for this marker are deactivated).

If the detector mode for the marker trace is set to "Auto", the RMS detector is used.

Demodulating Marker Values and Providing Audio Output

The R&S FSW provides demodulators for AM, FM and PM signals. The demodulation marker function sends the demodulated data at the current marker frequency to the audio

output. Thus, a displayed signal can be identified acoustically through the use of the internal loudspeaker or with headphones.

This function is not available for Spectrum Emission Mask measurements.

The sweep stops at the frequency determined by marker 1 for the selected time and the RF signal is demodulated in a bandwidth that corresponds to the RBW. Alternatively, demodulation can be activated continuously, i.e. audio output occurs regardless of the marker position and the marker stop time. For measurements in the time domain (zero span), demodulation is always continuous.

Optionally, a mimumum level ("Squelch level") can be defined so that the signal is only demodulated when it exceeds the set level. This is useful during continuous demodulation to avoid listening to noise.

The squelch function activates the video trigger function (see "Video" on page 385) and deactivates any other trigger or gating settings. The squelch level and trigger level are set to the same value. The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

7.4.2 Marker Configuration

When working with markers, the following configuration settings and functions are available:

7.4.2.1 Marker Settings

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

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

The remote commands required to define these settings are described in chapter 11.8.3.1, "Setting Up Individual Markers", on page 856.

Individual Marker Setup

Up to 17 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.

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

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 859
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 858

Marker Position (X-value)
Defines the position (x-value) of the marker in the diagram.

Remote command:
CALCulate<n>:MARKer<m>:X on page 860
CALCulate<n>:DELTamarker<m>:X on page 858

Frame (Spectrogram only)
Spectrogram frame the marker is assigned to.

Remote command:
CALCulate:MARKer<m>:SGRam:FRAMe on page 872

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 859
CALCulate<n>:DELTamarker<m>[:STATe] on page 858

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

If a fixed reference point is configured (see "Defining a Fixed Reference" on page 449), the reference point ("FXD") can also be selected instead of another marker.

Remote command:
CALCulate<n>:DELTamarker<m>:MREF on page 857

Linking to Another Marker
Links the current marker to the marker selected from the list of active markers. If the x-axis value of the inital marker is changed, the linked marker follows on the same x-position. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:
CALCulate<n>:MARKer<m1>:LINK:TO:MARKer<m2> on page 859
CALCulate<n>:DELTamarker<m1>:LINK:TO:MARKer<m2> on page 857
CALCulate<n>:DELTamarker<m>:LINK on page 856

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.

The marker can also be assigned to the currently active trace using the "Marker to Trace" softkey in the "Marker" menu.

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

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 859

Select Marker
Opens a dialog box to select and activate or deactivate one or more markers quickly.

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

All Markers Off
Deactivates all markers in one step.

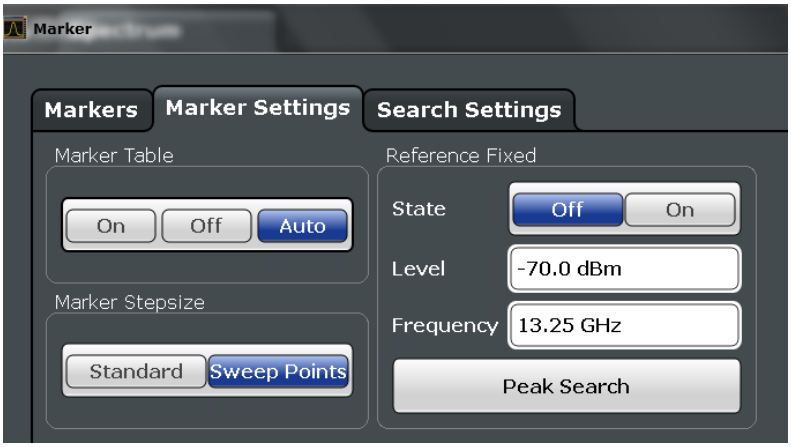
Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 859

General Marker Settings

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

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

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



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.

"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 860

Marker Stepsize
Defines the size of the steps that the marker position is moved using the rotary knob.

"Standard" The marker position is moved from pixel to pixel on the display. This is the default and 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.

Remote command:
`CALCulate:MARKer:X:SSIZe` on page 861

Defining a Fixed Reference
Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis.

When you set the "State" to "On", a vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value. The delta marker refers to the fixed reference marker.

If activated, the fixed reference marker ("FXD") can also be selected as a "Reference Marker" instead of another marker.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference marker.

Alternatively, a **Peak Search** can be performed to set the current maximum value of the trace assigned to marker 1 as the fixed reference marker.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y` on page 879
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X` on page 879
`CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK]` on page 879

7.4.2.2 Marker Search Settings and Positioning Functions

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

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

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

For more information on searching for signal peaks see chapter 7.4.1.4, "Searching for Signal Peaks", on page 438.

The remote commands required to define these settings are described in chapter 11.8.3.4, "Positioning the Marker", on page 864.

Marker Search Settings

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

For Spectrograms, special marker settings are available, see "Marker Search Settings for Spectrograms" on page 453.

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

- Press the MKR key, then select the "Marker Config" softkey. Then select the horizontal "Search Settings" tab.

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

Search Mode for Next Peak
Selects the search mode for the next peak search.

"Left" Determines the next maximum/minimum to the left of the current peak.

"Absolute" Determines the next maximum/minimum to either side of the current peak.

"Right" Determines the next maximum/minimum to the right of the current peak.

Remote command:
`CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 867
`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 865
`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 868
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 865
`CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 868
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 866
`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 868
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 866
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 868
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 866
`CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 869
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 867

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:MARKer:LOEXclude` on page 861

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

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 7.4.1.4, "Searching for Signal Peaks", on page 438.

Remote command:
`CALCulate<n>:MARKer:PEXCursion` on page 862

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

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

For EMI measurements, these functions are not available; use Automatic Peak Search instead (see chapter 5.13.4.2, "EMI Final Measurement Configuration", on page 263).

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 865
`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 866

Search Limits
The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 439.

Remote command:
`CALCulate:MARKer:X:SLIMits[:STATe]` on page 862
`CALCulate:MARKer:X:SLIMits:LEFT` on page 863
`CALCulate:MARKer:X:SLIMits:RIGHT` on page 863

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:THReshold` on page 864

Using Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom (see "Single Zoom" on page 402).

Remote command:
`CALCulate:MARKer:X:SLIMits:ZOOM[:STATe]` on page 863

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

Remote command:
`CALCulate:MARKer:X:SLIMits[:STATe]` on page 862
`CALCulate:THReshold:STATe` on page 864

Marker Search Settings for Spectrograms

Spectrograms show not only the current sweep results, but also the sweep history. Thus, when searching for peaks, you must define the search settings within a single time frame (x-direction) and within several time frames (y-direction).

These settings are only available for spectrogram displays.

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

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

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 865
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 865
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 866
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 866
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 866
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 867

Search Mode for Next Peak in Y Direction
Selects the search mode for the next peak search within all frames at the current marker position.

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

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

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

Remote command:
CALCulate:MARKer<m>:SGRam:Y:MAXimum:ABOVe on page 873
CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe on page 877
CALCulate:MARKer<m>:SGRam:Y:MAXimum:BELow on page 873
CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:BELow on page 877
CALCulate:MARKer<m>:SGRam:Y:MAXimum:NEXT on page 874
CALCulate:DELTamarker<m>:SGRam:Y:MAXimum:NEXT on page 877
CALCulate:MARKer<m>:SGRam:Y:MINimum:ABOVe on page 874
CALCulate:DELTamarker<m>:SGRam:Y:MINimum:ABOVe on page 878
CALCulate:MARKer<m>:SGRam:Y:MINimum:BELow on page 874
CALCulate:DELTamarker<m>:SGRam:Y:MINimum:BELow on page 878
CALCulate:MARKer<m>:SGRam:Y:MINimum:NEXT on page 874
CALCulate:DELTamarker<m>:SGRam:Y:MINimum:NEXT on page 878

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:MARKer<m>:SGRam:XY:MAXimum[:PEAK] on page 873
CALCulate:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK] on page 876
CALCulate:MARKer<m>:SGRam:XY:MINimum[:PEAK] on page 873
CALCulate:DELTamarker<m>:SGRam:XY:MINimum[:PEAK] on page 876
CALCulate:MARKer<m>:SGRam:Y:MAXimum[:PEAK] on page 874
CALCulate:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK] on page 877
CALCulate:MARKer<m>:SGRam:Y:MINimum[:PEAK] on page 875
CALCulate:DELTamarker<m>:SGRam:Y:MINimum[:PEAK] on page 878
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 865
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 868
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 867
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 869

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

"Visible" Only the visible frames are searched.

"Memory" All frames stored in the memory are searched.

Remote command:
CALCulate:MARKer:SGRam:SARea on page 873
CALCulate:DELTamarker<m>:SGRam:SARea on page 876

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:MARKer:LOEXclude` on page 861

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

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 7.4.1.4, "Searching for Signal Peaks", on page 438.

Remote command:
`CALCulate<n>:MARKer:PEXCursion` on page 862

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

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

For EMI measurements, these functions are not available; use Automatic Peak Search instead (see chapter 5.13.4.2, "EMI Final Measurement Configuration", on page 263).

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 865
`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 866

Search Limits
The search results can be restricted by limiting the search area or adding search conditions.

Search Limits (Left / Right) ← Search Limits
If activated, limit lines are defined and displayed for the search. Only results within the limited search range are considered.

For details on limit lines for searches see "Peak search limits" on page 439.

Remote command:
`CALCulate:MARKer:X:SLIMits[:STATe]` on page 862
`CALCulate:MARKer:X:SLIMits:LEFT` on page 863
`CALCulate:MARKer:X:SLIMits:RIGHT` on page 863

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:THReshold on page 864

Using Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom (see "Single Zoom" on page 402).

Remote command:
CALCulate:MARKer:X:SLIMits:ZOOM[:STATe] on page 863

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

Remote command:
CALCulate:MARKer:X:SLIMits[:STATe] on page 862
CALCulate:THReshold:STATe on page 864

Positioning Functions

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

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

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

Remote command:
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 865
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 868

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

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

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 865
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 868

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

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

Remote command:
`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 867
`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 869

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

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

Remote command:
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 866
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 868

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 762

Reference Level = Marker Level
Sets the reference level to the selected marker level.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:REFerence` on page 774

7.4.2.3 Marker Function Configuration

Special marker functions can be selected via the "Marker Function" dialog box.

To display this dialog box, do one of the following:

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

The remote commands required to define these settings are described in chapter 11.8.3, "Working with Markers", on page 855.

Precise Frequency (Signal Count) Marker

A special marker can be used to determine a particular frequency or time in a measured signal very accurately. Signal counters are configured in the "Signal Count Config" dialog box.

To display the "Signal Count Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Signal Count" button. Select the "Signal Count Config" softkey.

For details see "Performing a Highly Accurate Frequency Measurement (Signal Count)" on page 440

Signal counters are not available for measurements on I/Q-based data.

Signal Count Marker State
Activates or deactivates the special signal count marker function.

When activated, the sweep stops at the reference marker until the signal counter has delivered a result.

Remote command:
`CALCulate<n>:MARKer<m>:COUNt` on page 890
`CALCulate<n>:MARKer<m>:COUNt:FREQuency?` on page 890

Resolution
Defines the resolution with which the signal is analyzed around the reference marker 1.

Remote command:
`CALCulate<n>:MARKer<m>:COUNt:RESolution` on page 891

Noise Measurement Marker

For each of the 16 markers noise measurement can be activated. Noise measurement markers are configured in the "Noise Measurement Config" dialog box, using the "Noise Measurement" function.

The individual marker settings correspond to those defined in the "Marker" dialog box (see "Individual Marker Setup" on page 445). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Noise Measurement Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Noise Measurement" button. Select the "Noise Meas Config" softkey.

For details see "Measuring Noise Density" on page 441.

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 859
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 858

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 859
CALCulate<n>:DELTamarker<m>[:STATe] on page 858

Noise Measurement State
Activates or deactivates noise measurement for the marker in the diagram.

This function is only available for normal markers.

If activated, the marker displays the noise power density measured at the position of the marker.

For details see "Measuring Noise Density" on page 441.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] on page 883
CALCulate<n>:MARKer<m>:FUNCtion:NOISe:RESult? on page 883

Switching All Noise Measurements Off
Deactivates noise measurement for all markers.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:NOISe[:STATe] on page 883

Phase Noise Measurement Marker

For each of the 16 markers phase noise measurement can be activated. Phase noise measurement markers are configured in the "Phase Noise Config" dialog box, using the "Phase Noise" function.

The individual marker settings correspond to those defined in the "Marker" dialog box. Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Phase Noise Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Phase Noise" button. Select the "Phase Noise Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Phase Noise" button. Select the "Phase Noise Config" softkey.

For more information see "Measuring Phase Noise" on page 442.

Phase Noise Measurement State
Activates or deactivates phase noise measurement for the reference point in the diagram.

This function is only available for delta markers.

If activated, the delta markers display the phase noise measured at defined offsets from the reference position.

Remote command:
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe]` on page 884
`CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:RESult?` on page 884

Defining a Reference Point
Instead of using marker 1 as the reference marker, a fixed reference marker can be defined for phase noise measurement.

The "Level" and "Frequency" or "Time" settings define the position and value of the reference point.

Alternatively, a **Peak Search** can be performed to set the maximum value of the selected trace as the reference point.

If "Automatic Peak Search" is activated, a peak search is started automatically after each sweep and the result is used as the reference point.

Remote command:
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:Y on page 879
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:X on page 879
CALCulate<n>:DELTamarker<m>:FUNCtion:FIXed:RPOint:MAXimum[:PEAK] on page 879
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise:AUTO on page 884

Switching All Phase Noise Measurements Off
Deactivates phase noise measurement for all markers.

Remote command:
CALCulate<n>:DELTamarker<m>:FUNCtion:PNOise[:STATe] on page 884

n dB Down Marker

A special marker can be defined to determine a characteristic bandwidth or time span in a measured signal. n dB down markers are configured in the "N dB Down Config" dialog box, using the "n dB down" function.

To display the "N dB Down Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "n dB down" button. Select the "N dB Down Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "n dB down" button. Select the "N dB Down Config" softkey.

For details see "Measuring Characteristic Bandwidths (n dB Down Marker)" on page 443

n dB down Marker State
Activates or deactivates the special n dB down marker function.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:STATe on page 889
CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:RESult? on page 888

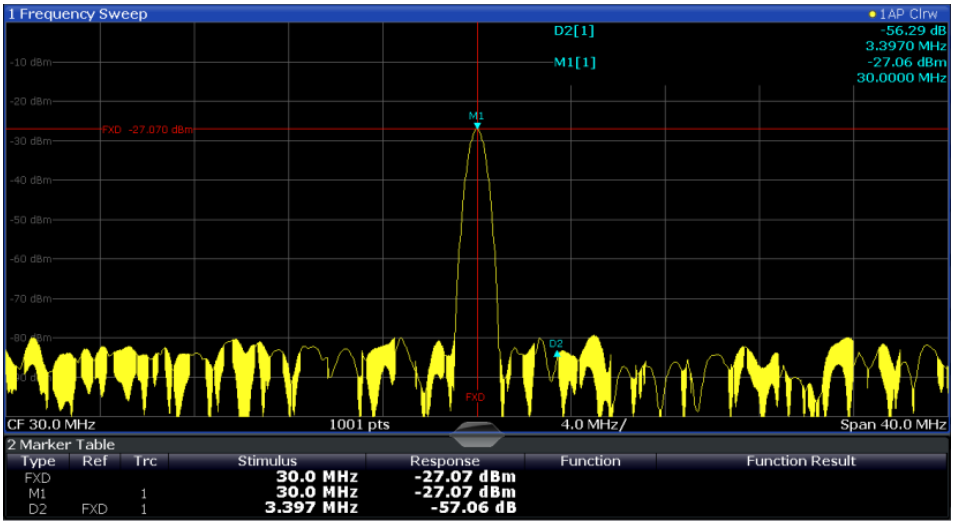
n dB down Delta Value
Defines the delta level from the reference marker 1 used to determine the bandwidth or time span.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:FREQuency?` on page 888
`CALCulate<n>:MARKer<m>:FUNCtion:NDBDown:TIME` on page 889

Reference Fixed

Instead of using a reference marker that may vary its position depending on the measurement results, a fixed reference marker can be defined for trace analysis. Once positioned, the reference marker does not move during subsequent sweeps unless you explicitely move it manually.

When you select this marker function, a vertical and a horizontal red display line are displayed, marked as "FXD". A normal marker is activated and set to the peak value and a delta marker to the next peak. The fixed reference marker is set to the position of the normal marker at the peak value. The delta marker refers to the fixed reference marker.



You can move the position of the fixed reference marker graphically by dragging the display lines, or numerically by entering values for the marker position and level.

For more information see chapter 7.4.3.2, "How to Use a Fixed Reference Marker", on page 471.

Band Power Marker

For each of the 16 markers band power measurement can be activated. Band power measurement markers are configured in the "Band Power Config" dialog box, using the "Band Power" function.

The individual marker settings correspond to those defined in the "Marker" dialog box (see "Individual Marker Setup" on page 445). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.

To display the "Band Power Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Band Power" button. Select the "Band Power Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Band Power" button. Select the "Band Power Config" softkey.

For more information see "Measuring the Power in a Channel (Band)" on page 444.

Band Power Measurement State
Activates or deactivates band power measurement for the marker in the diagram.

Band power markers are only available for standard frequency measurements (not zero span) in the Spectrum application.

If activated, the markers display the power or density measured in the band around the current marker position.

For details see "Measuring the Power in a Channel (Band)" on page 444.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 886

Span
Defines the span (band) around the marker for which the power is measured. The span is indicated by lines in the diagram.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN on page 886

Power Mode
Defines the mode of the power measurement result.

"Power" The result is an absolute power level displayed in dBm.

"Density" The result is a power level in relation to the bandwidth, displayed in dBm/Hz.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE on page 885

Switching All Band Power Measurements Off
Deactivates band power measurement for all markers.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] on page 886

Marker Demodulation

A special marker can be used to demodulate the signal at a particular position and send the result to the audio output. Marker Demodulation is configured in the "Marker Demod Config" dialog box, using the "Marker Demodulation" function.

To display the "Marker Demod Config" dialog box, do one of the following:

- Press the MKR FUNC key, then select the "Select Marker Function" softkey. Then select the "Marker Demodulation" button. Select the "Marker Demod Config" softkey.
- In the "Overview", select "Analysis", and switch to the vertical "Marker Function Config" tab. Then select the "Marker Demodulation" button. Select the "Marker Demod Config" softkey.

This function is not available for Spectrum Emission Mask measurements or measurements on I/Q-based data.

For details see "Demodulating Marker Values and Providing Audio Output" on page 444.

Marker Demodulation State
Activates or deactivates the demodulation output.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation[:STATe]` on page 892

Continuous Demodulation
If activated, the signal is demodulated continuously (not only at the marker position) and sent to the audio output. This allows you to monitor the frequency range acoustically (assuming the sweep time is long enough).

For zero span and EMI measurements, demodulation is always active continuously.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:CONTinuous` on page 891

Marker Stop Time
Defines how long the sweep is stopped at the marker position to output the demodulated signal.

For zero span measurements, demodulation is always active continuously, regardless of the marker stop time.

For EMI measurements, the duration of the demodulation at each marker position is limited by the dwell time of the EMI measurement marker (see "Dwell Time" on page 264).

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:HOLDoff` on page 892

Modulation
Defines the demodulation mode for output (AM/FM). The default setting is AM.

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:DEModulation:SELect` on page 892

Squelch
Activates or deactivates the squelch function. If activated, the audible AF is cut off below a defined threshold level. Thus, you avoid hearing noise at the audio output when no signal is available.

The squelch function activates the video trigger function (see "Video" on page 385) and deactivates any other trigger or gating settings. The squelch level and trigger level are set to the same value.

The trigger source in the channel bar is indicated as "SQL" for squelch. The squelch level is indicated by a red line in the diagram.

Remote command:
`[SENSe:]DEMod:SQUelch[:STATe]` on page 893

Squelch level
Defines the level threshold below which the audible AF is cut off if squelching is enabled. The video trigger level is set to the same value.

The squelch level is indicated by a red line in the diagram.

Remote command:
`[SENSe:]DEMod:SQUelch:LEVel` on page 893

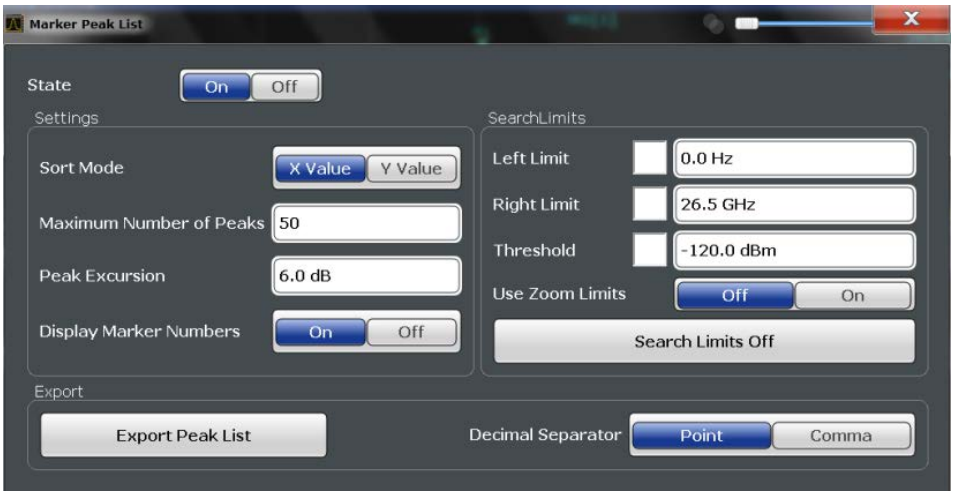
Marker Peak List Configuration

The marker peak list provides an overview of all marker peaks in the measurement. You can define search and sort criteria to influence the results of the analysis. The general marker search settings also apply to the marker peak list (see "Marker Search Settings" on page 450).

For more information see chapter 7.4.1.4, "Searching for Signal Peaks", on page 438.

To display the "Marker Peak List" dialog, do one of the following:

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



Peak List State
Activates/deactivates the marker peak list. If activated, the peak list is displayed and the peaks are indicated in the trace display.

For each listed peak the frequency/time ("X-value") and level ("Y-value") values are given.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STAT on page 882

Sort Mode
Defines whether the peak list is sorted according to the x-values or y-values. In either case the values are sorted in ascending order.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT on page 881

Maximum Number of Peaks
Defines the maximum number of peaks to be determined and displayed.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE on page 881

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

Entries from 0 dB to 80 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 6 dB.

For more information see chapter 7.4.1.4, "Searching for Signal Peaks", on page 438.

Remote command:
CALCulate<n>:MARKer:PEXCursion on page 862

Displaying Marker Numbers
By default, the marker numbers are indicated in the diagram so you can find the peaks from the list. However, for large numbers of peaks the marker numbers may decrease readability; in this case, deactivate the marker number display.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] on page 880

Exporting the Peak List
The peak list can be exported to an ASCII file (.DAT) for analysis in an external application.

Remote command:
MMEMory:STORe:LIST on page 926
FORMat:DEXPort:DSEParator on page 906

Deactivating All Marker Functions

All special marker functions can be deactivated in one step.

Use the "All Functions Off" button in the "Marker Functions" dialog box.

7.4.3 How to Work With Markers

The following step-by-step instructions demonstrate in detail how to work with markers.

7.4.3.1 How to Analyze a Signal Point in Detail

Step-by-step instructions on working with markers are provided here. For details on individual functions and settings see chapter 7.4.2.1, "Marker Settings", on page 445.

The remote commands required to perform these tasks are described in chapter 11.8.3, "Working with Markers", on page 855.

When you need to analyze a characteristic point in the signal in more detail, the following procedure can be helpful:

1. Perform a peak search to determine the characteristic point roughly by pressing the PEAK SEARCH key.
2. If the required signal point is not the maximum, continue the peak search to one of the subsequent maxima or minima:
   a) Press the MKR -> key.
   b) Select the "Next Peak" or "Next Min" key.
   c) If necessary, change the search settings by selecting the "Search Config" softkey.
3. Center the display around the determined signal point by setting the marker value to the center frequency. Select the "Center = Mkr Freq" softkey.
4. Determine the precise frequency of the signal point:
   a) Select the "Select Marker Function" softkey.
   b) Select the "Signal Count" button.
   c) Select the "Signal Count Resolution" softkey.
   d) Select the resolution depending on how precise the result needs to be.

7.4.3.2 How to Use a Fixed Reference Marker

By default, delta markers refer to marker 1. However, they can also refer to a fixed reference marker.

How to Define and Move a Fixed Reference Marker

1. To display a fixed reference marker, do one of the following:
   - Press the MKR FUNC key, then select the "Reference Fixed" marker function.
   - In the "Marker" dialog box, in the "Reference Fixed" area of the "Marker Config" tab, set the "State" to "On".

A vertical and a horizontal red display line are displayed, marked as "FXD". The normal marker 1 is activated and set to the peak value of the trace assigned to marker 1, and a delta marker to the next peak. The fixed reference marker is set to the position of marker 1 at the peak value.

2. To move the fixed reference marker, do one of the following:
   - Change the "Level" and "Frequency" of the reference point in the "Marker Config" tab of the "Marker" dialog box, . By default, the current peak value of trace 1 is set.
   - Set the fixed reference marker to the current peak value by selecting the "Peak Search" button in the "Marker Config" tab of the "Marker" dialog box.
   - Move the "FXD" display lines that define the position of the fixed reference marker by dragging them on the screen.

How to Assign a Fixed Reference Marker to Delta Markers

1. In the "Marker" dialog box, select the horizontal "Markers" tab.
2. For the active delta marker that is to refer to the fixed reference marker, select "FXD" from the "Ref. Marker" list.

   The delta marker indicates the offset of the current trace value at the marker position from the fixed reference value.

7.4.3.3 How to Output the Demodulated Signal Accoustically

For long sweep times you may wish to monitor a measurement accoustically rather than visually to determine when a certain signal level is reached.

CAUTION

Risk of hearing damage

To protect your hearing, make sure that the volume setting is not too high before putting on the headphones.

1. Set marker 1 to the signal level you want to monitor.
2. Press the MKR FUNCT key.
3. Select the "Select Marker Function" softkey.
4. Select the "Marker Demodulation" button.
5. Select the "Marker Demod Config" softkey.

   The marker function results are determined immediately according to the default settings.
6. Define how long you want to hear the output signal when the marker value is reached by entering the duration in the "Marker Stop Time" field.

Alternatively, the audio signal can be output continuously, regardless of the marker value; in this case, set "Continuous Demodulation" to "On".

7. Select the modulation type (AM/FM/PM) of the signal.
8. To avoid listening to noise during continuous output, set "Squelch" to "On" and define the signal level below which the signal is ignored ("Squelch level").
9. Set "Marker Demodulation" to "On".
10. Plug your headphones into the PHONES connector on the front panel of the R&S FSW.
11. Adjust the volume using the rotary knob next to the PHONES connector.

    During the next or currently running measurement, when the sweep reaches the marker position, the demodulated signal is output as an audio signal via the headphones for the given duration. Or, depending on the configuration, the demodulated signal is continuously output via the headphones, if the signal level exceeds the squelch level.

7.4.4 Measurement Example: Measuring Harmonics Using Marker Functions

This measurement example describes how to measure harmonics using the provided marker functions. Note that this task can be performed much simpler using the Harmonic Distortion measurement (see chapter 5.9, "Harmonic Distortion Measurement", on page 227).

Signal generator settings (e.g. R&S FSW SMU):

Frequency:	128 MHz
Level:	- 25 dBm

Procedure:

1. Preset the R&S FSW.
2. Set the center frequency to *128 MHz*.
3. Set the span to *100 kHz*.

   The R&S FSW displays the reference signal with a span of 100 kHz and resolution bandwidth of 1 kHz.
4. Switch on the marker by pressing the MKR key.
   The marker is positioned on the trace maximum.
5. Set the measured signal frequency and the measured level as reference values:
   a) Press the MKR FUNC key
   b) Press the "Reference Fixed" softkey.

The position of the marker becomes the reference point. The reference point level is indicated by a horizontal line, the reference point frequency with a vertical line. At the same time, the delta marker 2 is switched on.

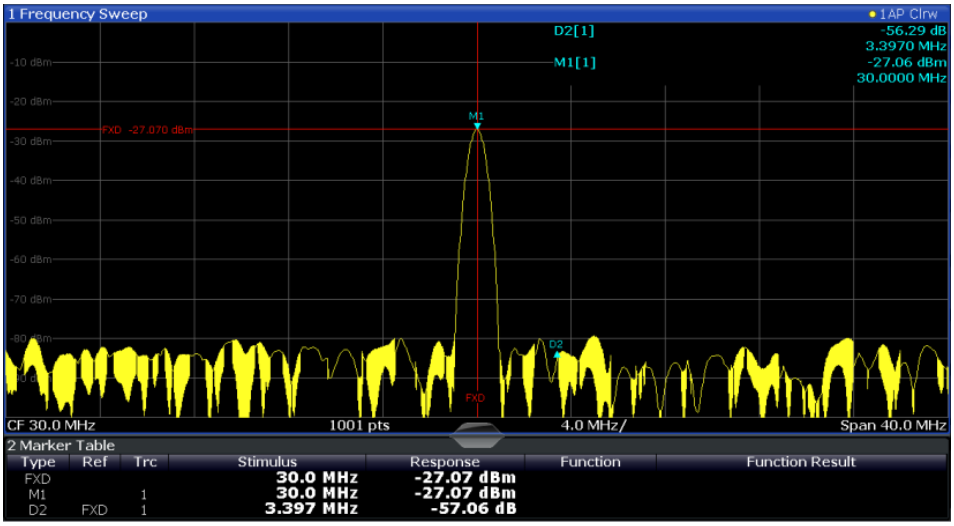


Fig. 7-13: Fundamental wave and the frequency and level reference point

6. Make the step size for the center frequency correspond to the signal frequency: in the "Frequency" configuration dialog box, select "Center Frequency Stepsize = Marker".

   The step size for the center frequency is now equal to the marker frequency.

7. Move the center frequency to the 2nd harmonic of the signal by pressing the UP (⇧) key on the front panel.

   The center frequency is set to the 2nd harmonic.

8. Place the delta marker on the 2nd harmonic: in the "Marker To" menu, select the "Peak" softkey.

   The delta marker moves to the maximum of the 2nd harmonic. The displayed level result is relative to the reference point level (= fundamental wave level).

The other harmonics are measured by repeating steps step 7 and step 8, with the center frequency being incremented or decremented in steps of 128 MHz using the UP or DOWN keys.

7.5 Display and Limit Lines

Display and limit lines help you analyze a measurement trace.

7.5.1 Basics on Display Lines

Display lines help you analyze a trace – as do markers. The function of a display line is comparable to that of a ruler that can be shifted on the trace in order to mark absolute values. They are used exclusively to visually mark relevant frequencies or points in time (zero span), as well as constant level values. It is not possible to check automatically whether the points are below or above the marked level values - use limit lines for that task (see chapter 7.5.2, "Basics on Limit Lines", on page 475).

Two different types of display lines are provided:

- Two horizontal level lines for marking levels – Display Line 1 and 2
  The level lines are continuous horizontal lines across the entire width of a diagram and can be shifted in y direction.
- Two vertical frequency or time lines for marking frequencies or points in time – Frequency/Time Line 1 and 2
  The frequency or time lines are continuous vertical lines across the entire height of the diagram and can be shifted in x direction.

Lables

Each line is identified by one of the following abbreviations in the diagrams:

- D1: Display Line 1
- D2: Display Line 2
- F1: Frequency Line 1
- F2: Frequency Line 2
- T1: Time Line 1
- T2: Time Line 2

7.5.2 Basics on Limit Lines

Limit lines are used to define amplitude curves or spectral distribution boundaries in the result diagram which are not to be exceeded. They indicate, for example, the upper limits for interference radiation or spurious waves which are allowed from a device under test (DUT). When transmitting information in TDMA systems (e.g. GSM), the amplitude of the bursts in a time slot must adhere to a curve that falls within a specified tolerance band. The lower and upper limits may each be specified by a limit line. Then, the amplitude curve can be controlled either visually or automatically for any violations of the upper or lower limits (GO/NOGO test).

The R&S FSW supports limit lines with a maximum of 200 data points. Eight of the limit lines stored in the instrument can be activated simultaneously. The number of limit lines stored in the instrument is only limited by the capacity of the storage device used.

Compatibility

Limit lines are compatible with the current measurement settings, if the following applies:

- The x unit of the limit line has to be identical to the current setting.

- The y unit of the limit line has to be identical to the current setting with the exception of dB based units; all dB based units are compatible with each other.

Validity

Only limit lines that fulfill the following conditions can be activated:

- Each limit line must consist of a minimum of 2 and a maximum of 200 data points.
- The frequencies/times for each data point must be defined in ascending order; however, for any single frequency or time, two data points may be entered (to define a vertical segment of a limit line).
- Gaps in frequency or time are not allowed. If gaps are desired, two separate limit lines must be defined and then both enabled.
- The entered frequencies or times need not necessarily be selectable in R&S FSW. A limit line may also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range representation, negative times may also be entered. The allowed range is -1000 s to +1000 s.

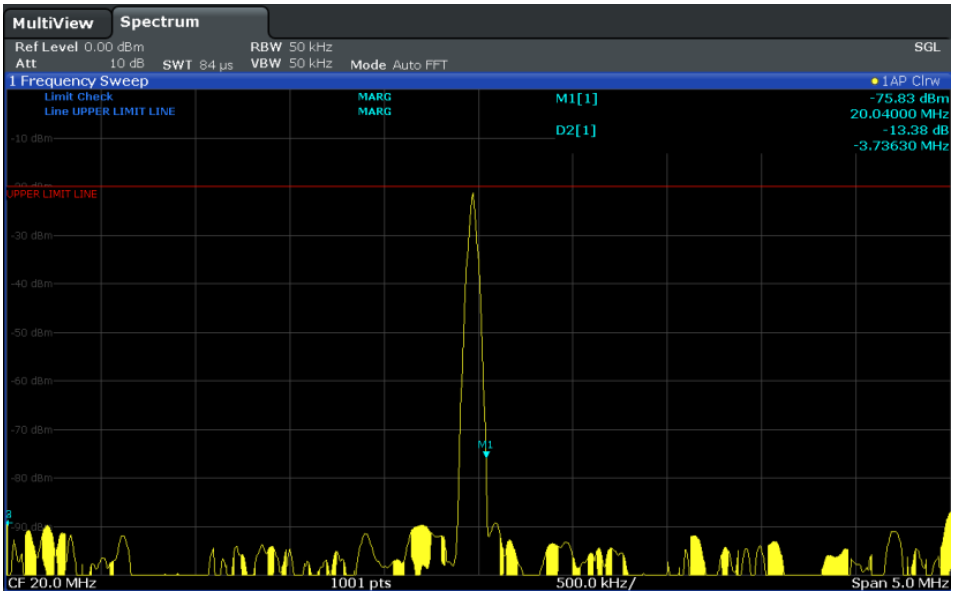


Fig. 7-14: Example for an upper limit line

Limits and Margins

Limit lines define strict values that must not be exceeded by the measured signal. A **margin** is similar to a limit, but less strict and it still belongs to the valid data range. It can be used as a warning that the limit is almost reached. The margin is not indicated by a separate line in the display, but if it is violated, a warning is displayed. Margins are defined as lines with a fixed distance to the limit line.

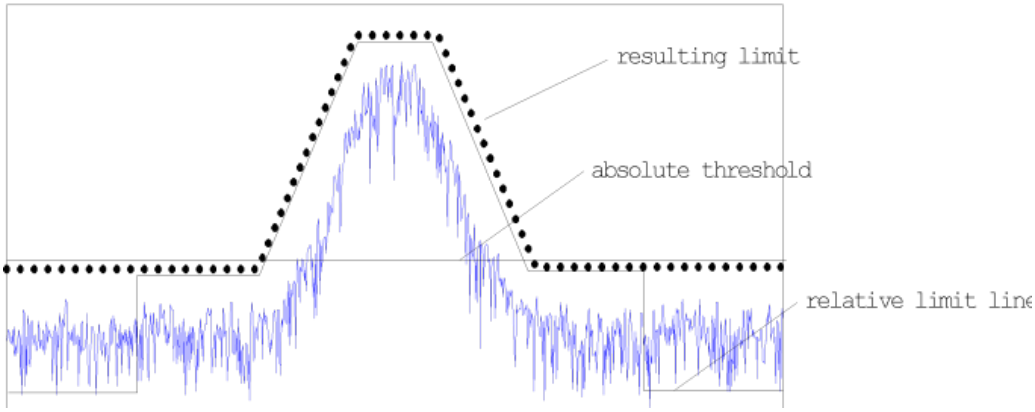
To check the signal for maximum levels you must define an **upper limit**, whereas to check the signal for minimum levels you must define a **lower limit**.

Limits can be defined relative to the reference level, the beginning of the time scale, or the center frequency, or as absolute values.

Relative scaling is suitable, for example, if masks for bursts are to be defined in zero span, or if masks for modulated signals are required in the frequency domain.

Thresholds

If the y-axis for the limit line data points uses relative scaling, an additional absolute **threshold** can be defined for the limit check. In this case, both the threshold value and the relative limit line must be exceeded before a violation occurs.



Offsets and Shifting

A configured limit line can easily be moved vertically or horizontally. Two different methods to do so are available:

- An **offset** moves the entire line in the diagram without editing the configured values or positions of the individual data points. This option is only available if relative scaling is used.
  Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally or vertically.
- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

Limit Check Results

A limit check is automatically performed as soon as any of the limit lines is activated ("Visibility" setting). Only the specified "Traces to be Checked" are compared with the active limit lines. The status of the limit check for each limit line is indicated in the diagram. If a violation occurs, the limit check status is set to "MARG" for a margin violation, or to"FAIL" for a limit violation.

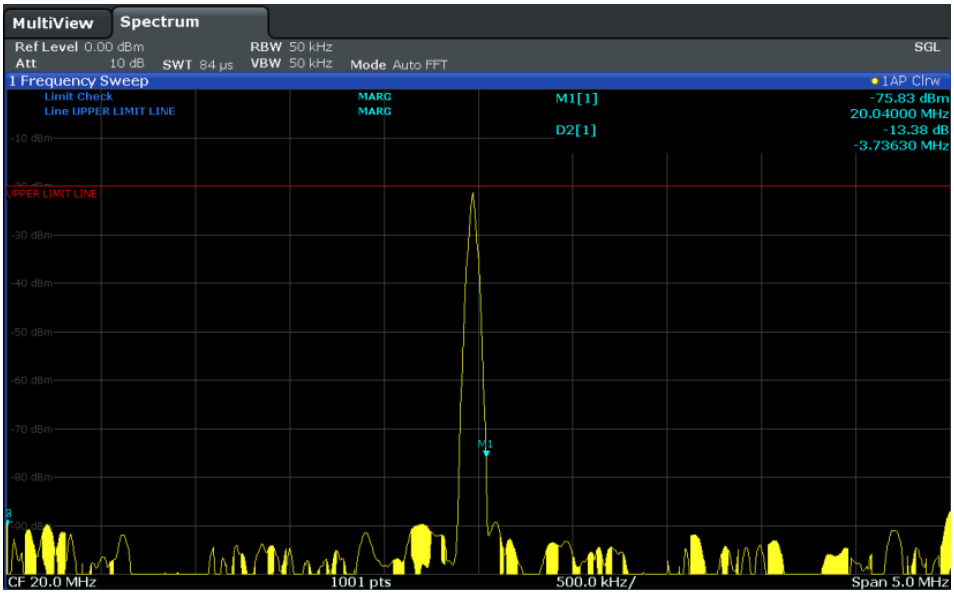


Fig. 7-15: Margin violation for limit check

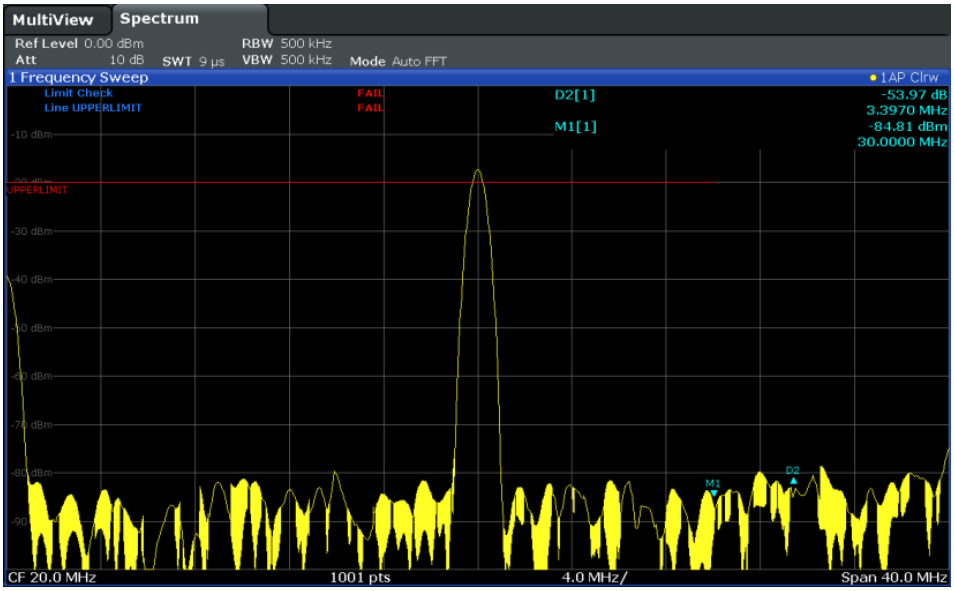


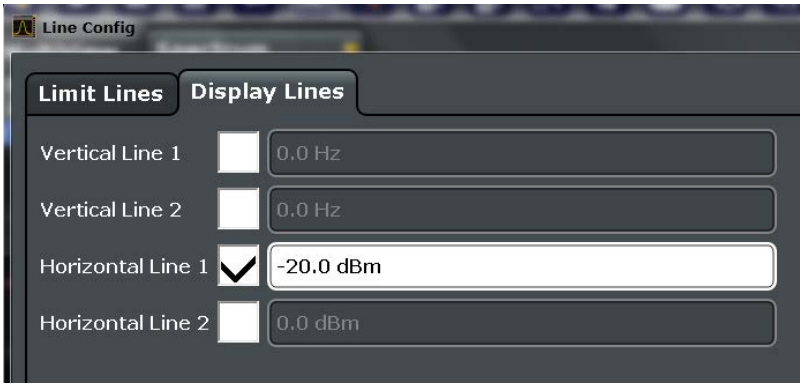
Fig. 7-16: Limit violation for limit check

7.5.3 Settings and Functions for Display and Limit Lines

For remote operation, see chapter 11.8.4, "Configuring Display and Limit Lines", on page 893.

7.5.3.1 Display Line Settings

Two vertical and two horizontal lines can be defined in the display.



Vertical Line 1/2
Activates a vertical display line (F1/F2 or T1/T2) in the diagram at the specified frequency or point in time, depending on the frequency span.

Remote command:
`CALCulate<n>:FLINe<k>` on page 894
`CALCulate<n>:FLINe<k>` on page 894
`CALCulate<n>:TLINe<Line>` on page 895
`CALCulate<n>:TLINe<Line>` on page 895

Horizontal Line 1/2
Activates a horizontal display line (D1/D2) in the diagram at the specified level.

Remote command:
`CALCulate<n>:DLINe<k>` on page 894
`CALCulate<n>:DLINe<k>` on page 894

7.5.3.2 Limit Line Settings and Functions

Up to 8 limit lines can be displayed simultaneously in the R&S FSW. Many more can be stored on the instrument.

Limit Line Management

Limit lines are managed in the "Line Config" dialog box which is displayed when you press the LINES key and then "Lines Config" softkey.

For the limit line overview, the R&S FSW searches for all stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder. The overview allows you to determine which limit lines are available and can be used for the current measurement.

For details on settings for individual lines see "Limit Line Details" on page 482.

For more basic information on limit lines see chapter 7.5.2, "Basics on Limit Lines", on page 475.

Name
The name of the stored limit line.

Unit
The unit in which the y-values of the data points of the limit line are defined.

Compatibility
Indicates whether the limit line definition is compatible with the current measurement settings.

For more information on which conditions a limit line must fulfill to be compatible, see chapter 7.5.2, "Basics on Limit Lines", on page 475.

Visibility
Displays or hides the limit line in the diagram. Up to 8 limit lines can be visible at the same time. Inactive limit lines can also be displayed in the diagram.

Remote command:
`CALCulate:LIMit<k>:LOWer:STATe` on page 899
`CALCulate:LIMit<k>:UPPer:STATe` on page 902
`CALCulate:LIMit:ACTive?` on page 903

Traces to be Checked
Defines which traces are automatically checked for conformance with the limit lines. As soon as a trace to be checked is defined, the assigned limit line is active. One limit line can be activated for several traces simultaneously. If any of the "Traces to be Checked" violate any of the active limit lines, a message is indicated in the diagram.

Remote command:
`CALCulate:LIMit<k>:TRACe<t>:CHECk` on page 904

Comment
An optional description of the limit line.

Included Lines in Overview (View Filter)
Defines which of the stored lines are included in the overview.

"Show compatible"	Only compatible lines Whether a line is compatible or not is indicated in the Compatibility setting.
"Show all"	All stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder (if not restricted by "Show lines for all modes" setting).

Show lines for all modes
If activated (default), limit lines from all applications are displayed. Otherwise, only lines that were created in the Spectrum application are displayed.

Note that limit lines from some applications may include additional properties that are lost when the limit lines are edited in the Spectrum application. In this case a warning is displayed when you try to store the limit line.

X-Offset
Shifts a limit line that has been specified for relative frequencies or times (x-axis) horizontally.

This setting does not have any effect on limit lines that are defined by absolute values for the x-axis.

Remote command:
CALCulate:LIMit<k>:CONTrol:OFFSet on page 897

Y-Offset
Shifts a limit line that has relative values for the y-axis (levels or linear units such as volt) vertically.

This setting does not have any effect on limit lines that are defined by absolute values for the y-axis.

Remote command:
CALCulate:LIMit<k>:LOWer:OFFSet on page 898
CALCulate:LIMit<k>:UPPer:OFFSet on page 901

Create New Line
Creates a new limit line.

Edit Line
Edit an existing limit line configuration.

Copy Line
Copy the selected limit line configuration to create a new line.

Remote command:
CALCulate:LIMit<k>:COPY on page 903

Delete Line
Delete the selected limit line configuration.

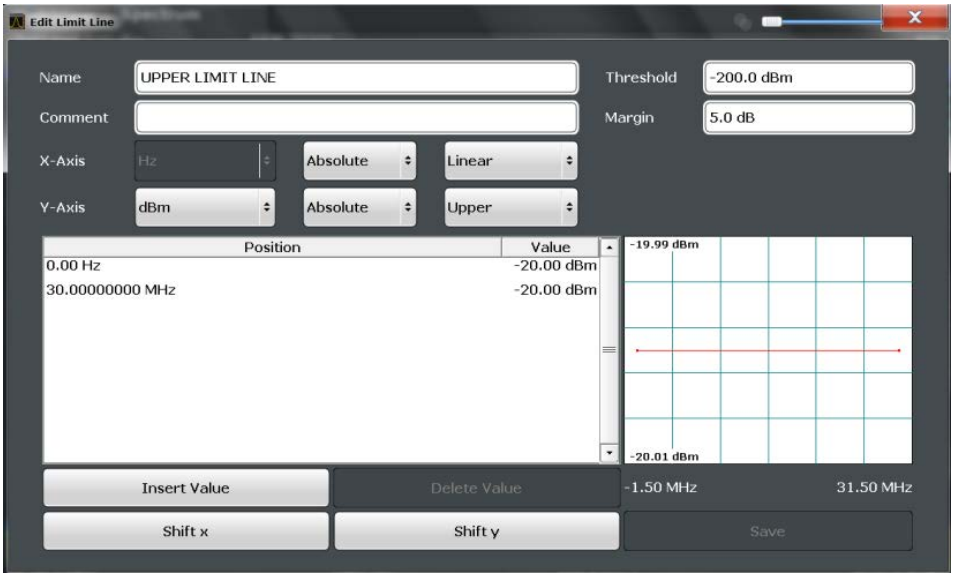
Remote command:
CALCulate:LIMit<k>:DELete on page 903

Disable All Lines
Disable all limit lines in one step.

Remote command:
CALCulate:LIMit<k>:STATe on page 903

Limit Line Details

Limit lines details are configured in the "Edit Line Line" dialog box which is displayed when you select the "New", "Edit" or "Copy To" buttons in the "Line Config" dialog box.



Name
Defines the limit line name. All names must be compatible with Windows conventions for file names. The limit line data is stored under this name (with a `.LIN` extension).

Remote command:
`CALCulate:LIMit<k>:NAME` on page 900

Comment
Defines an optional comment for the limit line. The text may contain up to 40 characters.

Remote command:
`CALCulate:LIMit:COMMent` on page 896

Threshold
Defines an absolute threshold value (only for relative scaling of the y-axis).

For details on thresholds see chapter 7.5.2, "Basics on Limit Lines", on page 475.

Remote command:
`CALCulate:LIMit<k>:LOWer:THReshold` on page 899
`CALCulate:LIMit<k>:UPPer:THReshold` on page 902

Margin
Defines a margin for the limit line. The default setting is 0 dB (i.e. no margin).

For details on margins see chapter 7.5.2, "Basics on Limit Lines", on page 475.

Remote command:
`CALCulate:LIMit<k>:LOWer:MARGin` on page 898
`CALCulate:LIMit<k>:UPPer:MARGin` on page 901

X-Axis
Describes the horizontal axis on which the data points of the limit line are defined. Includes the following settings:

- Domain:
  – "Hz": for frequency domain
  – "s": for time domain
- Scaling mode: absolute or relative (Hz/s/%) values
  For relative values, the frequencies are referred to the currently set center frequency. In the zero span mode, the left boundary of the diagram is used as the reference.
- Scaling: linear or logarithmic

Remote command:
`CALCulate:LIMit<k>:LOWer:SPACing` on page 899
`CALCulate:LIMit<k>:UPPer:SPACing` on page 902
`CALCulate:LIMit<k>:LOWer:MODE` on page 898
`CALCulate:LIMit<k>:UPPer:MODE` on page 901
`CALCulate:LIMit<k>:CONTrol:DOMain` on page 896

Y-Axis
Describes the vertical axis on which the data points of the limit line are defined. Includes the following settings:

- Level unit
- Scaling mode: absolute or relative (dB/%) values
  Relative limit values refer to the reference level.
- Limit type: upper or lower limit; values must stay above the lower limit and below the upper limit to pass the limit check

Remote command:
`CALCulate:LIMit<k>:UNIT` on page 900
`CALCulate:LIMit<k>:LOWer:SPACing` on page 899
`CALCulate:LIMit<k>:UPPer:SPACing` on page 902

Data points
Each limit line is defined by a minimum of 2 and a maximum of 200 data points. Each data point is defined by its position (x-axis) and value (y-value). Data points must be defined in ascending order. The same position can have two different values.

Remote command:
`CALCulate:LIMit<k>:CONTrol[:DATA]` on page 896
`CALCulate:LIMit<k>:LOWer[:DATA]` on page 898
`CALCulate:LIMit<k>:UPPer[:DATA]` on page 900

Insert Value
Inserts a data point in the limit line above the selected one in the "Edit Limit Line" dialog box.

Delete Value
Deletes the selected data point in the "Edit Limit Line" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "X-Offset" on page 481).

Remote command:
`CALCulate:LIMit<k>:CONTrol:SHIFt` on page 897

Shift y
Shifts the y-value of each data point vertically by the defined shift width (as opposed to an additive offset defined for the entire limit line, see "Y-Offset" on page 482).

Remote command:
`CALCulate:LIMit<k>:LOWer:SHIFt` on page 899
`CALCulate:LIMit<k>:UPPer:SHIFt` on page 901

Save
Saves the currently edited limit line under the name defined in the "Name" field.

7.5.4 How to Work with Display and Limit Lines

Step-by-step instructions on configuring display and limit lines are provided here. For details on individual functions and settings see chapter 7.5.3, "Settings and Functions for Display and Limit Lines ", on page 478.

The remote commands required to perform these tasks are described in chapter 11.8.4, "Configuring Display and Limit Lines", on page 893.

7.5.4.1 Defining Display Lines

1. Display lines are configured in the "Lines Config" dialog box. To display this dialog box, press the LINES key and then "Lines Config".
2. Select the "Display Lines" tab.
3. To define a vertical line, select "Vertical Line 1" or 2 and enter the x-value at which the line is to be displayed.
   To define a horizontal line, select "Horizontal Line 1" or 2 and enter the y-value at which the line is to be displayed.

7.5.4.2 Defining Limit Lines

Limit lines are configured in the "Lines Config" dialog box. To display this dialog box, do one of the following:

- Press the LINES key and then the "Lines Config" softkey, then select the "Lines Config" tab.
- In the "Overview", select "Analysis" and then the vertical "Limit Lines Config" tab.

Limit lines for spurious and SEM measurements

Note that for spurious and SEM measurements, special limit lines can be defined for each frequency range, see chapter 5.5.4.2, "Limit Lines in SEM Measurements", on page 169 and chapter 5.6.3.2, "Limit Lines in Spurious Measurements", on page 198. It is strongly recommended that you define limits only via the "Sweep list" dialog for these measurements, not using the LINES key.

Any changes to the special limit lines are automatically overwritten when the sweep list settings are changed.

The following tasks are described here:

How to find compatible limit lines

► In the "Line Config" dialog box, select the "View filter" option: "Show compatible".

All stored limit lines with the file extension `.LIN` in the `limits` subfolder of the main installation folder of the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a limit check

A limit check is automatically performed as soon as any of the limit lines is activated.

1. To activate a limit check:
   Select the "Check Traces" setting for a limit line in the overview and select the trace numbers to be included in the limit check. One limit line can be assigned to several traces.

   The specified traces to be checked are compared with the active limit lines. The status of the limit check is indicated in the diagram.
2. To deactivate a limit line, deactivate all "Traces to check" for it.
   To deactivate all limit lines at once, select the "Disable All Lines" button.

The limit checks for the deactivated limit lines are stopped and the results are removed form the display.

How to edit existing limit lines

Existing limit line configurations can be edited.

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Edit" button.
3. Edit the line configuration as described in "How to configure a new limit line" on page 487.
4. Save the new configuration by selecting the "Save" button.

   If the limit line is active, the edited limit line is displayed in the diagram.

How to copy an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Copy To" button.
3. Define a new name to create a new limit with the same configuration as the source line.
4. Edit the line configuration as described in "How to configure a new limit line" on page 487.
5. Save the new configuration by selecting the "Save" button.

   The new limit line is displayed in the overview and can be activated.

How to delete an existing limit line

1. In the "Line Config" dialog box, select the limit line.
2. Select the "Delete" button.
3. Confirm the message.

   The limit line and the results of the limit check are deleted.

How to configure a new limit line

1. In the "Line Config" dialog box, select the "New" button.

   The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.
3. Define the x-axis configuration:
   - Time domain or frequency domain
   - Absolute or relative limits
   - Linear or logarithmic scaling

4. Define the y-axis configuration:
   - Level unit
   - Absolute or relative limits
   - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Select "Insert Value" again and define the second data point.
   d) Repeat this to insert all other data points.
   To insert a data point before an existing one, select the data point and then "Insert Value".
   To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
   To delete a data point, select the entry and then "Delete Value".
6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
   If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
7. Optionally, define a "Margin" at a fixed distance to the limit line.
   The margin must be within the valid value range and is not displayed in the diagram or preview area.
8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.
9. Save the new configuration by selecting the "Save" button.

   The new limit line is displayed in the overview and can be activated.

How to move the limit line vertically or horizontally

A configured limit line can easily be moved vertically or horizontally. Thus, a new limit line can be easily generated based upon an existing limit line which has been shifted horizontally.

1. In the "Line Config" dialog box, select the limit line.
2. To shift the complete limit line parallel in the horizontal direction, select the "X-Offset" button and enter an offset value.
   To shift the complete limit line parallel in the vertical direction, select the "Y-Offset" button and enter an offset value.
3. To shift the individual data points of a limit line by a fixed value (all at once):
   a) Select the "Edit" button.
   b) In the "Edit Limit Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
   c) Save the shifted data points by selecting the "Save" button.

   If activated, the limit line is shifted in the diagram.

8 Data Management

The R&S FSW allows you to store and load instrument settings, as well as import and export measurement data for analysis at a later time. Finally, you can store or print the measurement results displayed on the screen.

General storage and import/export functions are available via the toolbar. Some special storage functions are (also) available via softkeys or dialog boxes in the corresponding menus, e.g. trace data or marker peak lists.

8.1 Restoring the Default Instrument Configuration (Preset)

When delivered, the R&S FSW has a default configuration. You can restore this defined initial state at any time as a known starting point for measurements. This is often recommendable as a first step in troubleshooting when unusual measurement results arise.

To restore the default instrument configuration for all channels at once

► Press the PRESET key.

Alternatively to the factory default settings, you can define user-specific recall settings to be restored after a preset or reboot, see "To recall settings automatically after preset or reboot" on page 500.

After you use the PRESET function, the history of previous actions is deleted, i.e. any actions performed previously cannot be undone or redone using the UNDO/REDO keys.

Remote command:

`*RST` or `SYSTem:PRESet`

To restore the default configuration for a single channel

The default measurement settings can also be reset for an individual channel only, rather than resetting the entire instrument.

► In the "Overview", select the "Preset Channel" button.

The factory default settings are restored to the current channel. Note that a user-defined recall settings file is **NOT** restored.

Remote command:

`SYSTem:PRESet:CHANnel[:EXECute]` on page 918

8.1.1 Factory Default Configuration

The factory default configuration is selected such that the RF input is always protected against overload, provided that the applied signal levels are in the allowed range for the instrument.

Table 8-1: Factory default configuration

Parameter	Setting
mode	Spectrum
sweep mode	auto
center frequency	$f_{max}/2$
center frequency step size	0.1 * span
span	R&S FSW8: 8 GHz R&S FSW13: 13 GHz R&S FSW26: 26.5 GHz R&S FSW43: 43 GHz R&S FSW50: 50 GHz
RF attenuation	10 dB
reference level	0 dBm
level range	100 dB log
level unit	dBm
sweep time	auto
resolution bandwidth	auto (3 MHz)
video bandwidth	auto (3 MHz)
FFT filters	off
span/RBW	100
RBW/VBW	1
sweep	cont
trigger	free run
trace mode	1: clr write; 2/3/4/5/6: blank
detector	auto peak
frequency offset	0 Hz
reference level offset	0 dB
reference level position	100 %

Parameter	Setting
grid	abs
cal correction	on
noise source	off
input	RF

8.2 Storing and Recalling Instrument Settings and Measurement Data

Possibly you would like to restore or repeat a measurement you performed under specific conditions on the instrument. Or you want to evaluate imported data in another application on the R&S FSW and would like to restore the measurement settings applied during measurement. In these cases, you can store and recall instrument and measurement settings, and possibly other related measurement data.

Two different methods are available for managing instrument settings:

- Quick Save/Quick Recall - a defined set of instrument or channel settings are stored or recalled quickly in just one step
- Configurable Save/Recall - a user-defined set of instrument or channel settings are stored to a definable storage location

8.2.1 Quick Save/Quick Recall

The Quick Save and Quick Recall functions allow you to store instrument or channel settings very easily and quickly in one step. Up to 10 different sets of settings can be stored to or recalled from "save sets". Each save set is identified by its storage date and type (instrument or specific channel) in the display. The save sets are stored in the `C:\r_s\instr\user\QuickSave` directory, in files named `QuickSave1.dfl` to `QuickSave10.dfl`. The storage file names and locations cannot be changed.

During recall, save sets of type "Instrument" replace the settings of the entire instrument. All other save sets start a new measurement channel with the stored settings.

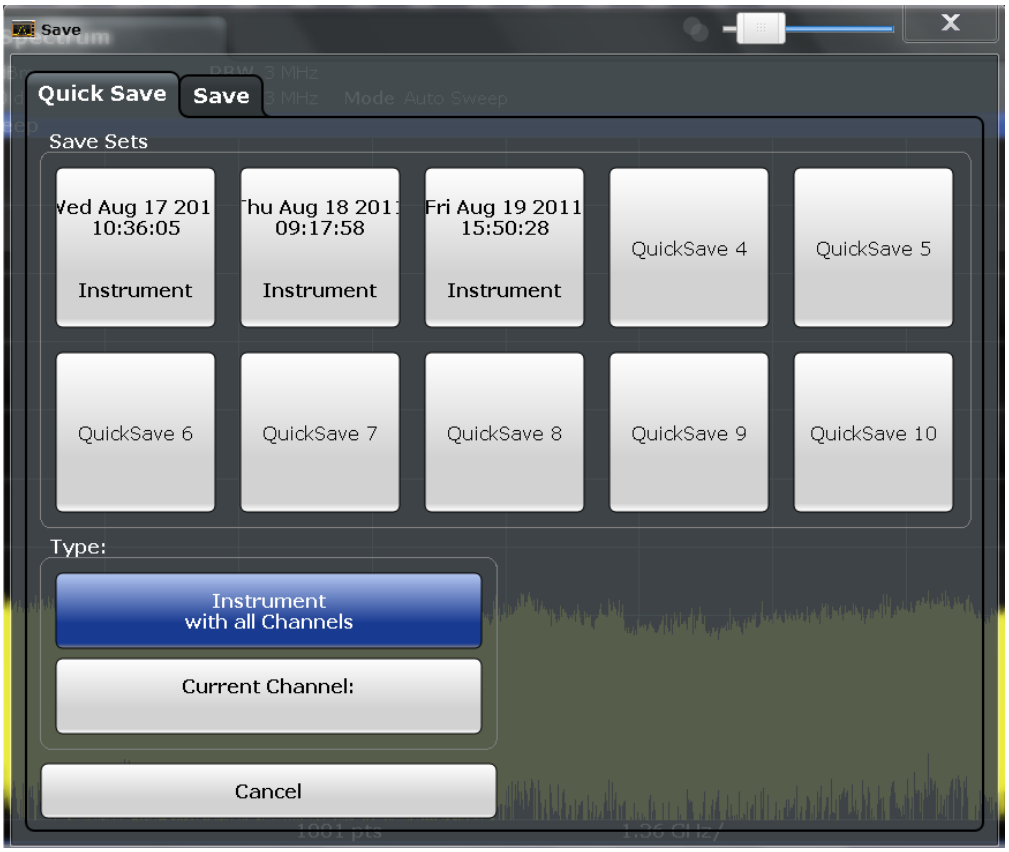
If a measurement channel with the same name as the channel to be restored is already active, the channel name for the new channel is extended by a consecutive number:

8.2.1.1 Quick Save / Quick Recall Dialog Boxes

The "QuickSave" dialog box is displayed when you select the "Save" icon in the toolbar.

The "Quick Recall" dialog box is displayed when you select the "Open" icon in the toolbar, or select the "Quick Recall" tab in the "Recall" dialog box.

Both dialog boxes are very similar and closely related.



QuickSave 1 / ... / QuickSave 10
Selects one of the save sets to store the current settings in or to be recalled. At the time of storage, the "QuickSave 1 / ... / QuickSave 10" placeholder is replaced by a label indicating the storage date and time and the storage type.

During recall, save sets of type "Instrument" replace the settings of the entire instrument. All other save sets start a new measurement channel with the stored settings.

Storage Type (Save only)
Defines which type of settings is to be stored in the save set.

"Instrument with all channels"	The instrument settings for all currently active channels are stored.
"Current Channel"	Only the instrument settings for the currently selected measurement channel are stored.

Recall
Restores the instrument settings as saved in the selected settings file. If the settings file contains settings for a specific channel only a new channel with the stored settings is activated, otherwise the entire instrument settings are loaded.

Note: After you use the "Recall" function, the history of previous actions is deleted, i.e. any actions performed previously cannot be undone or redone using the UNDO/REDO keys.

Note: If a measurement channel with the same name as the channel to be restored (in a new channel) is already active, the channel name for the new channel is extended by a consecutive number:

In remote commands, you must append this number to the channel name, as well.

Remote command:
`MMEMory:LOAD:STATe` on page 916

Cancel
Closes the dialog box without saving the settings.

8.2.2 Configurable Storage and Recall

The more sophisticated storage and recall functions allow you to define which settings are stored, and where the settings file is stored to. Any settings file can be selected for recall.

8.2.2.1 Stored Data Types

The following types of data can be stored to and loaded from files via the "Save" dialog box on the R&S FSW:

Table 8-2: Items that can be stored to files

Item	Description
Current Settings	Current instrument and measurement settings
All Transducers	Transducer factors for all active transducers.

Item	Description
All Traces	All active traces; R&S FSW-K30 only: also calibration data
All Limit Lines	All limit lines (Note: information on which limit lines are active is stored with the "Current Settings")
Noise - ENR	Data in "ENR Settings" dialog box (R&S FSW-K30 only)
Noise - Loss Settings	Data in "Loss Settings" dialog box (R&S FSW-K30 only)
Noise - Calibration data	Results from calibration measurement (R&S FSW-K30 only)
K40 Results	All current phase noise trace results (R&S FSW-K40 only)

8.2.2.2 Storage Location and File Name

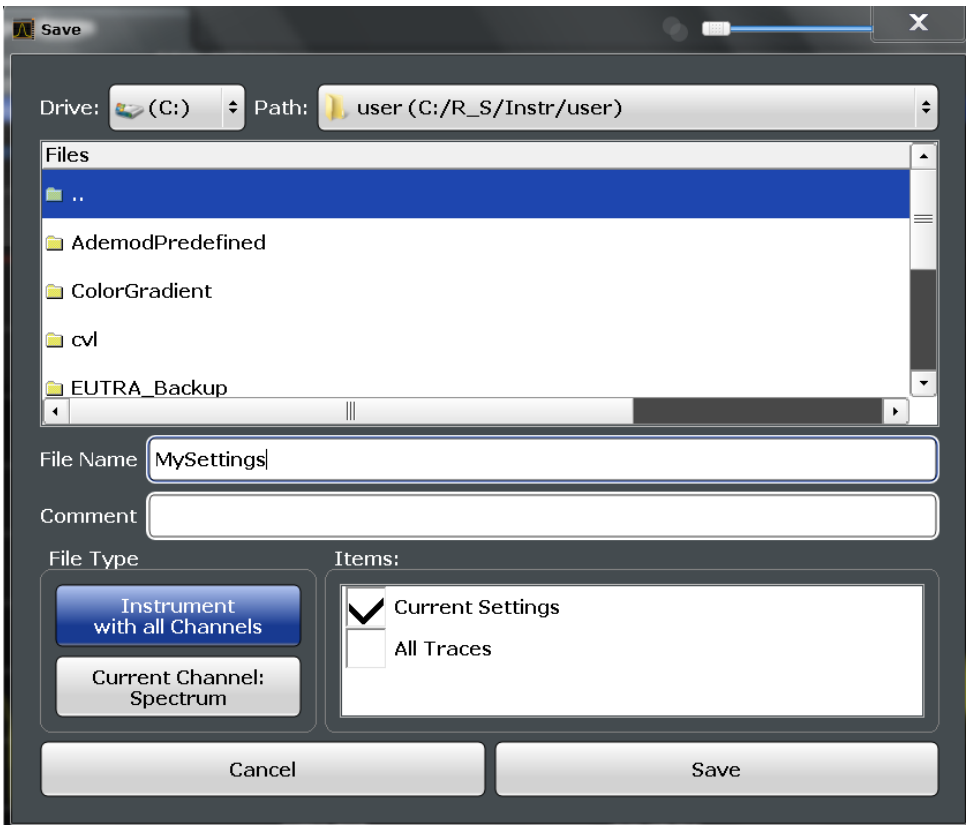
The data is stored on the internal flash disk or, if selected, on a memory stick or network drive. The operating system, firmware and stored instrument settings are located on drive C. All other folders and drives can be used to store measurement data.

The storage location and file name are selected in a file selection dialog box which is displayed when you perform a storage function.

By default, the name of a settings file consists of a base name followed by an underscore and three numbers, e.g. `limit_lines_005`. In the example, the base name is `limit_lines`. The base name can contain characters, numbers and underscores. The file extension `dfl` is added automatically. The default folder for settings files is `C:\r_s\instr\user`.

8.2.2.3 Save and Recall Dialog Boxes

The following dialog boxes are available via softkeys in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar. Both dialog boxes are very similar and closely related.



Selecting the Storage Location - Drive/ Path/ Files
Select the storage location of the settings file on the instrument or an external drive.

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

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

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

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

Remote command:
`MMEMory:CATalog?` on page 907

File Name
Contain the name of the data file without the path or extension.

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

For details on the file name and location see chapter 8.2.2.2, "Storage Location and File Name", on page 494.

Comment
An optional description for the data file. A maximum of 60 characters can be displayed.

Remote command:
`MMEMory:COMMent` on page 908

File Type
Determines whether the global instrument settings with all channels will be stored or recalled, or the current channel settings only.

Items
Defines which data and settings are stored or will be recalled. Depending on the "File Type", only channel settings or global settings are available. Which items are available also depends on the installed options (see also chapter 8.2.2.1, "Stored Data Types", on page 493).

Remote command:
`MMEMory:SELect[:ITEM]:ALL` on page 912
`MMEMory:SELect[:ITEM]:DEFault` on page 913
`MMEMory:SELect[:ITEM]:HWSettings` on page 913
`MMEMory:SELect[:ITEM]:LINes:ALL` on page 914
`MMEMory:SELect[:ITEM]:NONE` on page 914
`MMEMory:SELect[:ITEM]:TRACe[:ACTive]` on page 914
`MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 915

Save File
Saves the settings file with the defined file name.

Remote command:
`MMEMory:STORe:STATe` on page 917
`MMEMory:STORe:STATe:NEXT` on page 917

Recall in New Channel / Recall in Current Channel
Restores the instrument settings as saved in the selected settings file. If the settings file contains settings for a specific channel only, select "Recall in New Channel" to activate a new channel with the stored settings, or "Recall in Current Channel" to replace the current channel settings.

Note: After you use the "Recall" function, the history of previous actions is deleted, i.e. any actions performed previously cannot be undone or redone using the UNDO/REDO keys.

Note: If a measurement channel with the same name as the channel to be restored (in a new channel) is already active, the channel name for the new channel is extended by a consecutive number:

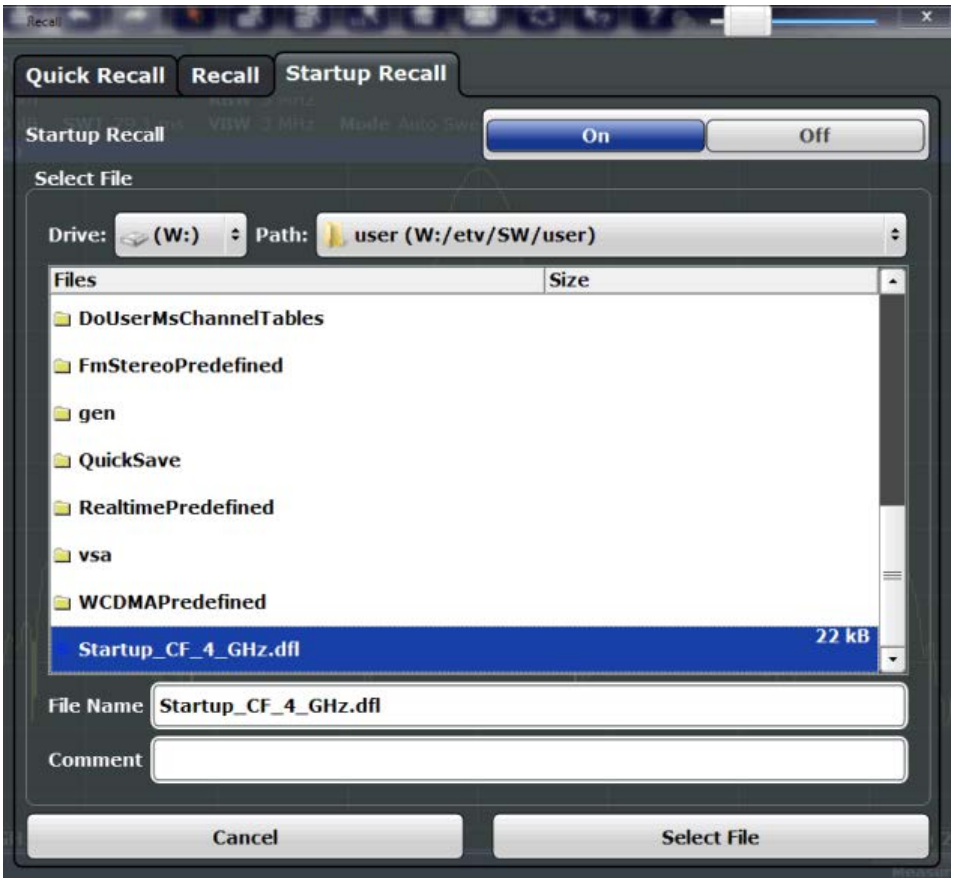
In remote commands, you must append this number to the channel name, as well.

Remote command:
`MMEMory:LOAD:STATe` on page 916

Cancel
Closes the dialog box without saving the settings.

8.2.2.4 Startup Recall Settings

The "Startup Recall" softkey opens the "Startup Recall" tab of the "Recall" dialog box.



Startup Recall
Activates or deactivates the startup recall function. If activated, the settings stored in the selected file are loaded each time the instrument is started or preset. If deactivated, the default settings are loaded.

Note that only *instrument* settings files can be selected for the startup recall function, not channel settings files.

Remote command:
`MMEMory:LOAD:AUTO` on page 916

Selecting the Storage Location - Drive/ Path/ Files
Select the storage location of the settings file on the instrument or an external drive.

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

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

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

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

Remote command:
`MMEMory:CATalog?` on page 907

File Name
Contain the name of the data file without the path or extension.

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

For details on the file name and location see chapter 8.2.2.2, "Storage Location and File Name", on page 494.

Comment
An optional description for the data file. A maximum of 60 characters can be displayed.

Remote command:
`MMEMory:COMMent` on page 908

Cancel
Closes the dialog box without saving the settings.

8.2.3 How to Save and Load Instrument Settings

Instrument settings can be saved to a file and loaded again later, so that you can repeat the measurement with the same settings. Optionally, user-defined measurement settings can automatically be restored each time you start or preset the instrument.

To save and recall instrument settings using the Quick Save function

1. Select the "Save" icon from the toolbar.

2. Select whether the instrument settings for **all** channels are to be stored, or only those for the **current** channel.
3. Select one of the save sets in which the settings are to be stored ("QuickSaveX").

   The selected settings are stored to the file `C:\r_s\instr\user\QuickSave\QuickSaveX.dfl`.
4. To restore the settings, select the "Open" icon from the toolbar.
5. Select the save set in which the settings were stored ("QuickSaveX").

   The selected settings are restored to the instrument or channel.

To save configurable instrument settings

1. Select the "Save" icon from the toolbar.
2. In the "Save" dialog box, switch to the "Save" tab.
3. In the file selection dialog box, select a file name and storage location for the settings file.
4. Optionally, define a comment to describe the stored settings.
5. Select whether the instrument settings for **all** channels are to be stored, or only those for the **current** channel.
6. Select the items to be saved with the settings. Either the settings for the currently selected channel only or for all channels can be stored, and various other items such as lines or traces etc. can be stored as well (see chapter 8.2.2.1, "Stored Data Types", on page 493).
7. Select "Save".

   A file with the defined name and path and the extension `.dfl` is created.

To recall configurable instrument settings

1. Select the "Open" icon from the toolbar.
2. In the "Recall" dialog box, switch to the "Recall" tab.
3. In the file selection dialog box, select the file name and storage location of the settings file.

   Note: The "File Type" indicates whether the file contains instrument settings for **all** channels, or only those for the current channel.
4. If several items were saved, select which items are to be restored.
5. If channel settings were saved, select whether the settings will replace the settings in the current channel, or whether a new channel with the saved settings will be opened.

6. Select "Recall".

   The settings and selected items from the saved measurement are restored and you can repeat the measurement with the same settings.

To recall settings automatically after preset or reboot

You can define the settings that are restored when you preset or reboot the instrument.

1. Configure the settings as required and save them as described in "To save configurable instrument settings" on page 499.
2. In the "Save/Recall" menu, select the "Startup Recall" softkey.
3. If the file selection dialog box is not displayed automatically, select the "Select Dataset" softkey.
4. Select the recall settings that are to be restored.
5. Tap "Select".
6. Toggle the "Startup Recall" softkey to "On".

   Now when you press the PRESET key or reboot the instrument, the defined settings will be restored.
7. To restore the factory preset settings, toggle the "Startup Recall" softkey to "Off".

8.3 Importing and Exporting Measurement Results for Evaluation

The R&S FSW provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with further, external applications. In this case, you can export the measurement data to a standard format file (ASCII or XML). Some of the data stored in these formats can also be re-imported to the R&S FSW for further evaluation at a later time, for example in other applications.

The following data types can be exported:

- Trace data
- Table results, such as result summaries, marker peak lists etc.
- I/Q data

The following data types can be imported:

- I/Q data

I/Q data can only be imported and exported in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

See the corresponding user manuals for those applications for details.

8.3.1 Import/Export Functions

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

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

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

Export
Opens a submenu to configure data export.

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

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

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

For details on the file format see chapter 8.3.4.1, "Reference: ASCII File Export Format", on page 503.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 927
`MMEMory:STORe:SGRam` on page 926

Trace Export Configuration ← Export
Opens the "Traces" dialog box to configure the trace and data export settings. See chapter 7.3.2.3, "Trace Export Settings", on page 423.

IQ Export ← Export
Opens a file selection dialog box to select an export file to which the IQ data will be stored. This function is only available in single sweep mode, and only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

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

Import
Provides functions to import data.

Currently, only I/Q data can be imported, and only by applications that process I/Q data.

See the R&S FSW I/Q Analyzer User Manual for more information.

8.3.2 How to Export Trace Data and Numerical Results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each sweep point the measured trace position and value are output. The file is stored with a `.DAT` extension. For details on the storage format see chapter 8.3.4.1, "Reference: ASCII File Export Format", on page 503.

For the results of a Spectrum Emission Mask (SEM) or Spurious Emissions measurement, special file export functions are available, see chapter 5.5.6.2, "How to Save SEM Result Files", on page 188(SEM) and "Saving the Evaluation List" on page 205 (Spurious).

To export trace data and table results

Trace data can be exported either from the "Trace" menu, or from the "Save/Recall" menu.

1. Press the TRACE key, then select the "Trace Config" softkey and switch to the "Trace/Data Export" tab.
   Or:
   Select the "Save" icon in the toolbar, then select the "Export" softkey.
2. Select the "Export Config" softkey to configure the export settings.
   a) Select "Export all Traces and all Table Results" to export all available measurement result data for the current application, or select a specific "Trace to Export".
   b) Optionally, select the "Include Instrument Measurement Settings" option to insert additional information in the export file header.
   c) If necessary, change the decimal separator to be used for the ASCII export file.
3. Select the "Export Trace to ASCII file" button.
4. In the file selection dialog box, select the storage location and file name for the export file.

5. Select "Save" to close the dialog box and export the data to the file.

8.3.3 How to Export a Peak List

You can save the results of a marker peak list to an ASCII file.

1. Press the MKR FUNCT key.
2. Select the "Marker Peak List" softkey.
3. Configure the peak search and list settings as described in "Marker Peak List Configuration" on page 469.
4. Set the marker peak list "State" to "On".
5. Press the RUN SINGLE key to perform a single sweep measurement and create a marker peak list.
6. Select the "Marker Peak List" softkey to display the "Marker Peak List" dialog box again.
7. If necessary, change the decimal separator to be used for the ASCII export file.
8. Select the "Export Peak List" button.
9. In the file selection dialog box, select the storage location and file name for the export file.
10. Select "Save" to close the dialog box and export the peak list data to the file.

8.3.4 Reference: File Format Descriptions

This reference describes in detail the format of the export files for result data.

For a description of the file formats for spectrum emission mask (SEM) measurement settings and results, see chapter 5.5.7, "Reference: SEM File Descriptions", on page 189.

The file format for Spurious Emissions measurement results is described in chapter 5.6.6, "Reference: ASCII Export File Format (Spurious)", on page 206.

8.3.4.1 Reference: ASCII File Export Format

Trace data can be exported to a file in ASCII format for further evaluation in other applications

(For details see chapter 8.3.2, "How to Export Trace Data and Numerical Results", on page 502).

The file consists of the header containing important scaling parameters and a data section containing the trace data. Optionally, the header can be excluded from the file (see "Include Instrument Measurement Settings" on page 424).

The data of the file header consist of three columns, each separated by a semicolon: parameter name; numeric value; basic unit. The data section starts with the keyword "Trace <n>" (<n> = number of stored trace), followed by the measured data in one or several columns (depending on the measurement) which are also separated by a semicolon.

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

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS-Excel. Different language versions of evaluation programs may require a different handling of the decimal point. Thus you can define the decimal separator to be used (decimal point or comma, see "Decimal Separator" on page 424).

If the spectrogram display is selected when you select the "ASCII Trace Export" softkey, the entire histogram buffer with all frames is exported to a file. The data corresponding to a particular frame begins with information about the frame number and the time that frame was recorded.

Table 8-3: ASCII file format for trace export

File contents	Description
Header data	
Type;R&S FSW;	Instrument model
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;	Operating mode
Preamplifier;OFF	Preamplifier status
Transducer; OFF	Transducer status
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Rf Att;20;dB	Input attenuation
El Att;2.0;dB	Electrical attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth

File contents	Description
SWT;0.005;s	Sweep time
Sweep Count;20;	Number of sweeps set
Ref Position;75;%	Position of reference level referred to diagram limits (0 % = lower edge)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Data section for individual window	
Window;1;Frequency Sweep	Window number and name
Trace 1;;	Selected trace
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASIPEAK
Values; 1001;	Number of measurement points
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Data section for individual trace	
Trace 2;;	Next trace in same window
...	
Data section for individual window	
Window;2 ..;	Name of next window
Data section for individual trace	
Trace 1;;	First trace
...	

Table 8-4: ASCII file format for spectrogram trace export

File contents	Description
Header	
Type;R&S FSW;	Instrument model

File contents	Description
Version;5.00;	Firmware version
Date;01.Oct 2006;	Date of data set storage
Mode;ANALYZER;**SPECTROGRAM**	Operating mode
Center Freq;55000;Hz	Center frequency
Freq Offset;0;Hz	Frequency offset
Span;90000;Hz	Frequency range (0 Hz in zero span and statistics measurements)
x-Axis;LIN;	Scaling of x-axis linear (LIN) or logarithmic (LOG)
Start;10000;Hz Stop;100000;Hz	Start/stop of the display range. Unit: Hz for span > 0, s for span = 0, dBm/dB for statistics measurements
Ref Level;-30;dBm	Reference level
Level Offset;0;dB	Level offset
Ref Position;75; %	Position of reference level referred to diagram limits (0 % = lower edge)
y-Axis;LOG;	Scaling of y-axis linear (LIN) or logarithmic (LOG)
Level Range;100;dB	Display range in y direction. Unit: dB with x-axis LOG, % with x-axis LIN
Rf Att;20;dB	Input attenuation
RBW;100000;Hz	Resolution bandwidth
VBW;30000;Hz	Video bandwidth
SWT;0.005;s	Sweep time
Trace Mode;AVERAGE;	Display mode of trace: CLR/WRITE,AVERAGE,MAXHOLD,MINHOLD
Detector;AUTOPEAK;	Detector set: AUTOPEAK,MAXPEAK,MINPEAK,AVERAGE,RMS,SAMPLE,QUASIPEAK
Sweep Count;20;	Number of sweeps set
Data section	
Trace 1:;;	Selected trace
x-Unit;Hz;	Unit of x values: Hz with span > 0; s with span = 0; dBm/dB with statistics measurements
y-Unit;dBm;	Unit of y values: dB*/V/A/W depending on the selected unit with y-axis LOG or % with y-axis LIN
Values; 1001;	Number of measurement points
Frames;2;	**Number of exported frames**
Frame;0;	**Most recent frame number**
Timestamp;17.Mar 11;11:27:05.990	**Timestamp of this frame**

File contents	Description
10000;-10.3;-15.7 10130;-11.5;-16.9 10360;-12.0;-17.4 ...;...;	Measured values, identical to spectrum data: <x value>, <y1>, <y2>; <y2> being available only with detector AUTOPEAK and containing in this case the smallest of the two measured values for a measurement point.
Frame;-1;	**Next frame**
Timestamp;17.Mar 11;11:27:05.342	**Timestamp of this frame**
...	

8.4 Creating Screenshots of Current Measurement Results and Settings

In order to document the graphical results and the most important settings for the currently performed measurement, you can create a hardcopy or screenshot of the current display. Screenshots can either be printed or stored to a file.

8.4.1 Print and Screenshot Settings

The settings for saving and printing screenshots are configured via the "Print" menu which is displayed when you select the "Print" icon in the toolbar.

For step-by-step instructions see chapter 8.4.2, "How to Store or Print Screenshots of the Display", on page 511.

Remote commands for these settings are described in chapter 11.9.4, "Storing or Printing Screenshots", on page 919.

To print a screensot of the current display with the current settings immediately, without switching to the "Print" menu, use the "Print immediately" icon at the right-hand side of the toolbar.

Printing or Storing a Screenshot (Print Screen)
Starts to print out or store all measurement results displayed on the screen: diagrams, traces, markers, marker lists, limit lines, etc., including the channel and status bars. Optionally, comments and the date and time are included at the bottom margin of the printout. All displayed items belonging to the software user interface (e.g. softkeys or dialog boxes) are not printed out.

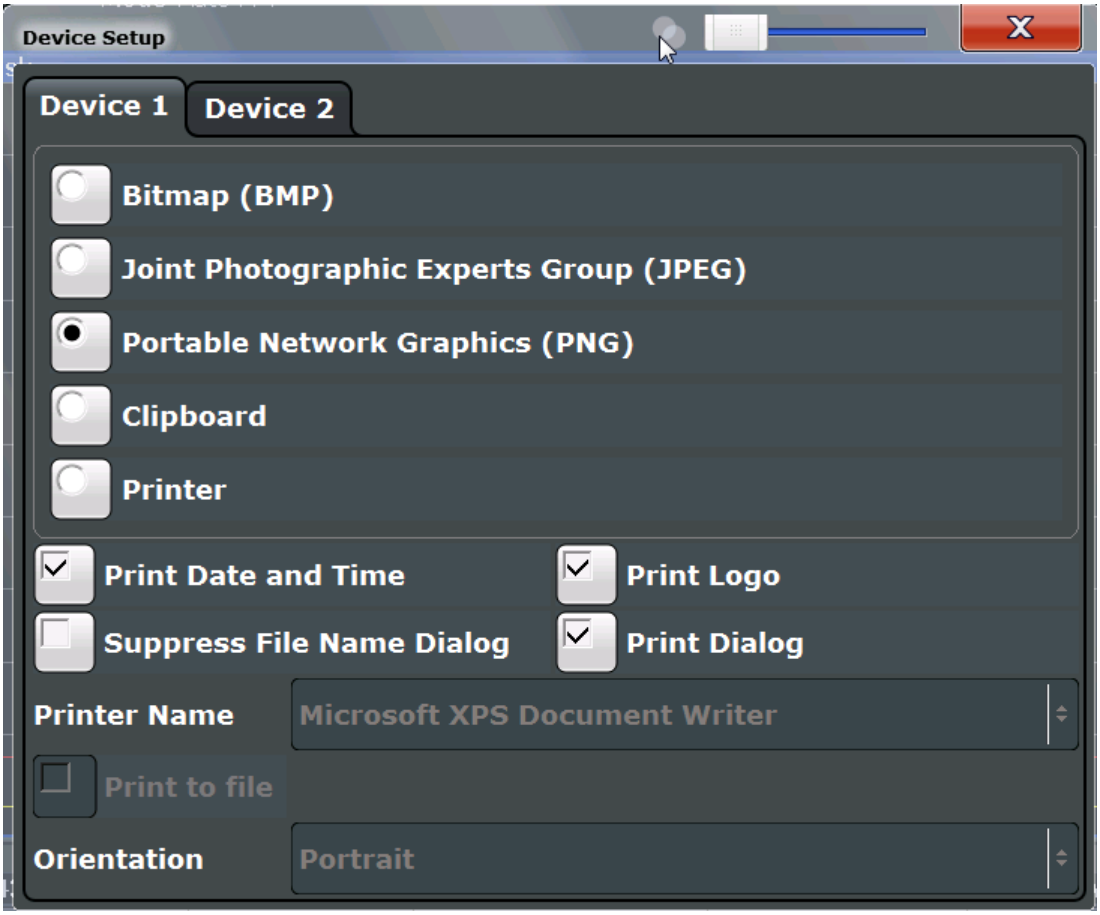
Whether the output is sent to the printer or stored in a file or the clipboard depends on the selected device and the device settings.

If the output is stored to a file, a file selection dialog box is opened to select the file name and location. The default path is `C:\r_s\instr\user`.

The "Print" menu is displayed to configure printing.

Remote command:
`HCOPy:ITEM:ALL` on page 923
`HCOPy[:IMMediate<device>]` on page 922
`HCOPy[:IMMediate<device>]:NEXT` on page 922

Device Setup
Defines the behavior of the "Print Screen" function, depending on which device is selected. Two different devices can be configured, e.g. one for printing and one for storage to a file.



Output Medium ← Device Setup
Defines the medium to which the screenshot is printed or stored.

"File formats" Stores the screenshot to a file in the selected format. The file name is queried at the time of storage.

"Clipboard" Stores the screenshot to the clipboard.

"Printer" Prints the screenshot on the printer selected from the "Name" list.

Remote command:
`HCOPy:DEVice:LANGuage<device>` on page 922

Print Date and Time ← Device Setup
Activates/deactivates the printout of the current date and time at the bottom of the screenshot.

Print Logo ← Device Setup
Activates/deactivates the printout of the Rohde & Schwarz company logo in the upper left corner.

Suppress File Name Dialog ← Device Setup
When the screenshot is stored to a file, the file selection dialog box is not displayed. Instead, the current storage location and file name are used (default: `C:\r_S\instr\user`). Each new the file name is extended by a consecutive number, e.g. `File002`, `File003` etc.

Print Dialog ← Device Setup
Includes any currently displayed dialog in the screenshot.

Printer Name ← Device Setup
Defines the printer to print to.

Remote command:
`SYSTem:COMMunicate:PRINter:ENUMerate[:NEXT]?` on page 924
`SYSTem:COMMunicate:PRINter:ENUMerate:FIRSt?` on page 924
`SYSTem:COMMunicate:PRINter:SELect<device>` on page 924

Print to File ← Device Setup
If a printer is selected as the output medium, use this option to store the data in a `.prn` file using the selected printer driver.

Orientation ← Device Setup
Selects the page orientation of the printout: portrait or landscape (printer only)

Remote command:
`HCOPy:PAGE:ORIentation<device>` on page 923

Device
Two different printout devices can be configured, e.g. one for printing and one for storage to a file. When the "Print Screen" function is executed, the selected device and its settings determine the behavior.

Remote command:
`HCOPy:DESTination<device>` on page 921

Colors
Opens the "Print Color" dialog box to configure the colors for printing screenshots. For details see chapter 9.4.3, "Display Theme and Colors", on page 541.

Comment
Defines an optional comment to be printed with the screenshot of the display. Maximum 120 characters are allowed. 60 characters fit in one line. In the first line, at any point a manual line-feed can be forced by entering "@".

Date and time are inserted automatically. The comment is printed below the diagram area, but not displayed on the screen. If a comment should not be printed, it must be deleted.

Remote command:
`HCOPy:ITEM:WINDow:TEXT` on page 923

Install Printer
Opens the standard Windows dialog box to install a new printer. All printers that are already installed are displayed.

Only user accounts with administrator rights can install a printer.

For further information refer to the Microsoft Windows documentation.

8.4.2 How to Store or Print Screenshots of the Display

► If the R&S FSW has already been set up according to your current requirements, simply press the "Print immediate" icon ( ) at the far right end of the toolbar.

A screenshot of the current measurement display is printed or stored to a file, as configured.

To set up screenshot outputs

This configuration assumes a printer has already been installed. To install a new printer, use the Install Printer softkey.

1. Select the "Printer" tool in the toolbar.
2. Select the "Device Setup" softkey.
3. Select the tab for Device 1 or Device 2 to configure a device.
4. To set up the print function to store a screenshot to a file, select the required file format as the output medium.
   To set up the print function to store a screenshot to the clipboard, select "Clipboard" as the output medium.
   To set up the print function to print a screenshot on a printer, select "Printer" as the output medium and an installed printer from the "Name" list.
5. For printout, select the page orientation.
6. Optionally, deactivate the date and time or the logo so they are not added to the screenshot.
7. Select "OK" to close the "Device Setup" dialog box.
8. Toggle the "Device" softkey to the device configuration you want to use.
9. Optionally, configure the colors to be used for printout, e.g. as displayed on the screen instead of inversed.
10. Optionally, add a comment to be included with the screenshot.
11. Select the "Print Screen" softkey or the "Printer" or "Screenshot" tool in the toolbar to execute the print function and check the results.
12. If you configured the print function to store the screenshot to a file, enter a file name in the file selection dialog box.

9 General Instrument Setup

Some basic instrument settings can be configured independantly of the selected operating mode or application. Usually, you will configure most of these settings initially when you set up the instrument according to your personal preferences or requirements and then only adapt individual settings to special circumstances when necessary. Some special functions are provided for service and basic system configuration.

9.1 Basics on Alignment

When you put the instrument into operation for the first time or when strong temperature changes occur, it may be necessary to align the data to a reference source (see also "Temperature check" on page 513).

During instrument start, the installed hardware is checked against the current firmware version to ensure the hardware is supported. If not, an error message is displayed ("WRONG_FW") and you are asked to update the firmware. Until the firmware version is updated, self-alignment fails.

The correction data and characteristics required for the alignment are determined by comparison of the results at different settings with the known characteristics of the high-precision calibration signal source at 64 MHz.

Alignment results

The alignment results are displayed and contain the following information:

- date and time of last correction data record
- overall results of correction data record
- list of found correction values according to function/module

The results are classified as follows:

PASSED	Calibration successful without any restrictions
CHECK	Deviation of correction value larger than expected, correction could however be performed
FAILED	Deviations of correction value too large, no correction was possible. The found correction data is not applicable.

The results are available until the next self-alignment process is started or the instrument is switched off.

Temperature check

During self-alignment, the instrument's (frontend) temperature is also measured (as soon as the instrument has warmed up completely). This temperature is used as a reference for a continuous temperature check during operation. If the current temperature deviates from the stored self-alignment temperature by a certain degree, a warning is displayed in the status bar indicating the resulting deviation in the measured power levels. A status bit in the `STATUs:QUEStionable:TEMPerature` register indicates a possible deviation. The current temperature of the RF Frontend can be queried using a remote command (see `SOURce:TEMPerature:FRONtend?` on page 937).

Touch screen alignment

When the device is delivered, the touch screen is initially calibrated. However, to ensure that the touch screen responds to the finger contact correctly, a touch screen alignment is required.

Alignment of the touch screen is useful:

- At first use
- After an image update or after exchanging a hard disk
- If you notice that touching a specific point on the screen does not achieve the correct response
- If the position of the instrument has been changed and you cannot look straight on the screen
- If another person operates the instrument

9.2 Basics on Transducer Factors

The transducer allows you to manipulate the trace at discrete trace points to correct the signal coming from an input device. Transducers are often used to correct the frequency response for antennas, for example. The transducer is configured by defining transducer factors for specific trace points. A set of transducer factors defines an interpolated transducer line and can be stored on the instrument.

In the Spectrum application, the correction factor from all active transducers is calculated for each displayed trace point once in advance and is added to the result of the level measurement during the sweep. If the sweep range changes, the correction values are calculated again. If several measured values are combined in one point, only one value is taken into consideration. If the active transducer line is not defined for the entire sweep range, the missing values are replaced by zeroes.

When a transducer is used, the trace is shifted by a calculated factor. However, an upward shift reduces the dynamic range for the displayed values. Thus, the reference level can be adapted automatically to restore the original dynamic range. The reference level is shifted by the maximum transducer factor. By default, if transducers are active the reference level function is adapted automatically to obtain the best dynamic performance.

If a transducer factor is active, "TDF" is displayed in the channel bar.

Transducers can also be defined when an optional external mixer is used (R&S FSW-B21).

When using probes for RF input, transducers are automatically created according to the probe's detected characteristics as soon as the probe is connected (see chapter 6.2.1.2, "RF Input from the Analog Baseband Connector", on page 275).

Y-Axis Unit

The individual transducer factors can be defined as absolute values or relative (dB) values. However, all factors for one transducer line use the same unit. As soon as a transducer is activated, the unit of the transducer is automatically used for all the level settings and outputs. The unit cannot be changed in the amplitude settings since the R&S FSW and the active transducer are regarded as one measuring instrument. Only for relative transducer factors (unit dB), the unit originally set on the instrument is maintained and can be changed.

When all transducers have been switched off, the R&S FSW returns to the unit that was used before a transducer was activated.

Configuration

The R&S FSW supports transducer lines with a maximum of 1001 data points. Eight of the transducer lines stored in the instrument can be activated simultaneously. The number of transducer lines stored in the instrument is only limited by the capacity of the storage device used.

A transducer line consists of the following data:

- A maximum of 1001 data points with a position and value
- A unit for the values
- A name to distinguish the transducer lines

Validity

The transducer factors must comply with the following rules to ensure correct operation:

- The frequencies for the data points must always be defined in ascending order. Otherwise the entry will not be accepted and the an error message is displayed.
- The frequencies of the data points may exceed the valid frequency range of the R&S FSW since only the set frequency range is taken into account for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Gain has to be entered as a negative value, and attenuation as a positive value.

9.3 General Instrument Settings

Instrument settings can be configured via the SETUP key.

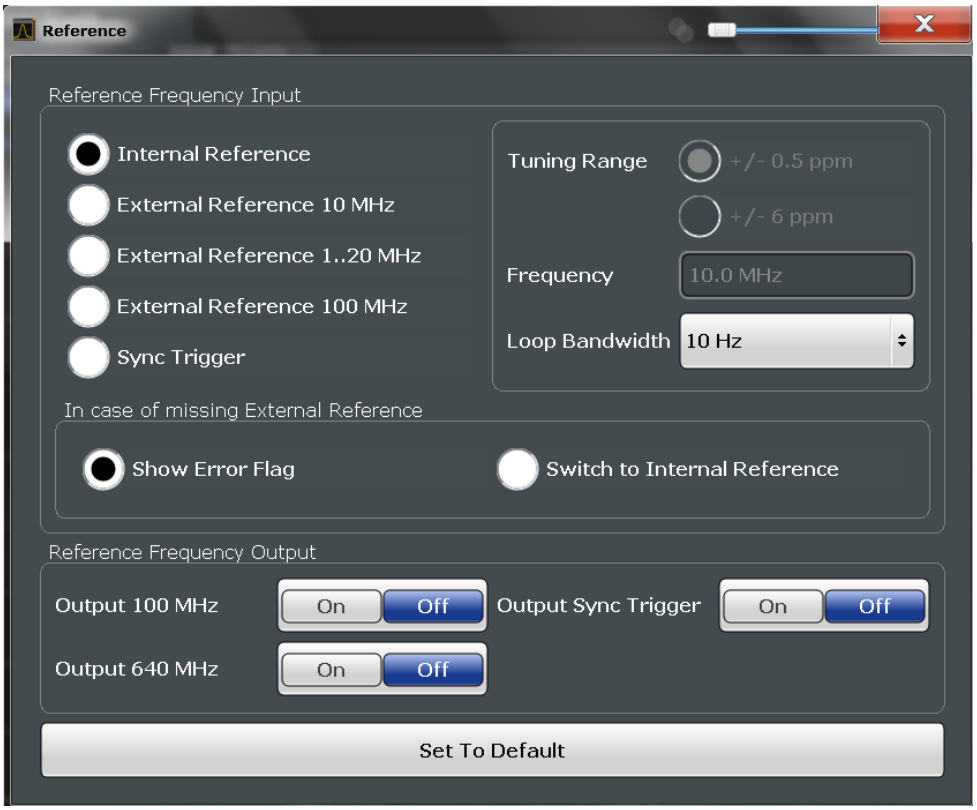
Network and Remote Settings, Display Settings

Settings for network and remote operation are described in chapter 10, "Network and Remote Operation", on page 553.

Display settings are described in chapter 9.4, "Display Settings", on page 535.

9.3.1 Reference Frequency Settings

The reference frequency settings are defined in the "Reference" dialog box which is displayed when you press the SETUP key and then select "Reference".



Reference Frequency Input
The R&S FSW can use the internal reference source or an external reference source as the frequency standard for all internal oscillators. A 10 MHz crystal oscillator is used as the internal reference source. In the external reference setting, all internal oscillators of the R&S FSW are synchronized to the external reference frequency. External references are connected to one of the REF INPUT or the SYNC TRIGGER connectors on the rear panel. For details see the "Getting Started" manual.

Note: Optionally (R&S FSW-B4), the more precise OCXO signal can replace the internal reference source.

The default setting is the internal reference. When an external reference is used, "EXT REF" is displayed in the status bar.

The following reference inputs are available:

Table 9-1: Available Reference Frequency Input

Source	Frequency	Tuning Range	Loop Band-width	Description
Internal	10 MHz	-	1-100 Hz	Internal reference signal or OCXO (option R&S FSW-B4)
External Reference 10 MHz	10 MHz	+/- 6 ppm	1-100 Hz	External reference from REF INPUT 1..20 MHZ connector; Fixed external 10 MHZ reference frequency. Good phase noise performance
External Reference 1..20 MHz	1..20 MHz in 1 Hz steps	+/- 0.5 ppm	0.1 Hz (fixed)	Variable external reference frequency in 0.1 Hz steps from REF INPUT 1..20 MHZ connector; Good external phase noise suppression. Small tuning range.
		+/- 6 ppm	1-30 Hz	Variable external reference frequency in 0.1 Hz steps from REF INPUT 1..20 MHZ connector; Wide tuning range.
External Reference 100 MHz	100 MHz	+/- 6 ppm	1-300 Hz	External reference from REF INPUT 100 MHZ connector Good phase noise performance
Sync Trigger	100 MHz	+/- 6 ppm	1-300 Hz	External reference from SYNC TRIGGER INPUT connector

Remote command:
`[SENSe:]ROSCillator:SOURce` on page 932
`SOURce:EXTernal:ROSCillator:EXTernal:FREQuency` on page 932

Behavior in case of missing external reference ← Reference Frequency Input
If an external reference is selected but none is available, there are different ways the instrument can react.

"Show Error Flag" The message "NO REF" is displayed to indicate that no synchronization is performed.

"Switch to internal reference" The instrument automatically switches back to the internal reference if no external reference is available. Note that you must re-activate the external reference if it becomes available again at a later time.

Remote command:
[SENSe:]ROSCillator:SOURce on page 932
[SENSe:]ROSCillator:SOURce:EAUTo? on page 933

Tuning Range ← Reference Frequency Input
The tuning range is only available for the variable external reference frequency. It determines how far the frequency may deviate from the defined level in parts per million (10^{-6}).

"+/- 0.5 ppm" With this smaller deviation a very narrow fixed loop bandwidth of 0.1 Hz is realized. With this setting the instrument can synchronize to an external reference signal with a very precise frequency. Due to the very narrow loop bandwidth, unwanted noise or spurious components on the external reference input signal are strongly attenuated. Furthermore, the loop requires about 30 seconds to reach a locked state. During this locking process, "NO REF" is displayed in the status bar.

"+/- 6 ppm" The larger deviation allows the instrument to synchronize to less precise external reference input signals.

Frequency ← Reference Frequency Input
Defines the external reference frequency to be used (for variable connectors only).

Loop Bandwidth ← Reference Frequency Input
Defines the speed of internal synchronization with the reference frequency. The setting requires a compromise between performance and increasing phase noise.

For a variable external reference frequency with a narrow tuning range (+/- 0.5 ppm), the loop bandwidth is fixed to 0.1 Hz and cannot be changed.

Reference Frequency Output
A reference frequency can be provided by the R&S FSW to other devices that are connected to this instrument. If one of the following options is activated, the reference signal is output to the corresponding connector.

"Output 100 MHz"
Provides a 100 MHz reference signal to the REF OUTPUT 100 MHZ connector.

"Ouput 640 MHz"
Provides a 640 MHz reference signal to the REF OUTPUT 640 MHZ connector.

"Output Sync Trigger"
Provides a 100 MHz reference signal to the SYNC TRIGGER OUTPUT connector.

Remote command:
[SENSe:]ROSCillator:O100 on page 931
[SENSe:]ROSCillator:O640 on page 931
[SENSe:]ROSCillator:SYNC on page 933

Resetting the Default Values
The values for the "Tuning Range", "Frequency" and "Loop Bandwidth" are stored for each source of "Reference Frequency Input". Thus, when you switch the input source, the previously defined settings are restored. You can restore the default values for all input sources using the "Preset Channel" function.

9.3.2 Transducer Settings

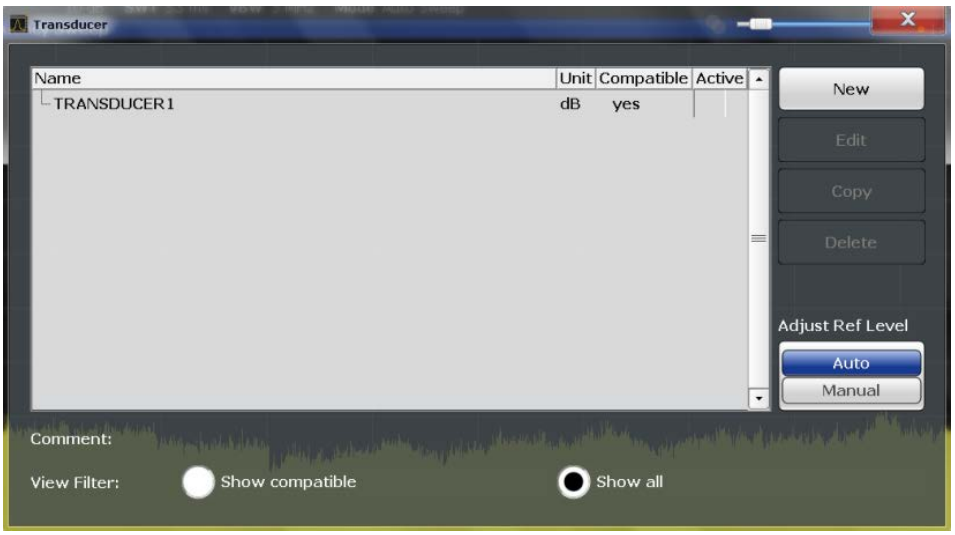
Up to 8 transducer lines can be activated simultaneously in the R&S FSW. Many more can be stored on the instrument.

The transducer settings are defined in the "Transducer" dialog box which is displayed when you press the SETUP key and then select "Transducer".

Transducers can also be defined when an optional external mixer is used (R&S FSW-B21).

9.3.2.1 Transducer Management

The settings required to manage all transducer lines on the instrument are described here.



For the transducer line overview, the R&S FSW searches for all stored transducer lines with the file extension `.TDF` in the `trd` subfolder of the main installation folder. The overview allows you to determine which transducer lines are available and can be used for the current measurement.

For details on settings for individual lines see chapter 9.3.2.2, "Transducer Factors", on page 520.

For instructions on configuring and working with transducers see chapter 9.6.5, "How to Configure the Transducer", on page 548.

Name
The name of the stored transducer line.

Unit
The unit in which the y-values of the data points of the transducer line are defined.

The following units are available:

- dB
- dBm
- dBmV
- dBµV
- dBµV/m
- dBµA
- dBµA/m
- dBpW
- dBpT

Compatibility
Indicates whether the transducer factors are compatible with the current measurement settings.

For more information on which conditions a transducer line must fulfill to be compatible, see chapter 9.2, "Basics on Transducer Factors", on page 513.

Activating/Deactivating
Activates/deactivates the transducer line. Up to 8 transducer lines can be active at the same time.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 938
`[SENSe:]CORRection:TRANsducer[:STATe]` on page 939

Comment
An optional description of the transducer line.

Included Lines in Overview (View Filter)
Defines which of the stored lines are included in the overview. The view can be restricted to compatible lines only or include all lines found. Whether a line is compatible or not is indicated in the Compatibility setting.

Adjusting the Reference Level
Activates or deactivates the automatic adjustment of the reference level to the selected transducer factor.

"Auto" Activates the automatic adjustment. The original dynamic range is restored by shifting the reference level by the maximum transducer factor.

"Man" Deactivates the automatic adjustment. Adjust the reference level via the "Amplitude" menu.

Remote command:
`[SENSe:]CORRection:TRANsducer:ADJust:RLEVel[:STATe]` on page 937

Create New Line
Create a new transducer line.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 938

Edit Line
Edit an existing transducer line configuration.

Copy Line
Copy the selected transducer line configuration to create a new line.

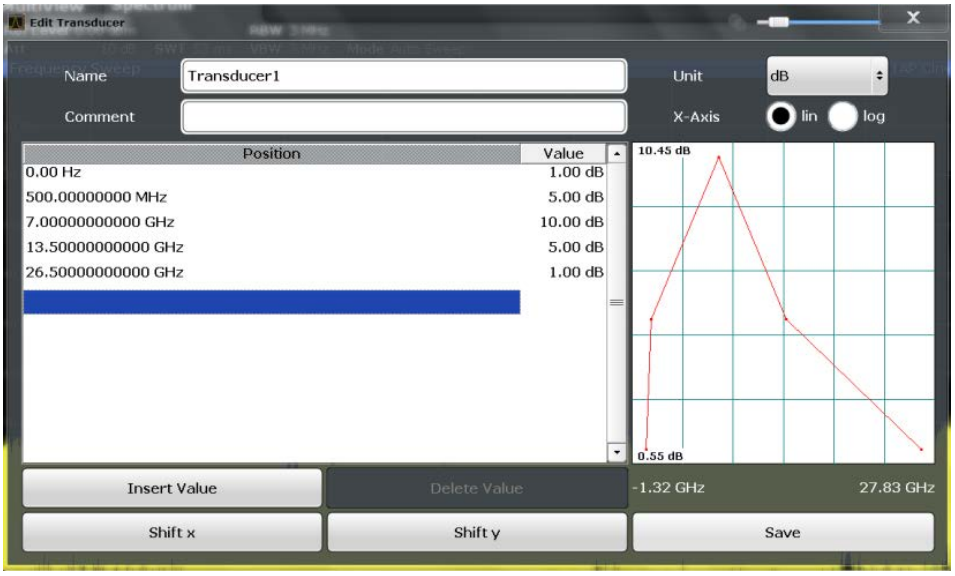
Delete Line
Delete the selected transducer line.

Remote command:
`[SENSe:]CORRection:TRANsducer:DELete` on page 938

9.3.2.2 Transducer Factors

The settings and functions available for individual transducer lines are described here.

For instructions on creating and editing transducer lines see chapter 9.6.5, "How to Configure the Transducer", on page 548.



Name
Defines the transducer line name. All names must be compatible with the Windows7 conventions for file names. The transducer data is stored under this name (with a `.TDF` extension) in the `trd` subfolder of the main installation folder.

Remote command:
`[SENSe:]CORRection:TRANsducer:SELect` on page 938

Comment
Defines an optional comment for the transducer line. The text may contain up to 40 characters.

Remote command:
`[SENSe:]CORRection:TRANsducer:COMMent` on page 938

Unit
The unit in which the y-values of the data points of the transducer line are defined.

As soon as a transducer is activated, the unit of the transducer is automatically used for all the level settings and outputs. The unit cannot be changed in the amplitude settings unless dB is used.

Remote command:
`[SENSe:]CORRection:TRANsducer:UNIT` on page 939

X-Axis Scaling
Describes the scaling of the horizontal axis on which the data points of the transducer line are defined. Scaling can be linear or logarithmic.

Remote command:
`[SENSe:]CORRection:TRANsducer:SCALing` on page 938

Data points
Each transducer line is defined by a minimum of 2 and a maximum of 50 data points. Each data point is defined by its position (x-axis) and value (y-value).

The data points must comply with the following rules to ensure correct operation:

- The frequencies for the data points must always be defined in ascending order. Otherwise the entry will not be accepted and the an error message is displayed.
- The frequencies of the data points may exceed the valid frequency range of the R&S FSW since only the set frequency range is taken into account for measurements. The minimum frequency of a data point is 0 Hz, the maximum frequency 200 GHz.
- The value range for the transducer factor is ±200 dB.
- Gain has to be entered as a negative value, and attenuation as a positive value.

Remote command:
`[SENSe:]CORRection:TRANsducer:DATA` on page 938

Insert Value
Inserts a data point in the transducer line above the selected one in the "Edit Transducer" dialog box.

Delete Value
Deletes the selected data point in the "Edit Transducer" dialog box.

Shift x
Shifts the x-value of each data point horizontally by the defined shift width.

Shift y
Shifts the y-value of each data point vertically by the defined shift width.

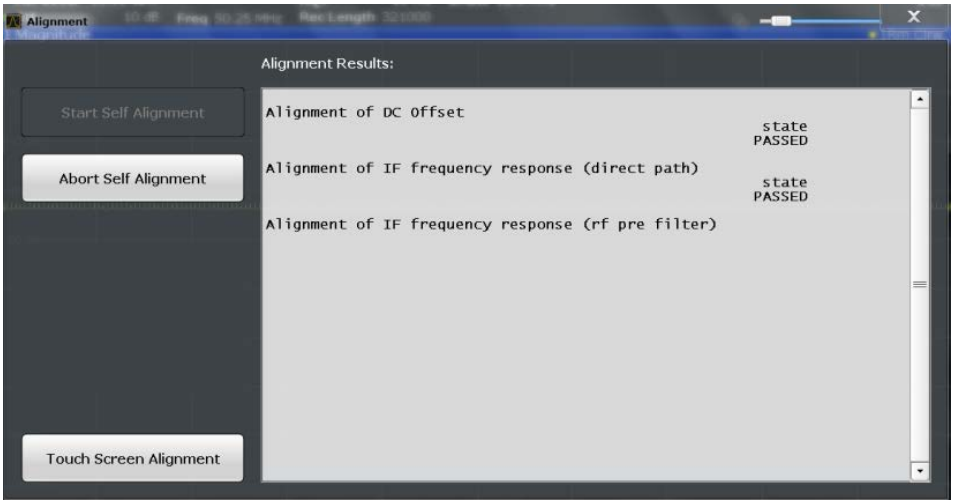
Save
Saves the currently edited transducer line under the name defined in the "Name" field.

Remote command:
`MMEMory:SELect[:ITEM]:TRANsducer:ALL` on page 915
`MMEMory:STORe:STATe` on page 917

9.3.3 Alignment Settings

Both the instrument and the touch screen can be aligned when necessary (see chapter 9.1, "Basics on Alignment", on page 512).

The alignment settings are defined in the "Alignment" dialog box which is displayed when you press the SETUP key and then select "Alignment".



Starting a Self-alignment
Starts recording correction data for the instrument. If the correction data acquisition fails or if the correction values are deactivated, a corresponding message is displayed in the status field.

For details see chapter 9.1, "Basics on Alignment", on page 512.

Note:
A running Sequencer operation is aborted when you start a self-alignment.

Remote command:
`*CAL?` on page 619, see also `CALibration[:ALL]?` on page 934

Aborting the Self-alignment
As long as the self-alignment data is being collected the procedure can be cancelled using the "Abort Self-alignment" button.

Starting the Touch Screen Alignment
Starts the touch screen alignment.

Tap the 4 markers on the screen as you are asked to do. The touch screen is aligned according to the executed pointing operations.

Alignment Results
Information on whether the alignment was performed succesfully and on the applied correction data is displayed. The results are available until the next self-alignment process is started or the instrument is switched off.

Remote command:
`CALibration:RESult?` on page 934

9.3.4 System Configuration Settings

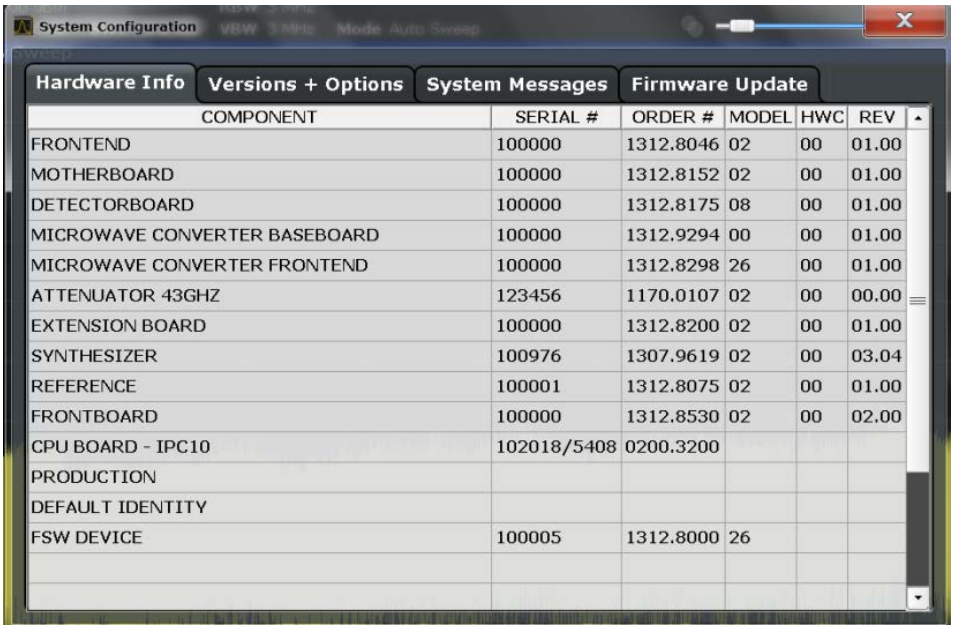
The system configuration information and settings are provided in the "System Configuration" dialog box which is displayed when you press the SETUP key and then select "System Configuration".

9.3.4.1 Hardware Information

An overview of the installed hardware in your R&S FSW is provided in the "Hardware Info" tab of the "System Configuration" dialog box.

Every listed component is described by its serial number, order number, model information, hardware code, and hardware revision.

This information can be useful when problems occur with the instrument and you require support from Rohde & Schwarz.



COMPONENT	SERIAL #	ORDER #	MODEL	HWC	REV
FRONTEND	100000	1312.8046	02	00	01.00
MOTHERBOARD	100000	1312.8152	02	00	01.00
DETECTORBOARD	100000	1312.8175	08	00	01.00
MICROWAVE CONVERTER BASEBOARD	100000	1312.9294	00	00	01.00
MICROWAVE CONVERTER FRONTEND	100000	1312.8298	26	00	01.00
ATTENUATOR 43GHZ	123456	1170.0107	02	00	00.00
EXTENSION BOARD	100000	1312.8200	02	00	01.00
SYNTHESIZER	100976	1307.9619	02	00	03.04
REFERENCE	100001	1312.8075	02	00	01.00
FRONTBOARD	100000	1312.8530	02	00	02.00
CPU BOARD - IPC10	102018/5408	0200.3200			
PRODUCTION					
DEFAULT IDENTITY					
FSW DEVICE	100005	1312.8000	26		

Remote command:

`DIAGnostic:SERVice:HWINfo?` on page 951

9.3.4.2 Information on Versions and Options

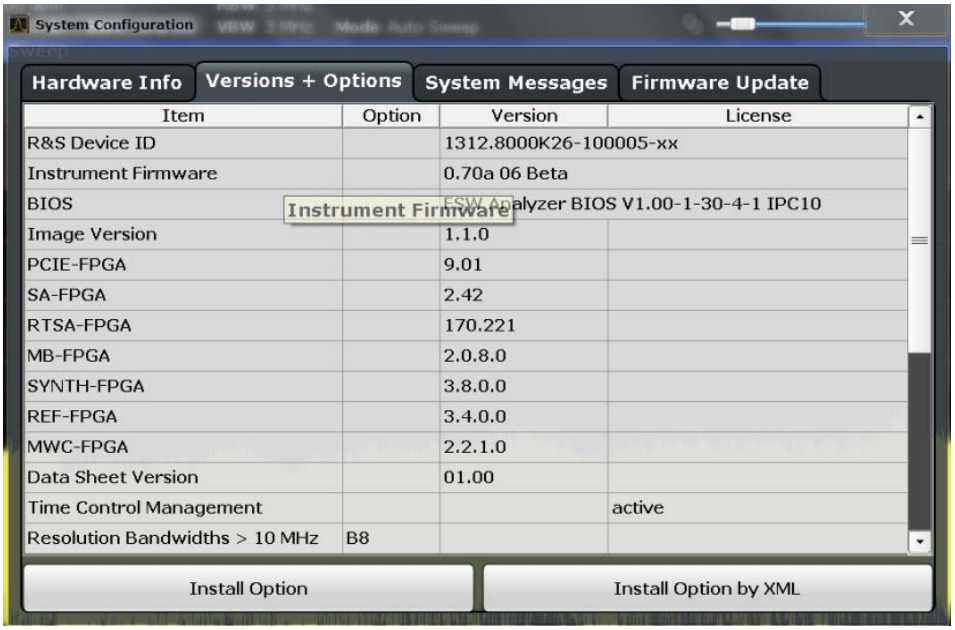
Information on the firmware version and options installed on your instrument is provided in the "Versions Options" tab of the "System Configuration" dialog box. The unique R&S device ID is also indicated here, as it is required for license and option administration.

You can also install new firmware options in this dialog box.

Expired option licenses

If an option is about to expire, a message box is displayed to inform you. You can then use the "Install Option" function to enter a new license key.

If an option has already expired, a message box appears for you to confirm. In this case, all instrument functions are unavailable (including remote control) until the R&S FSW is rebooted. You must then use the "Install Option" function to enter the new license key.



For details on options refer to the "Getting Started" manual, "Checking the Supplied Items".

Remote commands:

`SYSTem:FORMat:IDENt` on page 953

`DIAGnostic:SERVice:BIOSinfo?` on page 951

Install Option

Opens an edit dialog box to enter the license key for the option that you want to install.

Only user accounts with administrator rights are able to install options.

Install Option by XML

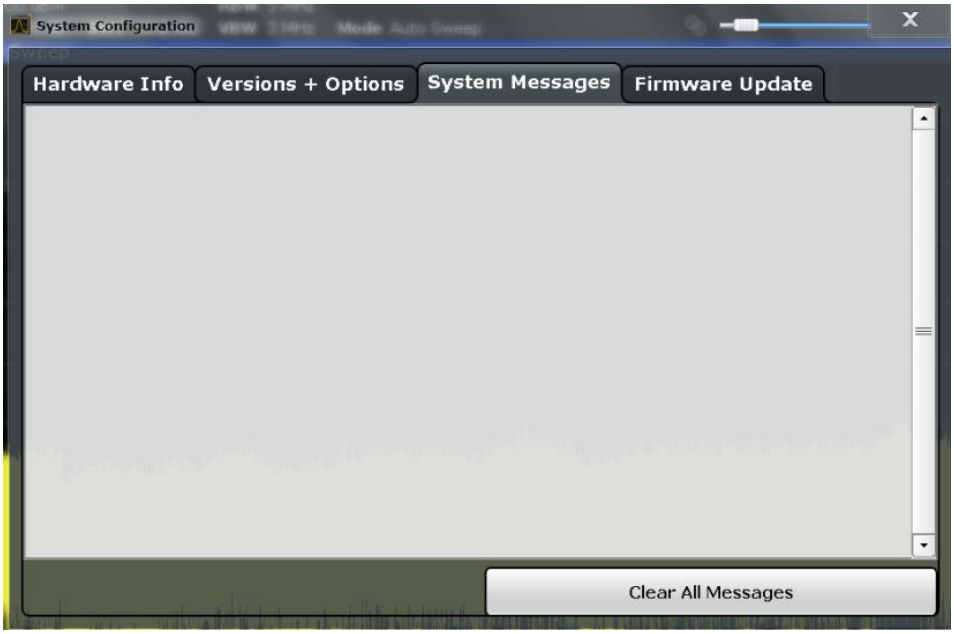
Opens a file selection dialog box to install an additional option to the R&S FSW using an XML file. Enter or browse for the name of an XML file that contains the option key and press "Select".

Only user accounts with administrator rights are able to install options.

9.3.4.3 System Messages

The system messages generated by the R&S FSW are displayed in the "System Messages" tab of the "System Configuration" dialog box.

The messages are displayed in the order of their occurrence; the most recent messages are placed at the top of the list. Messages that have occurred since you last visited the system messages tab are marked with an asterisk '*'.



If the number of error messages exceeds the capacity of the error buffer, "Message buffer overflow" is displayed. To clear the message buffer use the "Clear All Messages" button.

The following information is available:

No	device-specific error code
Message	brief description of the message
Component	hardware messages: name of the affected module
	software messages: name of the affected software
Date/Time	date and time of the occurrence of the message

Remote command:

`SYSTem:ERRor:LIST?` on page 953

9.3.4.4 Firmware Updates

During instrument start, the installed hardware is checked against the current firmware version to ensure the hardware is supported. If not, an error message is displayed ("WRONG_FW") and you are asked to update the firmware. Until the firmware version is

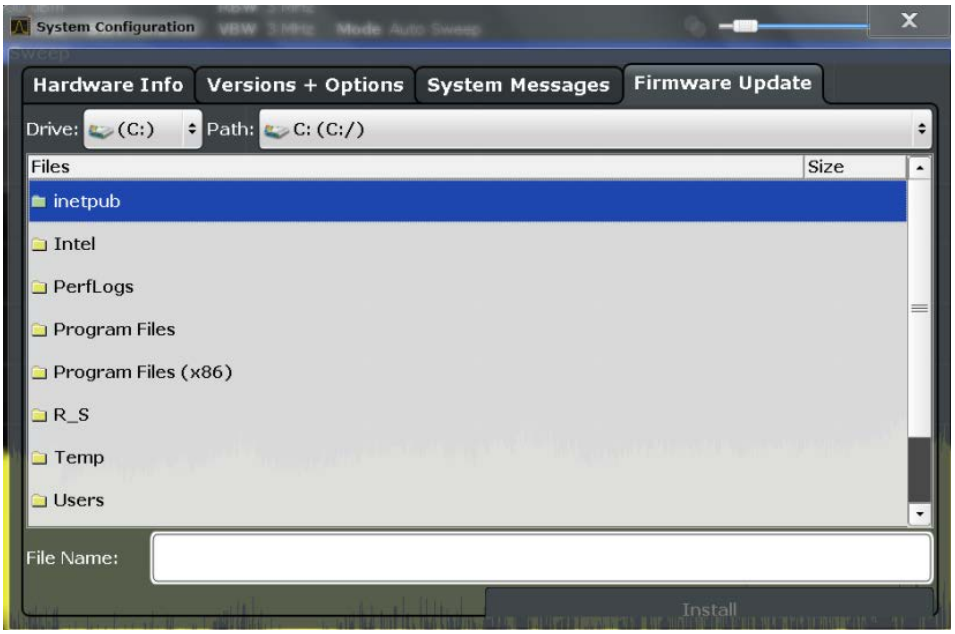
updated, self-alignment fails. To see which components are not supported, see the System Messages.

The firmware on your R&S FSW may also need to be updated in order to enable additional new features or if reasons for improvement come up. Ask your sales representative or check the Rohde&Schwarz website for availability of firmware updates. A firmware update package includes at least a setup file and release notes.

Before updating the firmware on your instrument, read the release notes delivered with the firmware version.

As of firmware version 1.60, administrator rights are no longer required to perform a firmware update.

The firmware can be updated in the "Firmware Update" tab of the "System Configuration" dialog box.



Enter the name or browse for the firmware installation file and press the "Install" button.

9.3.4.5 Preset

The default operating mode is Signal and Spectrum Analyzer mode (SAN), however, the presetting can be changed to Multi-Standard Radio Analysis (MSRA). The defined operating mode is activated when you switch on the R&S FSW or press the PRESET key.

The presettings can be defined in the "Preset" tab of the "System Configuration" dialog box.

For details on operating modes see chapter 4, "Applications and Operating Modes", on page 88.

Remote command:

`SYSTem:PRESet:COMPatible` on page 953

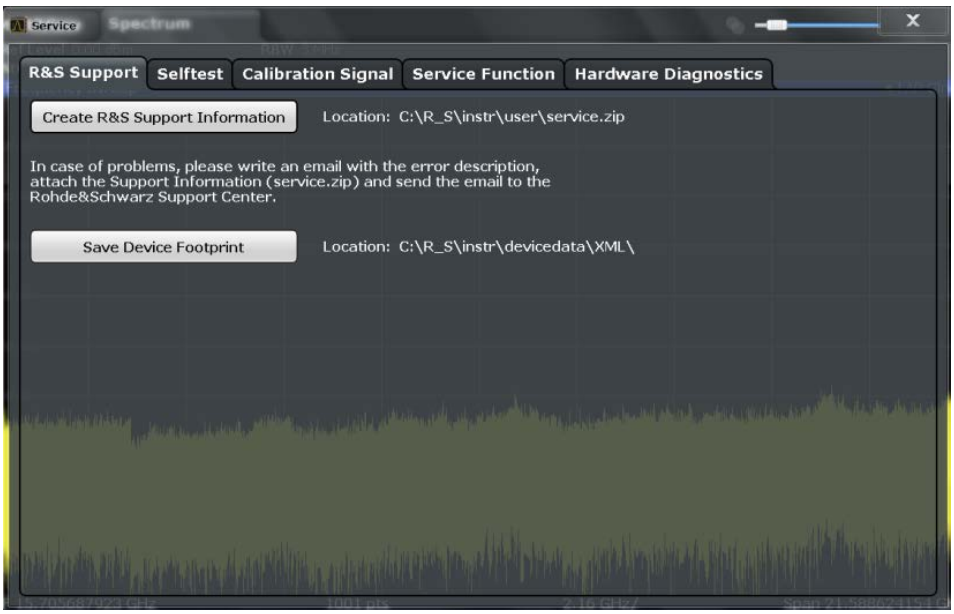
9.3.5 Service Functions

When unexpected problems arise with the R&S FSW some service functions may help you solve them.

The service functions are available in the "Service" dialog box which is displayed when you press the SETUP key and then select "Service".

9.3.5.1 R&S Support Information

In case of errors you can store useful information for troubleshooting and send it to your Rohde & Schwarz support center.



Creating R&S Support Information
Creates a *.zip file with important support information. The *.zip file contains the system configuration information ("device footprint"), the current eeprom data and a screenshot of the screen display.

This data is stored to the `C:\R_S\Instr\user\` directory on the instrument. The file name consists of the unique device ID and the current date and time of the file creation.

If you contact the Rohde&Schwarz support to get help for a certain problem, send these files to the support in order to identify and solve the problem faster.

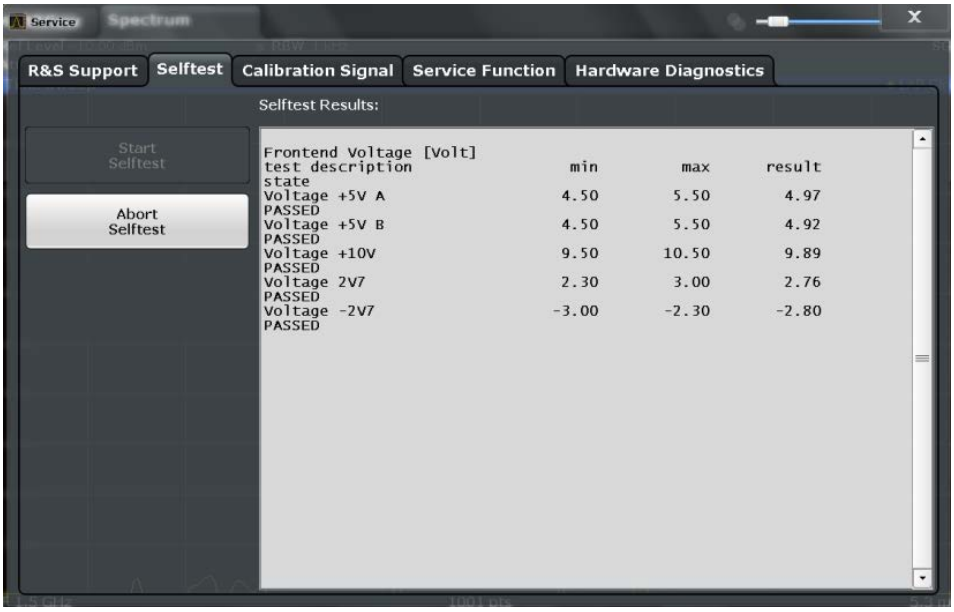
Remote command:
`DIAGnostic:SERVice:SINFo?` on page 955

Save Device Footprint
Creates an *.xml file with information on installed hardware, software, image and FPGA versions. The *.xml file is stored under `C:\R_S\Instr\devicedata\xml\` on the instrument. It is also included in the `service.zip` file.

9.3.5.2 Selftest Settings and Results

If the R&S FSW fails you can perform a self test of the instrument to identify any defective modules.

The selftest settings and results are available in the "Selftest" tab of the "Service" dialog box.



Once the self test is started, all modules are checked consecutively and the test result is displayed. You can abort a running test.

In case of failure a short description of the failed test, the defective module, the associated value range and the corresponding test results are indicated.

A running Sequencer process is aborted when you start a self-alignment.

Remote command:

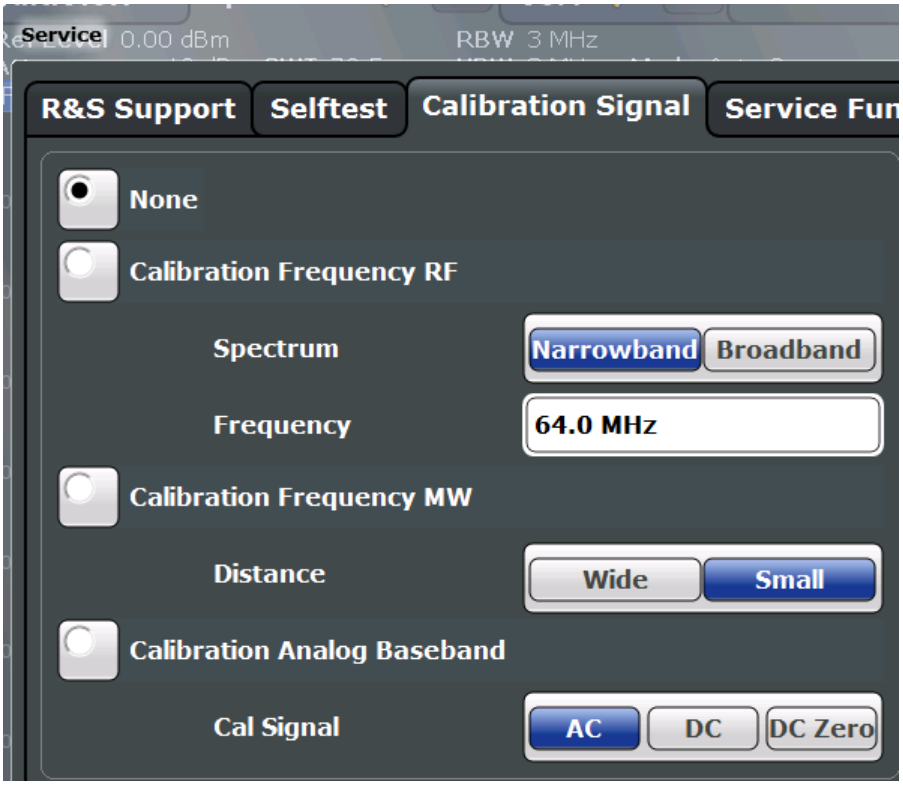
`*TST?` on page 622

`DIAGnostic:SERVice:STESt:RESult?` on page 936

9.3.5.3 Calibration Signal Display

Alternatively to the RF input signal from the front panel connector you can use the instrument's calibration signal as the input signal, for example to perform service functions on.

The calibration signal settings are available in the "Calibration Signal" tab of the "Service" dialog box.



None
Uses the current RF signal at the input, i.e. no calibration signal (default).

Remote command:
`DIAGnostic:SERVice:INPut[:SELect]` on page 936

Calibration Frequency RF
Uses the internal calibration signal as the RF input signal.

Remote command:
`DIAGnostic:SERVice:INPut:PULSed:CFRequency` on page 935

Spectrum ← Calibration Frequency RF
Defines whether a broadband or narrowband calibration signal is sent to the RF input.

"Narrowband" Used to calibrate the absolute level of the frontend at 64 MHz.

"Broadband" Used to calibrate the IF filter.

Remote command:
`DIAGnostic:SERVice:INPut:RF:SPECtrum` on page 935

Frequency ← Calibration Frequency RF
Defines the frequency of the internal broadband calibration signal to be used for IF filter calibration (max. 64 MHz). For narrowband signals, 64 MHz is sent.

Calibration Frequency MW
Uses the microwave calibration signal as the RF input (for frequencies greater than 8 GHz; for R&S FSW 26 only). This function is used to calibrate the YIG-filter on the microwave converter.

The microwave calibration signal is pulsed. You can define whether the distance between input pulses is small or wide.

Remote command:
`DIAGnostic:SERVice:INPut:MC:DISTance` on page 934

Calibration Analog Baseband
Uses an internal calibration signal as input to the optional Analog Baseband interface. This signal is only available if the R&S FSW-B71 option is installed.

For more information on the Analog Baseband Interface (R&S FSW-B71) see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Remote command:
`DIAGnostic:SERVice:INPut[:SELect]` on page 936

Calibration Signal Type ← Calibration Analog Baseband
Defines the type of calibration signal to be used for Analog Baseband.

"AC" 1.5625 MHz square wave AC signal

"DC" 1.5625 MHz square wave DC signal

"DC zero" no signal

Remote command:
`DIAGnostic:SERVice:INPut:AIQ[:TYPE]` on page 935

9.3.5.4 Service Functions

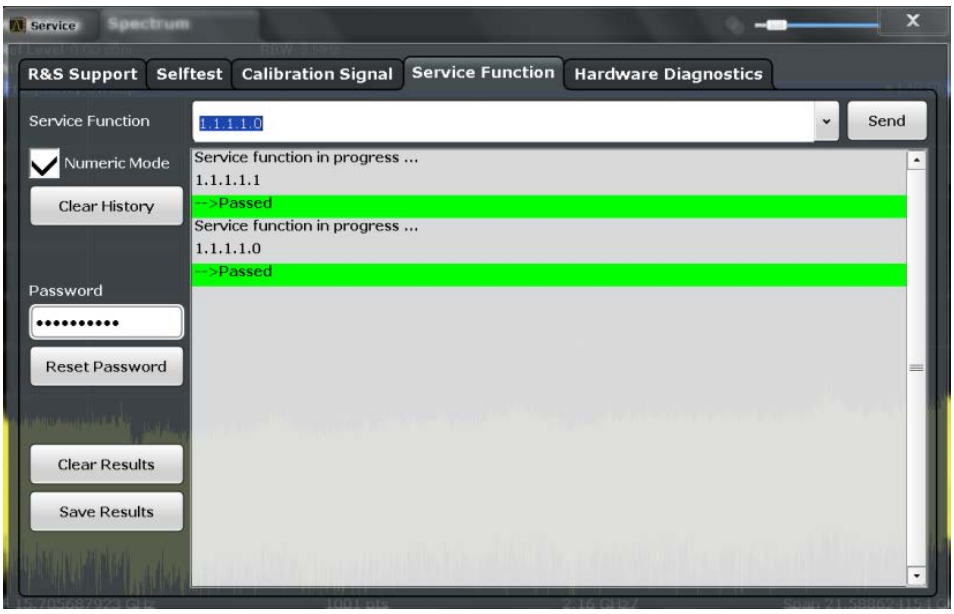
NOTICE

Using service functions

The service functions are not necessary for normal measurement operation. Incorrect use can affect correct operation and/or data integrity of the R&S FSW.

Therefore, only user accounts with administrator rights can use service functions and many of the functions can only be used after entering a password. These functions are described in the instrument service manual.

The service functions are available in the "Service Function" tab of the "Service" dialog box.



Service Function
Selects the service function by its numeric code or textual name.

The selection list includes all functions previously selected (since the last "Clear History" action).

Remote command:
`DIAGnostic:SERVice:SFUNction` on page 954

Numeric Mode
If activated, the service function is selected by its numeric code. Otherwise, the function is selected by its textual name.

Send
Starts the selected service function.

Remote command:
`DIAGnostic:SERVice:SFUNction` on page 954

Clear History
Deletes the list of previously selected service functions.

Password
Most service functions require a special password as they may disrupt normal operation of the R&S FSW. There are different levels of service functions, depending on how restrictive their use is handled. Each service level has a different password.

"Reset Password" returns to the lowest (least restrictive) service level.

Clear Results
Clears the result display for all previously performed service functions.

Remote command:
`DIAGnostic:SERVice:SFUNction:RESults:DELete` on page 955

Save Results
Opens a file selection dialog box to save the results of all previously performed service functions to a file.

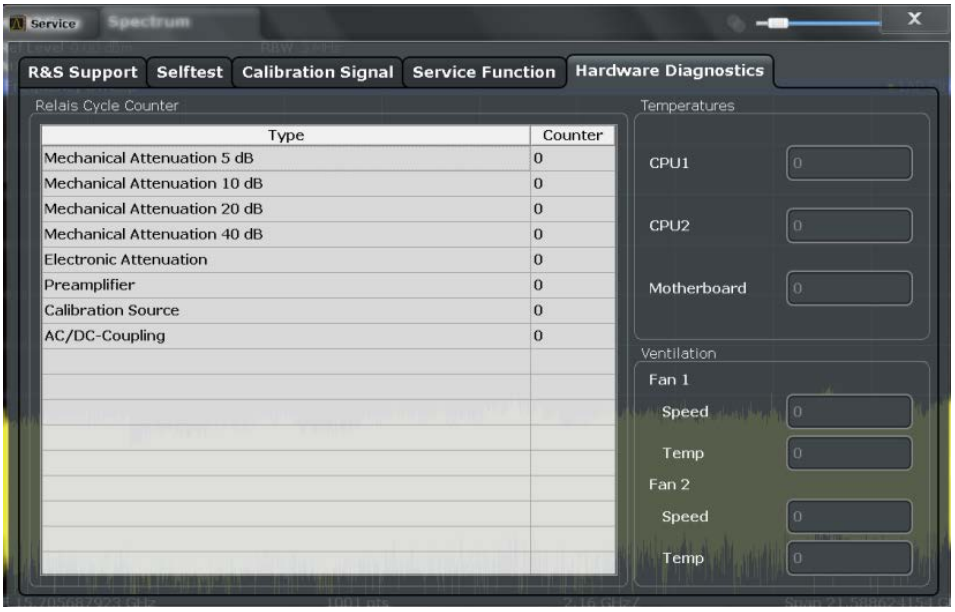
Remote command:
`DIAGnostic:SERVice:SFUNction:RESults:SAVE` on page 955

Result List
The Results List indicates the status and results of the executed service functions.

9.3.5.5 Hardware Diagnostics

In case problems occur with the instrument hardware, some diagnostic tools provide information that may support troubleshooting.

The hardware diagnostics tools are available in the "Hardware Diagnostics" tab of the "Service" dialog box.



Relay Cycle Counter
The hardware relays built into the R&S FSW may fail after a large number of switching cycles (see data sheet). The counter indicates how many switching cycles the individual relays have performed since they were installed.

Remote command:
`DIAGnostic:INFO:CCOunter?` on page 950

Temperatures
Some hardware parts fail at high temperatures. Several temperature sensors in the R&S FSW provide the current temperature for the CPUs and the motherboard, which are indicated here.

Ventilation
High temperatures in the R&S FSW may occur when the fans fail. The current speed and temperatures of the built-in fans are displayed. High temperatures or very slow fan speed may indicate a hardware problem.

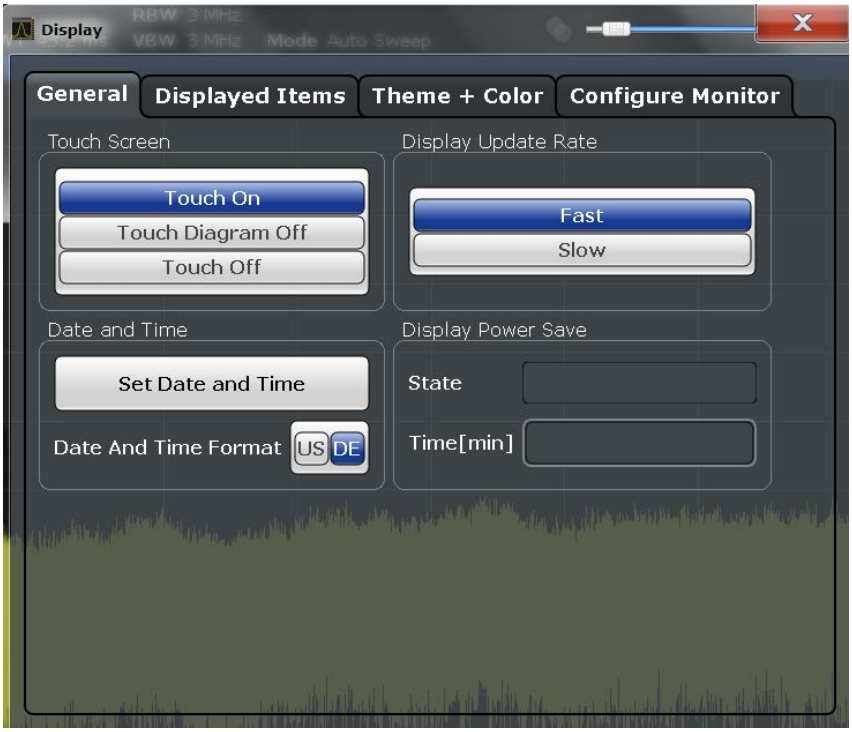
9.4 Display Settings

Some general display settings are available regardless of the current application or operating mode. For information on optimizing your display for measurement results see chapter 7.1, "Result Display Configuration", on page 397.

The general display settings are defined in the "Display" dialog box which is displayed when you press the SETUP key and then select "Display".

9.4.1 General Display Settings

This section includes general screen display behavior and date and time display. These settings are available in the "General" tab of the "Display" dialog box.



Deactivating and Activating the Touch Screen

The touch screen function can be deactivated, e.g. when the instrument is being used for demonstration purposes and tapping the screen should not provoke an action.

To reactivate the touch screen, simply press the SETUP key on the front panel. The "Display" dialog box is opened automatically and the "Touch Screen" option is set to "ON".

"TOUCH ON" Touch screen function is active for the entire screen

"TOUCH OFF" Touch screen is deactivated for the entire screen

"TOUCH DIAGRAM OFF"
Touch screen is deactivated for the diagram area of the screen, but active for the surrounding softkeys, toolbars and menus

Remote command:

`DISPlay:TOUChscreen:STATe` on page 942

Display Update Rate

By default, a fast update rate ensures the most recent measurement results on the display. However, when performance is poor due to slow data transfer (for example during remote control), it may be helpful to decrease the frequency with which the screen display is updated.

Setting the Date and Time
The current date and time on the instrument is set using the standard Windows "Date and Time Properties" dialog box which is displayed when you select the "Set Date and Time" button in the "Display" dialog box, or when you tap the date and time display in the status bar.

Date and Time Format
Switches the time and date display on the screen between US and German (DE) format.

Remote command:
`DISPlay[:WINDow]:TIME:FORMat` on page 943

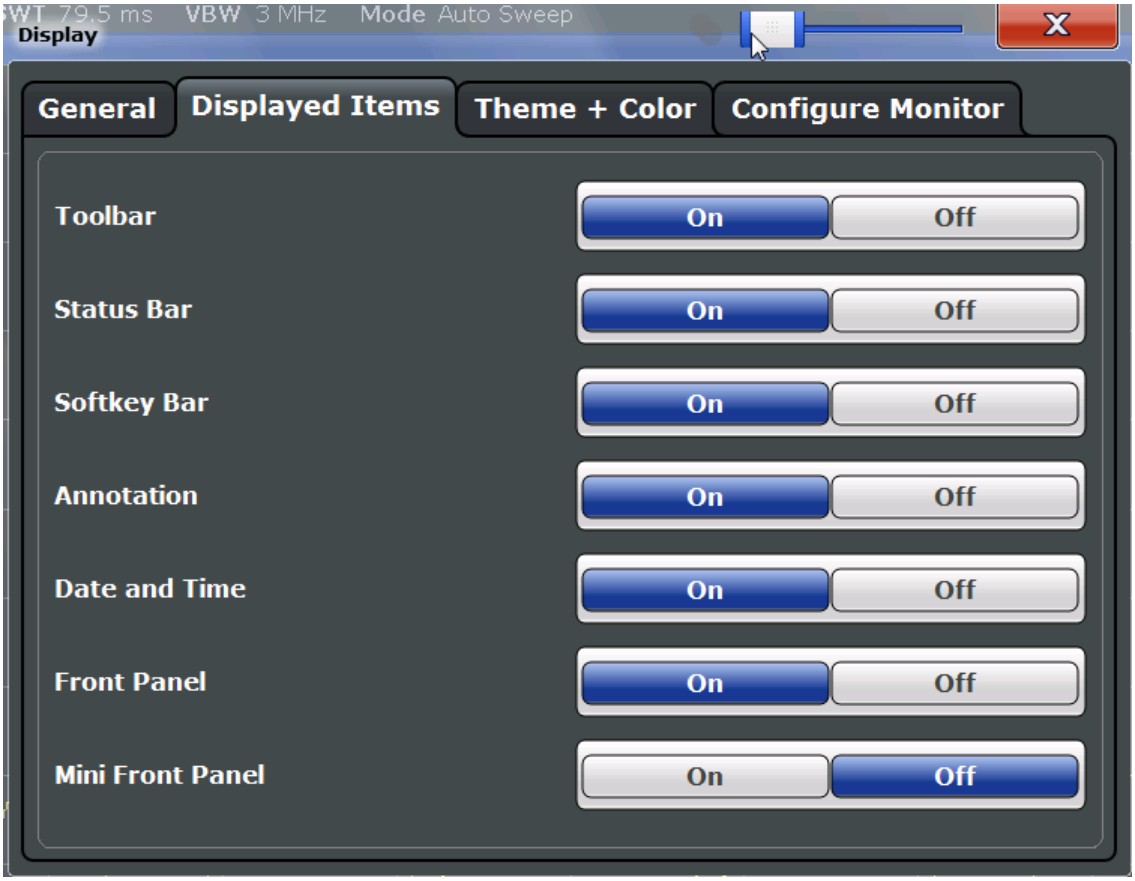
Display Power Save Function
The touch screen can be set to a power-save mode in which the display is temporarily switched off, including the backlight. This is useful during remote control, for example, or when a measurement with a long duration is running that needs not be monitored. You can define a waiting time after which the power-save mode sets in automatically if no manual interaction with the instrument occurs.

To switch the display back on, tap the screen or press a key.

Remote command:
`DISPlay:PSAVe[:STATe]` on page 941
`DISPlay:PSAVe:HOLDoff` on page 941

9.4.2 Displayed Items

Several elements on the screen display can be hidden or shown as required, for example to enlarge the display area for the measurement results. These settings are available in the "Displayed Items" tab of the "Display" dialog box.



Toolbar

The toolbar provides access to frequently used functions via icons at the top of the screen. Some functions, such as zooming, finding help, printing screenshots or storing and loading files are not accessible at all without the toolbar.

Remote command:

`DISPlay:TBAR[:STATe]` on page 942

Status Bar

The status bar beneath the diagram indicates the global instrument settings, the instrument status and any irregularities during measurement or display.

Some of the information displayed in the status bar can be queried from the status registry via remote commands, see chapter 11, "Remote Commands", on page 617.

Remote command:

`DISPlay:SBAR[:STATe]` on page 941

Softkey Bar
Softkeys are virtual keys provided by the software. Thus, more functions can be provided than those that can be accessed directly via the function keys on the device.

The functions provided by the softkeys are often also available via dialog boxes. However, some functions may not be accessible at all without the softkey bar.

Note: The softkey bar is hidden while the SmartGrid is displayed and restored automatically when the SmartGrid is closed.

Remote command:
`DISPlay:SKEYs[:STATe]` on page 942

Diagram Footer (Annotation)
The diagram footer beneath the diagram contains information on the x-axis of the diagram display, such as the current center frequency and span settings, the displayed span per division and the number of sweep points.

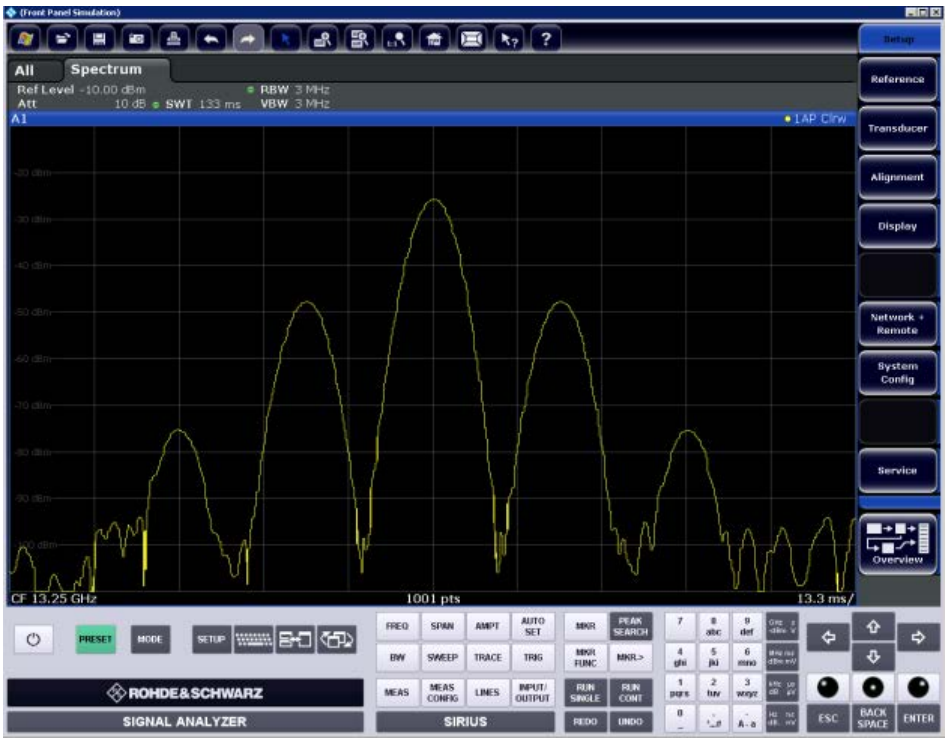
Remote command:
`DISPlay:ANNotation:FREQuency` on page 940

Date and Time
The date and time display can be switched off independantly of the status bar.

You can set the current date and time and configure the display format in the "General" tab of the "Display" dialog box.

Remote command:
`DISPlay[:WINDow]:TIME` on page 942

Front Panel
The "Front Panel" display simulates the entire front panel of the device (except for the external connectors) on the screen. This allows you to interact with the R&S FSW without requiring the keypad and keys located on the front panel of the device. This is useful, for example, when working with an external monitor or operating via remote control from a computer.



To activate or deactivate the front panel temporarily, press the F6 key on the external keyboard (if available) or the remote computer.

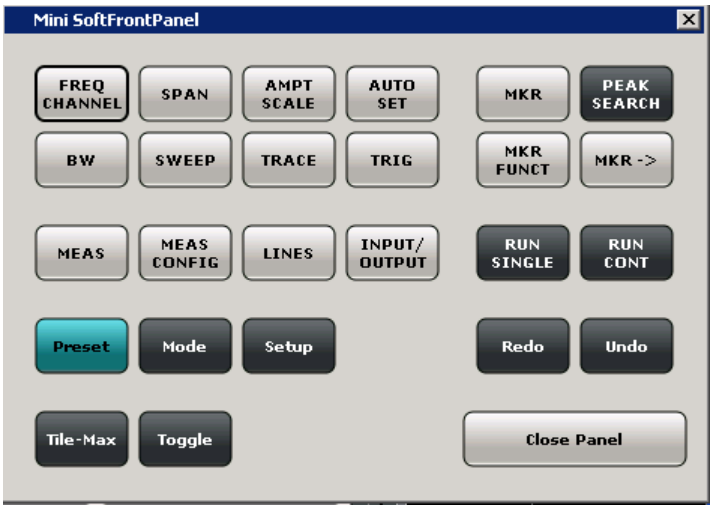
For more information see chapter 9.6.7, "How to Work with the Soft Front Panels", on page 551.

Remote command:

`SYSTem:DISPlay:FPANel[:STATe]` on page 943

Mini Front Panel

If you require a front panel display but do not want to lose too much space for results in the display area, a mini front panel is available. The mini version displays only the main function hardkeys in a separate window in the display area. This window can be closed automatically after pressing a key ("Auto Close" option), or remain open, as desired.



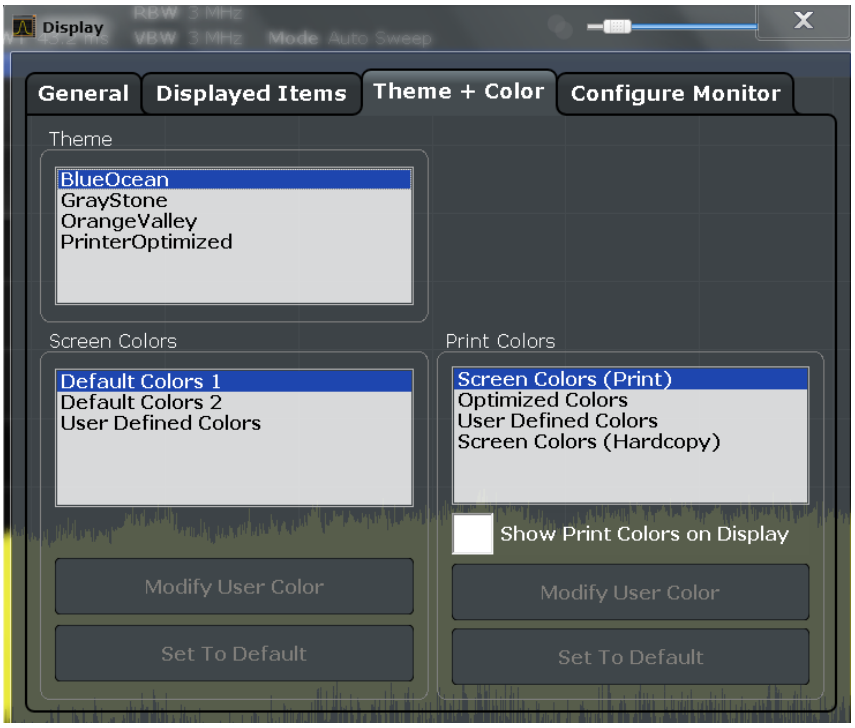
Note:
You can also activate the Mini Front Panel using the key combination ALT + M (be aware of the keyboard language defined in the operating system!). This is useful when you are working from a remote PC and the Front Panel function is not active.

Remote command:
`SYSTem:DISPlay:FPANel[:STATe]` on page 943

9.4.3 Display Theme and Colors

You can configure the used colors and styles of display elements on the screen. These settings are available in the "Theme + Color" tab of the "Display" dialog box.

For step-by-step instructions see chapter 9.6.6, "How to Configure the Colors for Display and Printing", on page 550.



Theme
The theme defines the colors and style used to display softkeys and other screen objects. The default theme is "BlueOcean".

Remote command:
DISPlay:THEMe:SELect on page 945

Screen colors
Two different color sets are provided by the instrument, a third user-defined set can be configured.

The default color schemes provide optimum visibility of all screen objects when regarding the screen from above or below. Default setting is "Default Colors 1".

If "User Defined Colors" is selected, a user-defined color set can be defined.

Remote command:
DISPlay:CMAP<item>:DEFault<colors> on page 944

Print colors
Defines the color settings used for printout. In addition to the predefined settings, a user-defined color set can be configured.

If "Show Print Colors on Display" is activated, the currently selected print colors are displayed as a preview for your selection.

Optimized Colors	Selects an optimized color setting for the printout to improve the visibility of the colors (default setting). Trace 1 is blue, trace 2 black, trace 3 green, and the markers are turquoise. The background is always printed in white and the grid in black.
Screen Colors (Print)	Selects the current screen colors for the printout. The background is always printed in white and the grid in black.
Screen Colors (Hardcopy)	Selects the current screen colors without any changes for a hardcopy.
User Defined Colors	Selects the user-defined color setting.

Remote command:
HCOPy:CMAP<item>:DEFault<colors> on page 919

Modifying User-Defined Colors
You can configure the colors used to display and print individual screen objects according to your specific requirements.

The colors are configured in the (identical) "Screen Color Setup"/"Printer Color Setup" dialog boxes.

Selecting the Object ← Modifying User-Defined Colors
Selects the object for which the color is to be defined. Colors can be defined for the following objects:

- Background
- Grid
- Individual traces
- Display lines
- Limit lines and check results
- Markers and marker information

Remote command:
Each object is assigned to a specific suffix of the CMAP commands, see chapter 11.10.5.3, "CMAP Suffix Assignment", on page 945.

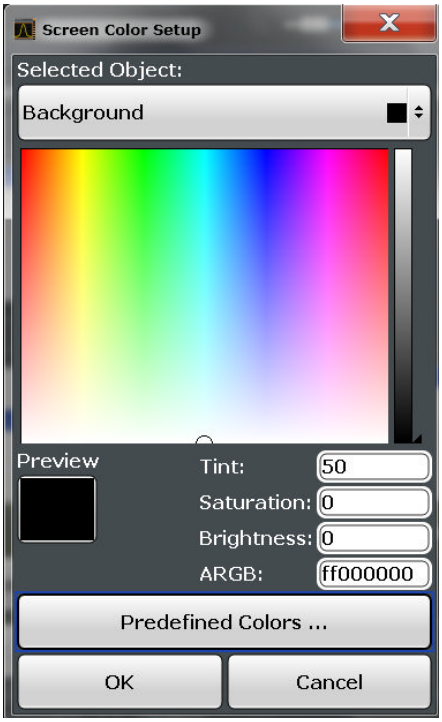
Predefined Colors ← Modifying User-Defined Colors
Displays the available colors from the predefined color set that can be used for the selected object.

Remote command:
`HCOPy:CMAP<item>:PDEFined` on page 920

Preview
Indicates the currently selected color that will be used for the selected object.

Defining User-specific Colors
In addition to the colors in the predefined color set you can configure a user-specific color to be used for the selected object.

When you select "Userdefined Colors", the set of predefined colors is replaced by a color palette and color configuration settings.



The color palette allows you to select the color directly. The color settings allow you to define values for tint, saturation and brightness.

Remote command:
`HCOPy:CMAP<item>:HSL` on page 920

Restoring the User Settings to Default Colors
In addition to the predefined color settings, a user-defined setting can be configured. By default, the same settings as defined in "Default Colors 1" are used. They can then be modified according to user-specific requirements (see "Modifying User-Defined Colors" on page 542).

The "Set to Default" function restores the original default settings for the user-defined color set. You can select which of the three default settings are restored.

Remote command:
`DISPlay:CMAP<item>:PDEFined` on page 945

9.5 External Monitor Settings

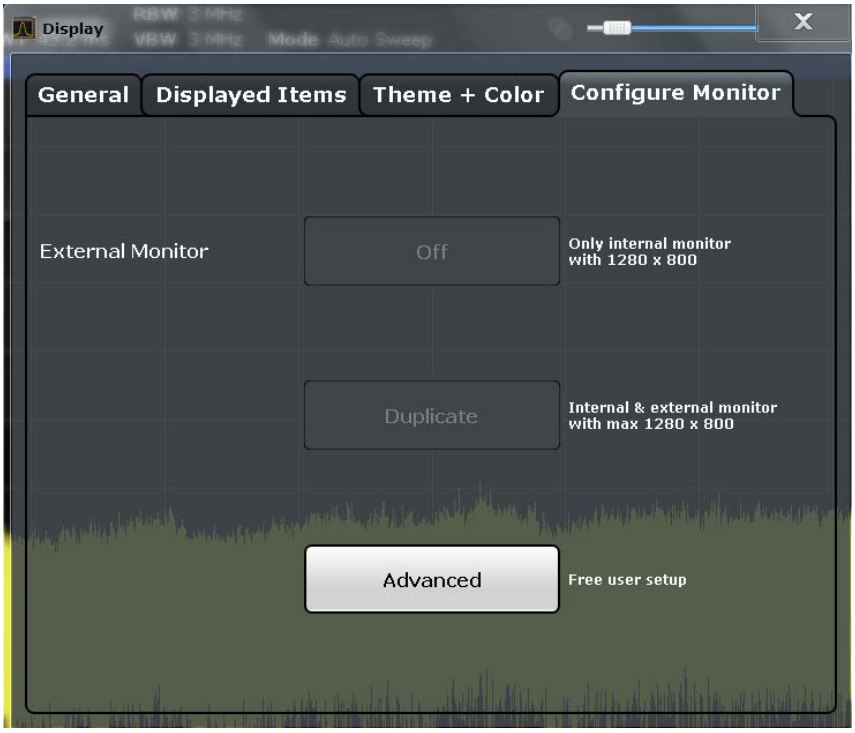
You can connect an external monitor (or projector) to the DVI or DISPLAY PORT connector on the instrument's rear panel (see the R&S FSW Getting Started manual).

Which display device is used by the instrument is configured in the "Configure Monitor" tab of the "Display" dialog box.

Screen resolution and format

The touch screen of the R&S FSW is calibrated for a 16:10 format. If you connect a monitor or projector using a different format (e.g. 4:3), the calibration will not be correct and the screen will not react to your touch actions properly.

The touch screen has a screen resolution of 1280x800 pixels. Most external monitors have a higher screen resolution. If the screen resolution of the monitor is set higher than the instrument's resolution, the application window uses an area of 1280x800 pixels on the monitor display. For full screen display, adjust the monitor's screen resolution.



External Monitor Off
Only the internal monitor of the R&S FSW is used for display.

Duplicate
Both the internal and the external monitor are used.

Advanced
User-defined configuration; opens the standard Windows configuration dialog box to configure the display devices to be used

9.6 How to Configure the Basic Instrument Settings

The following step-by-step instructions demonstrate how to configure the basic instrument settings. For details on individual functions and settings see chapter 9.3, "General Instrument Settings", on page 514.

The remote commands required to perform these tasks are described in chapter 9.3, "General Instrument Settings", on page 514.

9.6.1 How to Perform a Self Test

The self test does not need to be repeated every time the instrument is switched on. It is only necessary when instrument malfunction is suspected.

Operating temperature
Before performing this functional test, make sure that the instrument has reached its operating temperature (for details, refer to the data sheet).

1. Press the SETUP key.
2. Press the "Service" softkey.
3. Press the "Selftest" softkey.

   Once the instrument modules have been checked successfully, a message is displayed.

9.6.2 How to Align the Instrument and the Touch Screen

Operating temperature
Before performing this functional test, make sure that the instrument has reached its operating temperature (for details, refer to the data sheet).

To perform a self-alignment

1. Press the SETUP key.
2. Select the "Alignment" softkey.
3. Select the "Start Self-alignment" button.
4. To abort the self-alignment process, select the "Abort Self-alignment" button.

   Once the system correction values have been calculated successfully, a message is displayed.

To display the alignment results again later

- Press the SETUP key.
- Press the "Alignment" softkey.

To align the touch screen

1. Press the SETUP key.
2. Select the "Alignment" softkey.
3. Select "Touch Screen Alignment".

   A blinking cross appears in the lower left corner of the screen.
4. Touch and hold the blinking cross until it stops blinking.
   Repeat this action for the crosses in the other corners.

9.6.3 How to Install an R&S FSW Option

Additional options for the R&S FSW can be enabled using a license key. To obtain the license key, consult your sales representative. You need the device ID and serial number of your instrument to get a license key (see chapter 9.3.4, "System Configuration Settings", on page 524). No additional installation is required.

9.6.4 How to Update the Instrument Firmware

1. Download the update package from the Rohde&Schwarz website and store it on a memory stick, on the instrument, or on a server network drive that can be accessed by the instrument.
2. **NOTICE!** Stop measurement. The firmware update must not be performed during a running measurement.

   If a measurement is running, stop it by pressing the highlighted RUN CONT or RUN SINGLE key.
3. Press the SETUP key.
4. Select the "Firmware Update" tab.
5. In the file selection dialog box select the `FSWSetup*.exe` file.
6. Tap "Install" to start the update.
7. After the firmware update, the R&S FSW reboots automatically.
8. Depending on the previous firmware version, a reconfiguration of the hardware might be required during the first startup of the firmware. The reconfiguration starts auto-

matically, and a message box informs you about the process. When the reconfiguration has finished, the instrument again reboots automatically.

Note: Do not switch off the instrument during the reconfiguration process!

Now the firmware update is complete. It is recommended that you perform a self-alignment after the update (see chapter 9.6.2, "How to Align the Instrument and the Touch Screen", on page 546).

9.6.5 How to Configure the Transducer

Configuring the transducer is very similar to configuring limit lines.

The transducer settings are defined in the "Transducer" dialog box which is displayed when you press the SETUP key and then select "Transducer".

The following tasks are described:

- "How to find compatible transducer lines" on page 548
- "How to activate and deactivate a transducer" on page 548
- "How to edit existing transducer lines" on page 548
- "How to copy an existing transducer line" on page 549
- "How to delete an existing transducer line" on page 549
- "How to configure a new transducer line" on page 549
- "How to move the transducer line vertically or horizontally" on page 550

How to find compatible transducer lines

► In the "Transducer" dialog box, select the "View filter" option: "Show compatible".

All transducer lines stored on the instrument that are compatible to the current measurement settings are displayed in the overview.

How to activate and deactivate a transducer

1. To activate a transducer select a transducer line in the overview and select the "Active" setting for it.

   The trace is automatically recalculated for the next sweep after a transducer line is activated.

2. To deactivate a transducer line, deactivate the "Active" setting for it.

   After the next sweep, the originally measured values are displayed.

How to edit existing transducer lines

Existing transducer line configurations can be edited.

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Edit" button.

3. Edit the line configuration as described in "How to configure a new transducer line" on page 549.
4. Save the new configuration by selecting the "Save" button.

   The trace is automatically recalculated for the next sweep if the transducer line is active.

How to copy an existing transducer line

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Copy" button.

   The "Edit Transducer" dialog box is opened with the configuration of the selected transducer.
3. Define a new name to create a new transducer with the same configuration as the source line.
4. Edit the line configuration as described in "How to configure a new transducer line" on page 549.
5. Save the new configuration by selecting the "Save" button.

   The new transducer line is displayed in the overview and can be activated.

How to delete an existing transducer line

1. In the "Transducer" dialog box, select the transducer line.
2. Select the "Delete" button.
3. Confirm the message.

   The transducer line is deleted. After the next sweep, the originally measured values are displayed.

How to configure a new transducer line

1. In the "Transducer" dialog box, select the "New" button.

   The "Edit Transducer" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new transducer line.
3. Define the scaling for the x-axis.
4. Define the data points: minimum 2, maximum 50:
   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.
   c) Select "Insert Value" again and define the second data point.

d) Repeat this to insert all other data points.
To insert a data point before an existing one, select the data point and then "Insert Value".
To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
To delete a data point, select the entry and then "Delete Value".

5. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.
6. Save the new configuration by selecting the "Save" button.

The new transducer line is displayed in the overview and can be activated.

How to move the transducer line vertically or horizontally

A configured transducer line can easily be moved vertically or horizontally. Thus, a new transducer line can be easily generated based upon an existing transducer line which has been shifted.

1. In the "Line Config" dialog box, select the transducer line.
2. Select the "Edit" button.
3. In the "Edit transducer Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
4. Save the shifted data points by selecting the "Save" button.

If activated, the trace is recalculated after the next sweep.

9.6.6 How to Configure the Colors for Display and Printing

You can configure the style and colors with which various screen objects are displayed or printed.

To select a color set

1. Press the SETUP key and select the "Display" softkey.
2. Select the "Theme + Color" tab.
3. In the "Screen Colors" area, select a predefined set of colors to be used for screen display, or select "User Defined Colors" to configure the color set yourself.
4. In the "Print Colors" area, select a predefined set of colors to be used for printing screenshots, or select "User Defined Colors" to configure the color set yourself.
Activate the "Show Print Colors on Display" option to see a preview of the print colors.

To configure a user-defined color set

1. In the "Theme + Color" tab of the "Display" dialog box select "User Defined Colors" either for the screen or the print colors.
2. Select "Modify User Color".

   The "Screen Color Setup" dialog box is opened.
3. From the "Selected Object" list, select the object to which you want to assign a color.
4. Select a color from the "Predefined Colors" or select the "Userdefined Colors..." button to define a different color.

   The "Preview" area indicates the currently selected color.
5. To assign a user-specific color to the selected object, do one of the following:
   - Select the color from the palette.
   - Enter values for the "Tint", "Saturation", and "Brightness".
     Note: In the continuous color spectrum ("Tint") red is represented by 0% and blue by 100%.
   - Enter an "ARGB" value in hexadecimal format.
6. Select the next object to which you want to assign a color from the "Selected Object" list and assign a color as described.
   Repeat these steps until all objects you want to configure have been assigned a color.
7. Select "OK" to close the dialog box and apply the colors to the assigned objects.

9.6.7 How to Work with the Soft Front Panels

Basic operation with the soft front panels is identical to normal operation, except for the following aspects:

To activate a key, select the key on the touch screen.

To simulate the use of the rotary knob, use the additional keys displayed between the keypad and the arrow keys:

Icon	Function
	Turn left
	Enter
	Turn right

Mini Front Panel

The Mini Front Panel provides only the hardkeys on the touchscreen, in order to operate the R&S FSW via an external monitor or remote desktop.

By default, the "Auto close" option is activated and the Mini Front Panel window closes automatically after you select a key. This is useful if you only require the Mini Front Panel display occassionally to press a single function key.

If you want the window to remain open, deactivate the "Auto close" option. You can close the window manually by selecting "Close Panel" or the key combination ALT + M (be aware of the keyboard language defined in the operating system!).

To display the soft front panel or mini front panel

1. Press the SETUP key and select the "Display" softkey.
2. Select the "Displayed Items" tab.
3. Select "Front Panel: On" or "Mini Front Panel: On".

To activate or deactivate the front panel temporarily, press the F6 key on the external keyboard (if available) or on the remote computer.