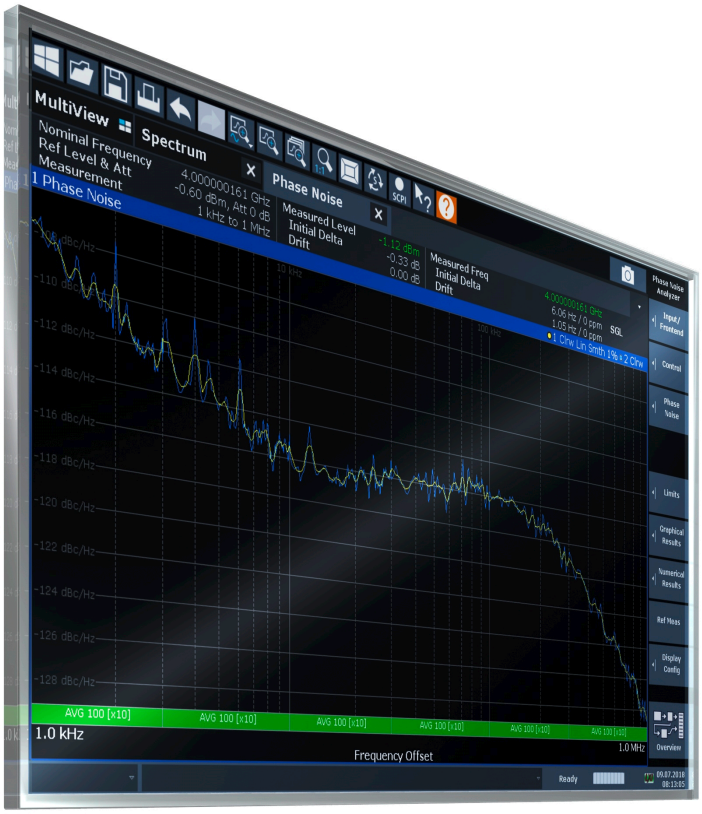
R&S®FSMR3-B60/B64
Phase Noise Measurements
User Manual



1179014502
Version 03

ROHDE&SCHWARZ
Make ideas real

This document describes the following R&S®FSMR3000 models:

- R&S®FSMR3008 (1345.4004K08)
- R&S®FSMR3026 (1345.4004K26)
- R&S®FSMR3050 (1345.4004K50)

The contents of this manual correspond to firmware version 1.20 and higher.
The following firmware options are described:

- R&S®FSMR3-B60 (1345.3114.08)
- R&S®FSMR3-B60 (1345.3114.26)
- R&S®FSMR3-B60 (1345.3114.50)
- R&S®FSMR3-B64 (1345.3120.02)

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1179.0145.02 | Version 03 | R&S®FSMR3-B60/B64

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®FSMR3000 is indicated as R&S FSMR3000.

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1 Welcome to the phase noise measurement application

The R&S FSMR3-B60/B64 is a hardware application that adds functionality to measure the phase noise characteristics of a device under test with the R&S FSMR3 measuring receiver.

This user manual contains a description of the functionality that the application provides, including remote control operation.

Functions that are not discussed in this manual are described in the R&S FSMR3 User Manual.

The latest versions of the manuals are available for download at the product homepage.

http://www.rohde-schwarz.com/product/FSMR3000.html.

Installation

Find detailed installing instructions in the Getting Started or the release notes of the R&S FSMR3.

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1.1 Starting the application

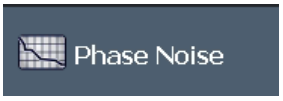
The phase noise measurement application adds a new type of measurement to the R&S FSMR3.

To activate the the Phase Noise application

1. Select the [MODE] key.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FSMR3.

2. Select the "Phase Noise" item.

   The R&S FSMR3 opens a new measurement channel for the Phase Noise application.
   All settings specific to phase noise measurements are in their default state.

For details see Chapter 2.3, "Selecting measurements", on page 22.

Multiple Measurement Channels and Sequencer Function

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

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

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

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

For details on the Sequencer function see the R&S FSMR3 User Manual.

1.2 Understanding the display information

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

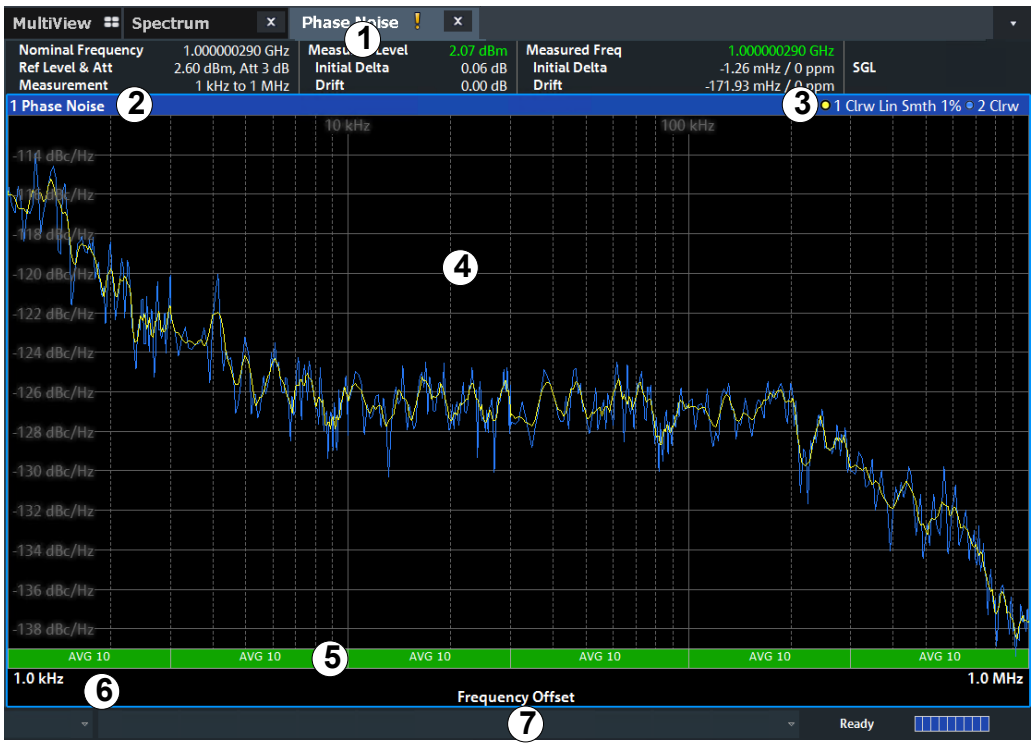


Figure 1-1: Screen layout of the phase noise measurement application

1 = Channel bar
2+3 = Diagram header
4 = Result display
5 = Measurement status
6 = Diagram footer
7 = Status bar

For a description of the elements not described below, please refer to the Getting Started of the R&S FSMR3.

Measurement status

The application shows the progress of the measurement in a series of green bars at the bottom of the diagram area. For each half decade in the measurement, the applications adds a bar that spans the frequency range of the corresponding half decade.

The bar has several features.

- The numbers within the green bar show the progress of the measurement(s) in the half decade the application currently works on.
  The first number is the current, the second number the total count of measurements for that half decade. The last number is the time the measurement requires.
- A double-click on the bar opens an input field to define the number of averages for that half decade.
- A right-click on the bar opens a context menu.

The context menu provides easy access to various parameters (resolution bandwidth, sweep mode etc.) that define the measurement characteristics for a half decade. The values in parentheses are the currently selected values.

Channel bar information

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

Figure 1-2: Channel bar of the phase noise application

Frequency — Frequency the R&S FSMR3 has been tuned to.

The frontend frequency is the expected frequency of the carrier. When frequency tracking or verification is on, the application might adjust the frontend frequency.

Ref Level & Att — Reference level (first value) and attenuation (second value) of the R&S FSMR3.

When level tracking or verification is on, the application might adjust the frontend level.

Measurement — Complete phase noise measurement range. For more information see Chapter 3.5.1, "Measurement range", on page 44.

Measured Level — DUT level that has been actually measured.

The measured level might differ from the frontend level, e.g. if you are using level verification.

Initial Delta — Difference between the nominal level and the first level that has been measured.

Drift — Difference between the 1st level that has been measured and the level that has been measured last.

In continuous sweep mode, the drift is the difference between the 1st level that has been measured in the 1st sweep and the level that has been measured last.

Measured Frequency — DUT frequency that has been actually measured.

The measured frequency might differ from the frontend frequency, e.g. if you are using level verification.

Initial Delta — Difference between the nominal frequency and the first frequency that has been measured.

Drift	Difference between the 1st frequency that has been measured and the frequency that has been measured last. In continuous sweep mode, the drift is the difference between the 1st frequency that has been measured in the 1st sweep and the frequency that has been measured last.
SGL [#/#]	Sweep mode (single or continuous). If you use trace averaging, it also shows the current measurement number out of the total number of measurements.

The following two figures show the relations between the frequency and level errors.

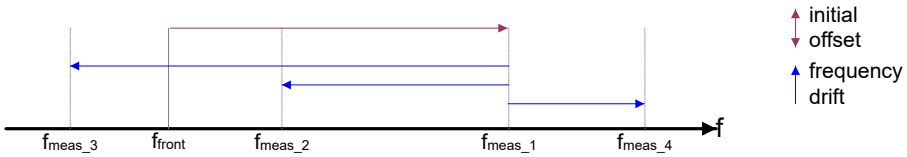


Figure 1-3: Frequency errors

f_{front} = initial frequency set on the frontend
f_{meas_x} = actual frequency that has been measured

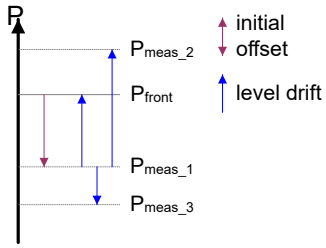


Figure 1-4: Level errors

P_{front} = reference level if tracking = off
P_{front} = initial reference level if tracking = on
P_{meas_1} = becomes reference level after first sweep if tracking = on
P_{meas_2} = becomes reference level after second sweep if tracking = on
P_{meas_3} = becomes reference level after third sweep if tracking = on

Window title bar information

For each diagram, the header provides the following information:

Figure 1-5: Window title bar information of the phase noise application

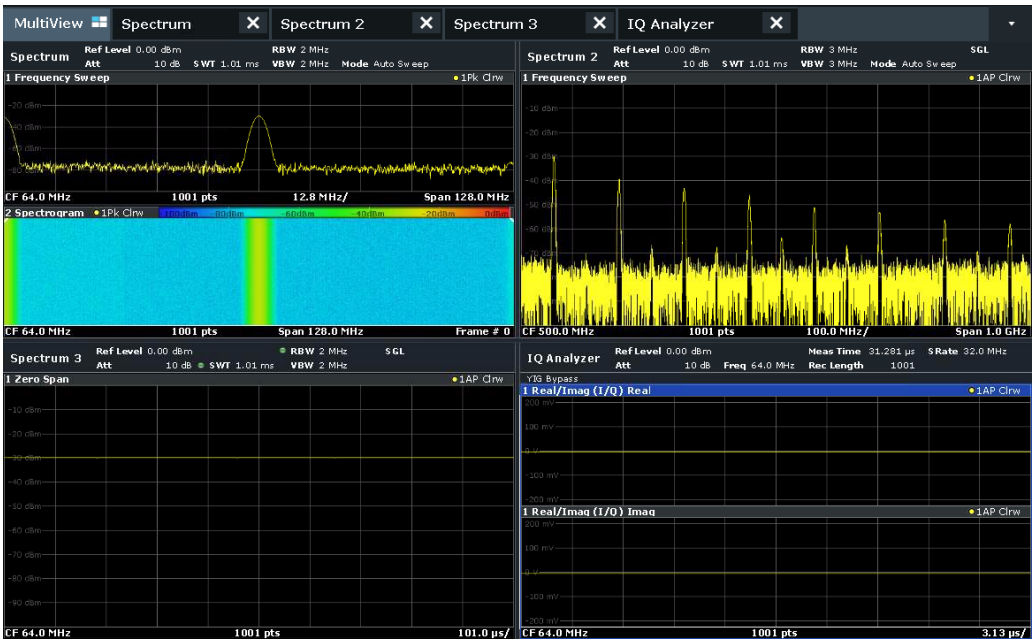
1 = Window number
2 = Window type
3 = Trace color and number
4 = Trace mode
5 = Smoothing state and degree

Status bar information

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

1.3 R&S multiview

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



Remote command:

`DISPlay:FORMat` on page 164

1.4 Running a sequence of measurements

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

- The sequencer concept 15
- Sequencer settings 17
- How to set up the sequencer 17

1.4.1 The sequencer concept

The instrument can only activate one specific channel at any time. Thus, only one measurement can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided, which changes the channel of the instrument as required. If activated, the measurements configured in the currently defined "Channel"s are performed one after the other in the order of the tabs.

For each individual measurement, the sweep count is considered. Thus, each measurement may consist of several sweeps. The currently active measurement is indicated by a ❁ symbol in the tab label.

The result displays of the individual channels are updated in the tabs as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

Sequencer modes

Three different Sequencer modes are available:

- **Single Sequence**
  Similar to single sweep mode; each measurement is performed once, until all measurements in all defined "Channel"s have been performed.
- **Continuous Sequence**
  Similar to continuous sweep mode; the measurements in each defined "Channel" are performed one after the other, repeatedly, in the same order, until sequential operation is stopped. This is the default Sequencer mode.
- **Channel-defined Sequence**
  First, a single sequence is performed. Then, only "Channel"s in continuous sweep mode are repeated continuously.

Example: Sequencer procedure

Assume the following active channel definition:

Tab name	Application	Sweep mode	Sweep count
Spectrum	Spectrum	Cont. Sweep	5
Spectrum 2	Spectrum	Single Sweep	6
Spectrum 3	Spectrum	Cont. Sweep	2
IQ Analyzer	IQ Analyzer	Single Sweep	7

For **Single Sequence**, the following sweeps will be performed:

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer

For **Continuous Sequence**, the following sweeps will be performed:

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer,

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer,

...

For **Channel-defined Sequence**, the following sweeps will be performed:

5x Spectrum, 6x Spectrum 2, 2 x Spectrum 3, 7x IQ Analyzer,

5x Spectrum, 2 x Spectrum 3,

5x Spectrum, 2 x Spectrum 3,

...

Run Single/Run Cont and Single Sweep/Sweep Continuous keys

While the Sequencer is active, the [Run Single] and [Run Cont] keys control the Sequencer, not individual sweeps. [Run Single] starts the Sequencer in single mode, while [Run Cont] starts the Sequencer in continuous mode.

The "Single Sweep" and "Continuous Sweep"*softkeys* control the sweep mode for the currently selected channel only; 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. A channel in continuous sweep mode is swept repeatedly.

1.4.2 Sequencer settings

The "Sequencer" menu is available from the toolbar.

Sequencer State 17
Sequencer Mode 17

Sequencer State
Activates or deactivates the Sequencer. If activated, sequential operation according to the selected Sequencer mode is started immediately.

Remote command:
`SYSTem:SEQuencer` on page 114
`INITiate:SEQuencer:IMMediate` on page 113
`INITiate:SEQuencer:ABORt` on page 113

Sequencer Mode
Defines how often which measurements are performed. The currently selected mode softkey is highlighted blue. During an active Sequencer process, the selected mode softkey is highlighted orange.

"Single Sequence"
Each measurement is performed once, until all measurements in all active channels have been performed.

"Continuous Sequence"
The measurements in each active channel are performed one after the other, repeatedly, in the same order, until sequential operation is stopped.
This is the default Sequencer mode.

"Channel Defined Sequence"
First, a single sequence is performed. Then, only channels in continuous sweep mode are repeated.

Remote command:
`INITiate:SEQuencer:MODE` on page 113

1.4.3 How to set up the sequencer

In order to perform the configured measurements consecutively, a Sequencer function is provided.

1. Configure a channel for each measurement configuration as required, including the sweep mode.
2. In the toolbar, select the "Sequencer" icon.

   The "Sequencer" menu is displayed.
3. Toggle the "Sequencer" softkey to "On".

   A continuous sequence is started immediately.
4. To change the Sequencer mode and start a new sequence immediately, select the corresponding mode softkey, or press the [Run Single] or [Run Cont] key.

   The measurements configured in the currently active channels are performed one after the other in the order of the tabs until the Sequencer is stopped.
   The result displays in the individual channels are updated as the measurements are performed.

To stop the sequencer

► To stop the Sequencer temporarily, press the highlighted [Run Single] or [Run Cont] key (not for a channel-defined sequence). To continue the Sequencer, press the key again.
To stop the Sequencer permanently, select the "Sequencer" icon in the toolbar and toggle the "Sequencer" softkey to "Off".

2 Measurements and result displays

The noise performance of a DUT is usually described by various effects and signal characteristics that can be measured by the R&S FSMR3.

The R&S FSMR3 provides several measurements, each of which analyzes different noise characteristics for different types of signal.

All measurements support several result displays, each of which shows different aspects of the noise characteristics of the measured signal.

- Basics on phase noise measurements 19
- Performing measurements 20
- Selecting measurements 22
- Result displays 23
- Result display configuration 28

2.1 Basics on phase noise measurements

2.1.1 Residual effects

Residual noise effects are modulation products that originate directly from the phase noise. It is possible to deduct them mathematically from the phase noise of a DUT.

The application calculates three residual noise effects. All calculations are based on an integration of the phase noise over a particular offset frequency range.

Residual PM

The residual phase modulation is the contribution of the phase noise to the output of a PM demodulator. It is evaluated over the frequency range you have defined.

$$\text{Residual PM} = \sqrt{2 \cdot \int_{f_{start}}^{f_{stop}} L(f_m) df_m} \; [rad]$$

with $L(f) =$ single sideband phase noise [dBc/Hz]

Residual FM

The residual frequency modulation is the contribution of the phase noise to the output of an FM demodulator. It is evaluated over the frequency range you have defined.

$$\text{Residual FM} = \sqrt{2 \cdot \int_{f_{start}}^{f_{stop}} f_m^2 L(f_m) df_m \ [Hz]}$$

with $L(f_m)$ = single sideband phase noise [dBc/Hz]

f_m = frequency [Hz]

Jitter

The jitter is the RMS temporal fluctuation of a carrier with the given phase noise evaluated over a given frequency range of interest.

$$\text{Jitter[s]} = \frac{\text{ResidualPM [rad]}}{2\pi \cdot f_0}$$

with f_0 = Carrier frequency

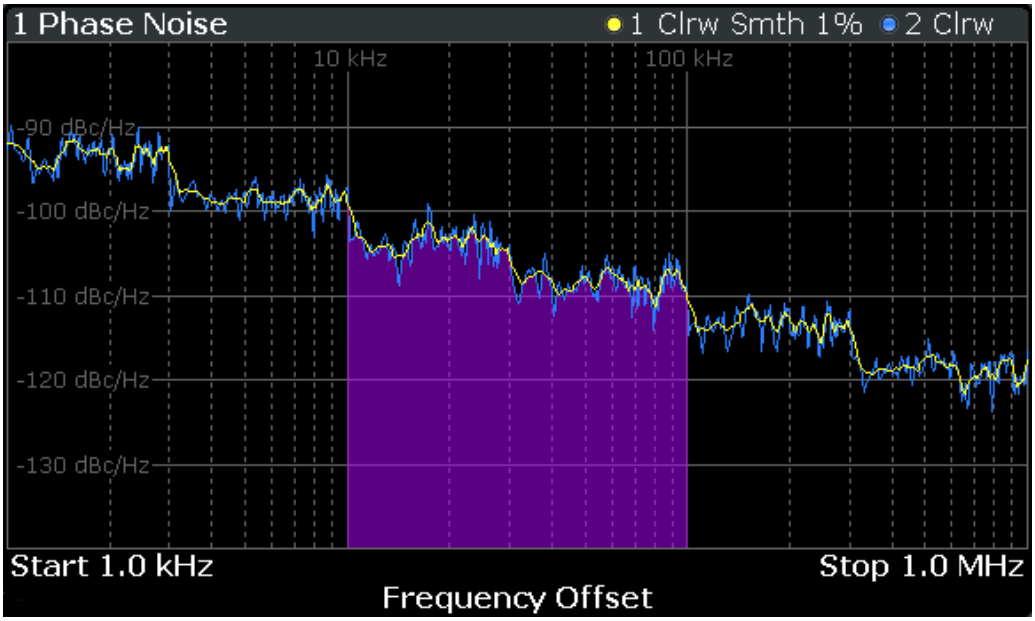


Figure 2-1: Residual noise based on an integration between 10 kHz and 100 kHz offset

2.2 Performing measurements

To start single measurements

1. Configure the measurement range you would like to measure ("Frequency" dialog box, see Chapter 3.4, "Frequency", on page 40).
2. Configure the number of measurements you would like to perform in a single measurement ("Sweep Config" dialog box, see "Sweep/Average Count" on page 48).

3. Define how the results are evaluated for display ("Trace" dialog box, see Chapter 4.2, "Trace configuration", on page 65).
4. To start the measurement, select one of the following:
   - [RUN SINGLE] key
   - "Single Sweep" softkey in the "Sweep" menu

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

To start continuous measurements

1. If you want to average the trace or search for a maximum over more (or less) than 10 measurements, configure the "Average/Sweep Count" ("Sweep Config" dialog box, see "Sweep/Average Count" on page 48).
2. To start the measurement, select one of the following:
   - [RUN CONT] key
   - "Continuous Sweep" softkey in the "Sweep" menu

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

Single Sweep / Run Single....21
Continuous Sweep / Run Cont....22
Continue Single Sweep....22

Single Sweep / Run Single
Initiates a single measurement. The measurement is finished after all frequencies in the frequency list have been measured. If necessary, the application automatically determines the reference level before starting the actual measurement.

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 takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, the Sequencer sweeps a channel in single sweep mode only once.
Furthermore, the [RUN SINGLE] key controls the Sequencer, not individual sweeps. [RUN SINGLE] starts the Sequencer in single mode.

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

For details on the Sequencer, see Chapter 1.4.1, "The sequencer concept", on page 15.

Remote command:
INITiate<n>[:IMMediate] on page 119

Continuous Sweep / Run Cont
Initiates a measurement and repeats it continuously until stopped. If necessary, the application automatically determines the reference level before starting the actual measurement.

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

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, the [RUN CONT] key controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see Chapter 1.4.1, "The sequencer concept", on page 15.

Remote command:
INITiate<n>:CONTinuous on page 118

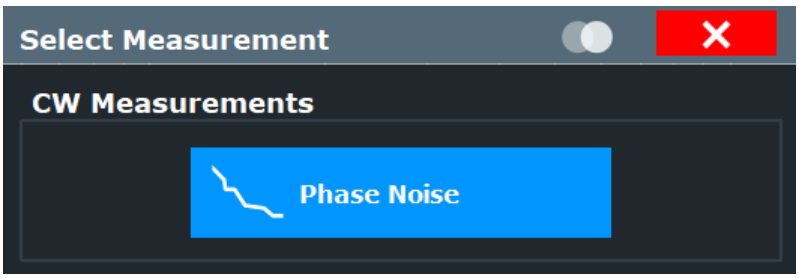
Continue Single Sweep
Repeats the number of measurements defined by the "Sweep Count", without deleting the trace of the last measurement.

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

Remote command:
INITiate<n>:CONMeas on page 118

2.3 Selecting measurements

Access: [MEAS]



The R&S FSMR3 provides several noise measurements, each determining different noise aspects of different types of signal.

Phase noise measurement 23

Phase noise measurement
Provides tools to measure the noise characteristics of a continuous wave signal.

This measurement measures the combined noise characteristics of the components in the test setup.

Remote command:
`CONFigure:PNOise:MEASurement` on page 117

2.4 Result displays

Result displays show different aspects of the measurement results in numerical or graphical form.

Depending on the measurement, one or more result displays are supported.

- "Noise Diagram" on page 23
- "Integrated Measurements" on page 24
- "Spurious List" on page 25
- "Marker Table" on page 27
- "Allan Variance / Allan Deviation" on page 26

Noise Diagram 23
Integrated Measurements 24
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Noise Diagram
The "Noise Diagram" result display shows the power level of the noise over a variable frequency offset from the carrier frequency.

The unit of both axes in the diagram is fix. The x-axis always shows the offset frequencies in relation to the carrier frequency on a logarithmic scale in Hz. It always has a logarithmic scale to make sure of an equal representation of offsets near and far away from the carrier. The range of offsets that the x-axis shows is variable and depends on the measurement range you have defined and the scope of the x-axis that you have set.

The y-axis always shows the noise power level contained in a 1 Hz bandwidth in relation to the level of the carrier.

The unit of the y-axis depends on which version of the "Noise Spectrum" diagram you have selected.

- "Noise Spectrum": Default display showing the single sideband phase noise with linear y-axis in dBc/Hz.

  - "PN Noise Spectrum": Preconfigured for phase noise measurements.
  - "AM Noise Spectrum": Preconfigured for AM noise measurements.
- "Noise Spectrum L(f)": Same as the "Noise Spectrum" without AM noise calculation.
- "Noise Spectrum SΦ(f)": Display showing the spectral density of phase fluctuations with linear y-axis in dB/Hz.
- "Noise Spectrum Sv(f)": Display showing the spectral density of frequency fluctuations with logarithmic y-axis in Hz/sqrt(Hz).
- "Noise Spectrum Sy(f)": Display showing the spectral density of fractional frequency fluctuations with logarithmic y-axis in 1/sqrt(Hz).
  The R&S FSMR3 adjusts numerical results like integrated measurements and spot noise accordingly. AM noise calculation is only supported by the "Noise Spectrum" result display.

The scale of the y-axis is variable. Usually it is best to use the automatic scaling that the application provides, because it makes sure that the whole trace is always visible. You can, however, also customize the range, the minimum and the maximum values on the y-axis by changing the y-axis scale.

The measurement results are displayed as traces in the diagram area. Up to six active traces at any time are possible. Each of those can have a different setup and thus show different aspects of the measurement results.

In the default state, the application shows two traces. A yellow one and a blue one. Both result from the same measurement data, but have been evaluated differently. On the first trace, smoothing has been applied, the second one shows the raw data.

The diagram also contains a grey area in its default state. This trace represents the cross-correlation gain indicator.

Remote command:
`TRACe<n>[:DATA]?` on page 125

Integrated Measurements
The "Integrated Measurements" result display summarizes the residual effects results in a table.

The table consists of up to four rows with each row representing a different integration interval. Each row basically contains the same information, which depends on the residual effects configuration.

Result	Description
Wnd	Shows the number of the measurement window the integration is done in (usually "1", unless you have several noise diagrams open at the same time).
Range	Shows the index of the integration range (1 to 4).
Trace	Shows the number of the trace the integration is applied to.
Start / Stop Offset	Shows the start and stop offset of the integration interval.
Weighting	Shows the name of the weighting filter, if you have applied one.

Result	Description
Int Noise	Shows the integrated noise. The integral is calculated over the frequency range defined by the "Start" and "Stop" values.
PM	Shows the residual PM result in degrees and rad. (Only available for Phase Noise traces.)
FM / AM	Shows the residual FM results in Hz or the residual AM results in %, depending on the trace configuration. (Only available for Phase Noise traces.)
Jitter	Shows the jitter in seconds. (Only available for Phase Noise traces.)

Remote command:
Int. PHN: `FETCh<n>[:RANGe<ri>]:PNOise<t>:IPN?` on page 122
FM: `FETCh<n>[:RANGe<ri>]:PNOise<t>:RFM?` on page 123
AM: `FETCh<n>[:RANGe<ri>]:PNOise<t>:RAM?` on page 122
PM: `FETCh<n>[:RANGe<ri>]:PNOise<t>:RPM?` on page 123
Jitter: `FETCh<n>[:RANGe<ri>]:PNOise<t>:RMS?` on page 123

Spurious List

Spurs are peak levels at one or more offset frequencies and are caused mostly by interfering signals. The "Spurious List" result display shows the location of all detected spurs in a table.

Note that only signals above a certain threshold are regarded as spurs. This threshold is also considered in the spurious list if spur removal has been turned off for a trace.

The table consists of a variable number of rows. For each detected spur, the table shows several results.

Wnd	Shows the number of the measurement window the spur is in (usually "1", unless you have several noise diagrams open at the same time).
Trace	Shows the trace that the spur is on.
Spur	Shows the spur number. Spurs are sorted by their frequency, beginning with the spur with the lowest frequency.
Offset	Shows the position (offset frequency) of the spur.
Power	Shows the power level of the spur in dBc.
Jitter	Shows the jitter value of the spur in s. In addition to the jitter for each spur, the result display also shows the discrete jitter and the random jitter at the end of the table. • The discrete jitter is the RMS average of all individual spur jitter values. • The random jitter is the jitter contribution of the phase noise without spurs.

Remote command:
FETCh<n>:PNOise<t>:SPURs? on page 120
FETCh<n>:PNOise<t>:SPURs:JITTer? on page 121
FETCh<n>:PNOise<t>:SPURs:DISCrete? on page 120
FETCh<n>:PNOise<t>:SPURs:RANDom? on page 121

Spot Noise
The "Spot Noise" result display shows the noise at a certain frequency offset (or spot) that is part of the measurement range. It is thus like a fixed marker.

The unit of spot noise results is dBc/Hz. The application shows the results in a table.

The table consists of a variable number of 10_x frequencies (depending on the measurement range), and a maximum of six user frequencies, with each row containing the spot noise information for a particular frequency offset.

The spot noise information is made up out of several values.

Offset Frequency	Shows the offset frequency the spot noise is evaluated for. You can add any offset that is part of the measurement range. The number in brackets (T<x>) indicates the trace the result refers to.
Noise[T<x>]	Shows the noise for the corresponding offset frequency. The number in brackets (T<x>) indicates the trace the result refers to.

Remote command:
Querying spot noise results on 10_x offset frequencies:
CALCulate<n>:SNOise<ri>[:TRACe<t>]:DECades:X? on page 156
CALCulate<n>:SNOise<ri>[:TRACe<t>]:DECades:Y? on page 157
Querying custom spot noise results:
CALCulate<n>:SNOise<ri>[:TRACe<t>]:Y? on page 158

Allan Variance / Allan Deviation
The "Allan Variance" and "Allan Deviation" result displays are tools to determine the frequency stability of a DUT over a long period of time (days or even months).

Frequency stability is a measure of how well a DUT is able to produce its specified frequency over time without deviating from that frequency. Because of the noise characteristics of oscillators, standard variance or deviation are not really applicable. Instead the Allan variance and deviation are the tools of choice for these statistical evaluations. Like the standard deviation, the Allan variance and deviation show how much the frequency of the DUT deviates from its specified (= average) value. Also like the standard variance and deviation, the deviation is the square root of the variance.

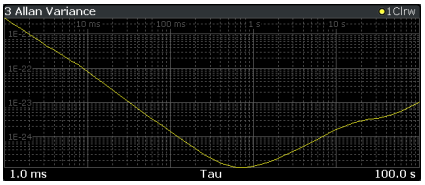
The R&S FSMR3 calculates the Allan variance from the phase noise spectrum using the following relationship:

$$\sigma_y^2(\tau) = 2\int_0^{f_h} S_y(f)\frac{sin^4(\pi\tau f)}{(\pi\tau f)}df$$

f_h = integration bandwidth
S_y = spectral density of fractional frequency fluctuations
τ = observation time
f = offset frequency

Overall, low values, both variance and deviation, correspond to a stable DUT, high values to an unstable DUT.

When you measure the stability of an oscillator, the resulting curve has a characteristic shape. The shape is the same for variance and deviation.



The point of interest in the diagram is the minimum of the curve. First, the deviation is high, because of noise. During the progression of the observation, the noise averages out until the minimum is reached. The minimum thus corresponds to the point in time when the deviation from the specified frequency is at its lowest. After that, the stability deteriorates due to temperature effects and aging.

From the slope of the curve, you can also identify the type of noise that is in effect (white noise, flicker phase, white frequency, flicker frequency, random walk).

For a comprehensive discussion of the Allan variance, refer to application note 1EF69: Time Domain Oscillator Stability Measurement - Allan Variance.

The logarithmic x-axis corresponds to the observation time ("Tau"). Note that Tau is not the measurement time, but the evaluated time - the measurement lasts longer than Tau. Because the R&S FSMR3 calculates the Allan variance based on the measurement range of the phase noise measurement (offset frequency), the observation time corresponds to the measurement range and vice versa.

The start time also defines the measurement bandwidth or integration bandwidth (f_h in the equation above):

$$BW_{Meas} = \frac{1}{\tau_{Start}}$$

The measurement bandwidth is displayed in the diagram area.

The y-axis shows the variance or deviation. It also has a logarithmic scale.

Remote command:
Trace data: `TRACe<n>[:DATA]?` on page 125
Measurement bandwidth: `[SENSe:]BWIDth:MEASurement?` on page 124

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

This table is displayed automatically if configured accordingly.

1 Marker Table

Wnd	Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
2	M1		1	2.1725 ms	-6.80 dBm		
2	D2	M1	1	13.859 ms	-0.00 dB		
2	D3	M1	1	4.6259 ms	-0.00 dB		
2	D4	M1	1	9.2331 ms	-0.00 dB		

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

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 165
Results:
`CALCulate<n>:MARKer<m>:X` on page 193

2.5 Result display configuration

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations. 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 result displays 28
- Laying out the result display with the smartgrid 28

2.5.1 Basic result displays

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 result displays described here are available for most measurements in the phase noise application.

2.5.2 Laying out the result display with the smartgrid

Measurement results can be evaluated in many different ways, for example graphically, as summary tables, statistical evaluations etc. Each type of evaluation is displayed in a separate window in the channel tab. Up to 16 individual windows can be displayed per channel (i.e. per tab). To arrange the diagrams and tables on the screen, the Rohde & Schwarz SmartGrid function helps you find the target position simply and quickly.

Principally, the layout of the windows on the screen is based on an underlying grid, the SmartGrid. However, the SmartGrid is dynamic and flexible, allowing for many different layout possibilities. The SmartGrid functionality provides the following basic features:

- Windows can be arranged in columns or in rows, or in a combination of both.
- Windows can be arranged in up to four rows and four columns.
- Windows are moved simply by dragging them to a new position on the screen, possibly changing the layout of the other windows, as well.
- All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar. If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. The same evaluation method can be displayed in multiple windows simultaneously.

- New windows are added by dragging an evaluation icon from the evaluation bar to the screen. The position of each new window depends on where you drop the evaluation icon in relation to the existing windows.
- All display configuration actions are only possible in SmartGrid mode. When SmartGrid mode is activated, the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.

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- How to activate smartgrid mode....30
- How to add a new result window....31
- How to close a result window....31
- How to arrange the result windows....32

2.5.2.1 Background information: the smartgrid principle

SmartGrid display

During any positioning action, the underlying SmartGrid is displayed. Different colors and frames indicate the possible new positions. The position in the SmartGrid where you drop the window determines its position on the screen.

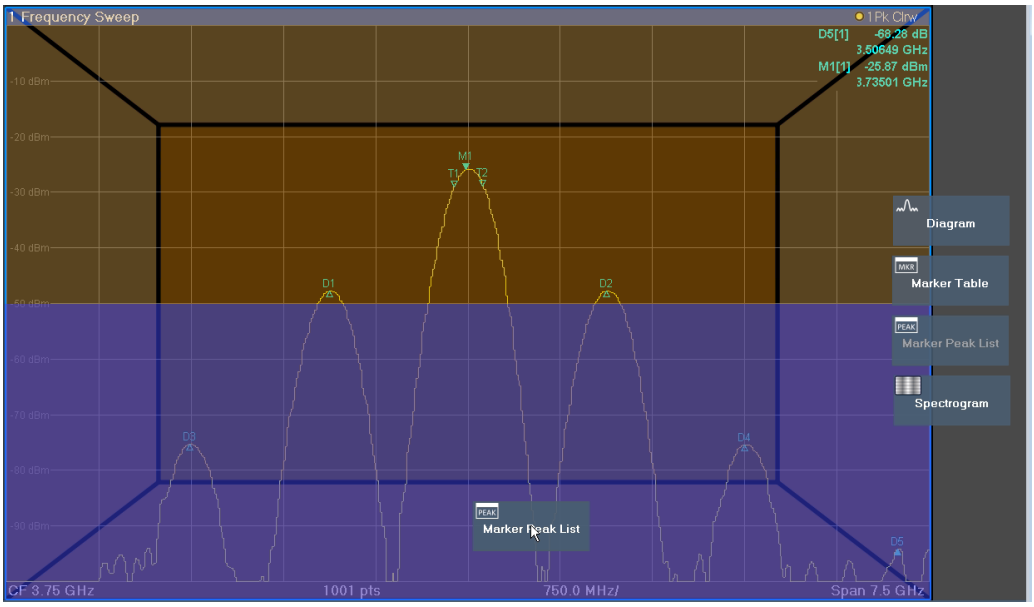

Figure 2-2: Moving a window in SmartGrid mode

The brown area indicates the possible "drop area" for the window, i.e. the area in which the window can be placed. A blue area indicates the (approximate) layout of the window as it would be if the icon were dropped at the current position. The frames indicate the possible destinations of the new window with respect to the existing windows: above/below, right/left or replacement (as illustrated in Figure 2-3). If an existing window would be replaced, the drop area is highlighted in a darker color shade.

Positioning the window

The screen can be divided into up to four rows. Each row can be split into up to four columns, where each row can have a different number of columns. However, rows always span the entire width of the screen and may not be interrupted by a column. A single row is available as the drop area for the window in the SmartGrid. The row can be split into columns, or a new row can be inserted above or below the existing row (if the maximum of 4 has not yet been reached).

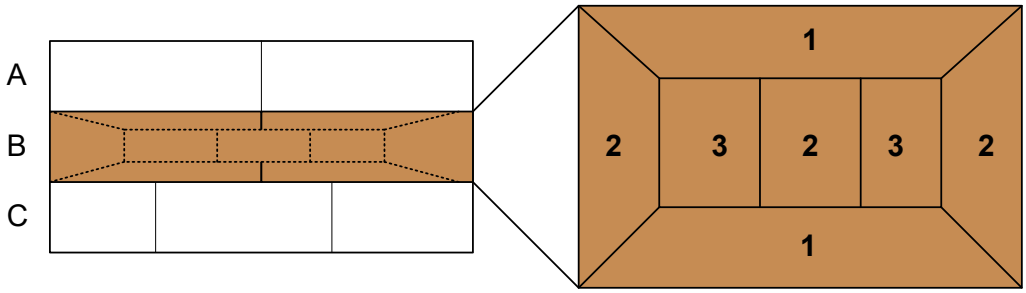

Figure 2-3: SmartGrid window positions

1 = Insert row above or below the existing row
2 = Create a new column in the existing row
3 = Replace a window in the existing row

SmartGrid functions

Once the evaluation icon has been dropped, icons in each window provide delete and move functions.

The "Move" icon allows you to move the position of the window, possibly changing the size and position of the other displayed windows.

The "Delete" icon allows you to close the window, enlarging the display of the remaining windows.

2.5.2.2 How to activate smartgrid mode

All display configuration actions are only possible in SmartGrid mode. In SmartGrid mode the evaluation bar replaces the current softkey menu display. When the SmartGrid mode is deactivated again, the previous softkey menu display is restored.

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

- 

  Select the "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the configuration "Overview".

- Select the "Display Config" softkey from the [Meas Config] menu.

The SmartGrid functions and the evaluation bar are displayed.

To close the SmartGrid mode and restore the previous softkey menu select the "Close" icon in the right-hand corner of the toolbar, or press any key.

2.5.2.3 How to add a new result window

Each type of evaluation is displayed in a separate window. Up to 16 individual windows can be displayed per channel (i.e. per tab).

1. Activate SmartGrid mode.

   All evaluation methods available for the currently selected measurement are displayed as icons in the evaluation bar.

2. Select the icon for the required evaluation method from the evaluation bar.
   If the evaluation bar contains more icons than can be displayed at once on the screen, it can be scrolled vertically. Touch the evaluation bar between the icons and move it up or down until the required icon appears.

3. Drag the required icon from the evaluation bar to the SmartGrid, which is displayed in the diagram area, and drop it at the required position. (See Chapter 2.5.2.5, "How to arrange the result windows", on page 32 for more information on positioning the window).

Remote command:

`LAYout:ADD[:WINDow]?` on page 165 / `LAYout:WINDow<n>:ADD?` on page 170

2.5.2.4 How to close a result window

► To close a window, activate SmartGrid mode and select the "Delete" icon for the window.

Remote command:

`LAYout:REMove[:WINDow]` on page 167 / `LAYout:WINDow<n>:REMove` on page 171

2.5.2.5 How to arrange the result windows

1. Select an icon from the evaluation bar or the "Move" icon for an existing evaluation window.

2. Drag the evaluation over the SmartGrid.
   A blue area shows where the window will be placed.
3. Move the window until a suitable area is indicated in blue.
4. Drop the window in the target area.

   The windows are rearranged to the selected layout, and "Delete" and "Move" icons are displayed in each window.
5. To close a window, select the corresponding "Delete" icon.

Remote command:

`LAYout:REPLace[:WINDow]` on page 168 / `LAYout:WINDow<n>:REPLace` on page 171

`LAYout:MOVE[:WINDow]` on page 167

3 Common measurement settings

Basic measurement settings that are common to many measurement tasks, regardless of the application or operating mode, are described here. If you are using an application other than the Phase Noise application, be sure to check the documentation for that application. The settings can deviate from the common settings described here.

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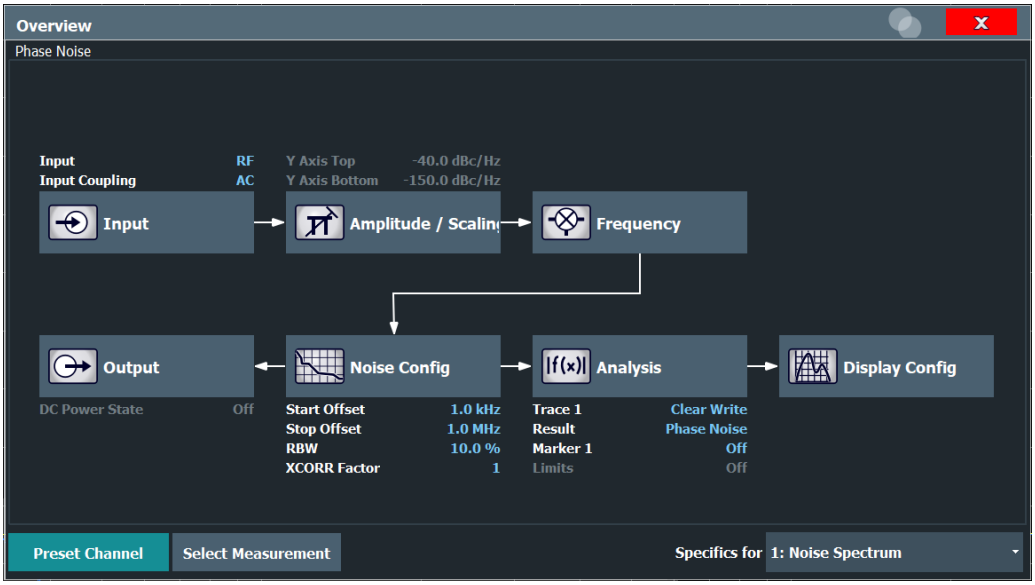
- Input source 35
- Level characteristics 36
- Frequency 40
- Noise measurement configuration 44
- Output 56

3.1 Configuration overview

Access: "Overview"

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



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

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

1. Input
   See Chapter 3.2, "Input source", on page 35.
2. Amplitude / Scaling
   See Chapter 3.3, "Level characteristics", on page 36.
3. Frequency
   See Chapter 3.4, "Frequency", on page 40.
4. Noise
   See Chapter 3.5, "Noise measurement configuration", on page 44.
5. Output
   See Chapter 3.6, "Output", on page 56.
6. Analysis
   See Chapter 4, "Common analysis and display functions", on page 58.
7. Display Configuration
   See Chapter 2, "Measurements and result displays", on page 19.

In addition, the dialog box provides the "Select Measurement" button that serves as a shortcut to select the measurement type.

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Preset Channel 34
Specific Settings for 34

Selecting the noise measurement type
The R&S FSMR3 provides different types of measurements to measure the noise characteristics of a DUT.

- Phase Noise
  Phase noise and AM noise measurements for continuous wave signals.

Remote command:
`CONFigure:PNOise:MEASurement` on page 117

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

Note: Do not confuse the "Preset Channel" button with the [Preset] *key*, which restores the entire instrument to its default values and thus closes *all channels* on the R&S FSMR3 (except for the default channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 112

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

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

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

3.2 Input source

The phase noise application supports input from several signal sources.

- RF input....35

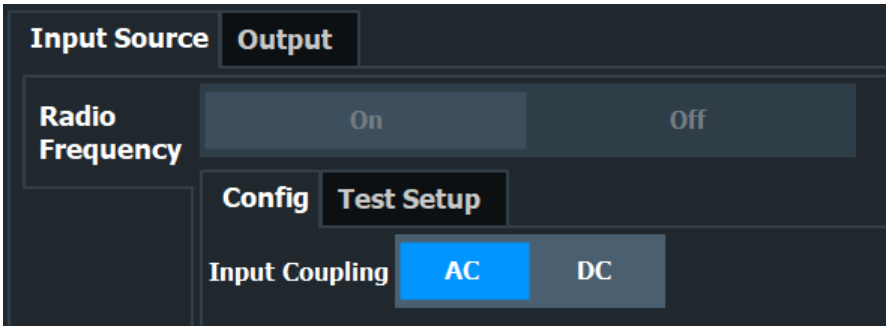
3.2.1 RF input

Access (RF input settings): "Overview" > "Input" > "Input Source" > "Radio Frequency" > "Config"

Access (schematic test setups): "Overview" > "Input" > "Input Source" > "Radio Frequency" > "Test Setup"

The RF Input is the default input source.

A typical test setup for measurements over the RF input depends on the selected measurement and the equipment used in the test setup. A schematic representation of such a setup is provided in the dialog box. The DUT directly sends a signal to the RF input of the R&S FSMR3.



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Input Coupling.... 35

Radio Frequency State
Activates input from the "RF Input" connector.

Remote command:
`INPut<ip>:SELect` on page 128

Input Coupling
The RF input of the R&S FSMR3 can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. AC coupling is activated by default to prevent damage to the instrument. Very low frequencies in the input signal can be distorted.

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

Remote command:
`INPut<ip>:COUPling` on page 128

3.3 Level characteristics

Measurement results usually consist of the measured signal levels (amplitudes) displayed on the vertical y-axis for the determined frequency spectrum (horizontal, x-axis). The settings for the vertical axis, regarding amplitude and scaling, are described here.

- Signal attenuation 36
- Amplitude characteristics 37
- Diagram scale 39

3.3.1 Signal attenuation

Signal attenuation reduces the level of the signal that you feed into the R&S FSMR3. Reducing the level is necessary to protect the input mixer from signals with high levels, because high levels can cause an overload of the input mixer. An input mixer overload in turn can lead to incorrect measurement results or even damage or destroy the input mixer.

The level at the input mixer is determined by the set RF attenuation according to the formula:

$level_{mixer} = level_{input}$ - RF attenuation

The maximum level that the input mixer can handle is 0 dBm. Levels above this value cause an overload. The R&S FSMR3 indicates an overload situation by the "RF OVLD" label in the status bar.

The R&S FSMR3 features a mechanical attenuator. The mechanical attenuator is located directly after the RF input of the R&S FSMR3. Its step size is 5 dB.

Effects of the attenuator

Attenuation has a direct effect on the sensitivity of the analyzer - attenuation must be compensated for by reamplifying the signal levels after the mixer. Thus, high attenuation values cause the inherent noise (or noise floor) to rise, which in turn decreases the sensitivity of the analyzer. The highest sensitivity is obtained at an RF attenuation of 0 dB. Each additional 10 dB of attenuation reduces the sensitivity by 10 dB, i.e. the displayed noise is increased by 10 dB. To measure a signal with an improved signal-to-noise ratio, decrease the RF attenuation.

Another (positive) effect is that high attenuation also helps to avoid intermodulation.

For ideal sinusoidal signals, the displayed signal level is independent of the RF attenuation.

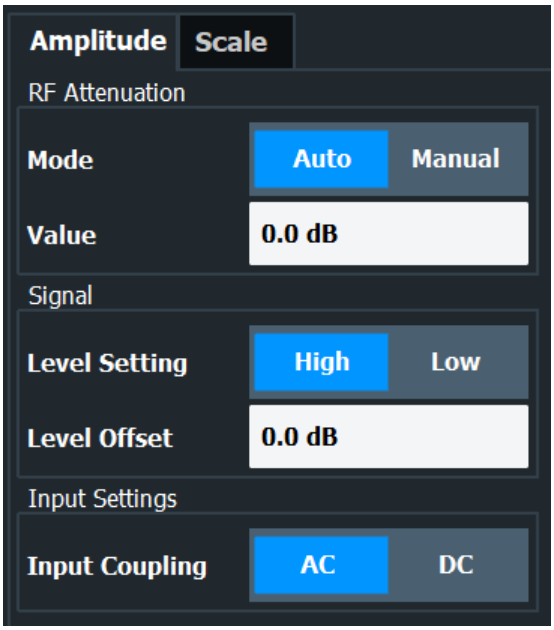
In the default state, the R&S FSMR3 automatically determines the attenuation according to the signal level that is currently applied. Automatic determination of the attenuation is a good way to find a compromise between a low noise floor, high intermodulation levels, and protecting the instrument from high input levels.

However, you can also define the attenuation manually, if necessary.

3.3.2 Amplitude characteristics

Access: "Overview" > "Amplitude / Scaling" > "Amplitude"

Amplitude settings allow you to adapt the R&S FSMR3 for the signal that is fed into its input (for example the RF input).



Functionality to configure amplitude characteristics described elsewhere:

- "Input Coupling" on page 35
- Level Setting

The remote commands required to configure the amplitude are described in Chapter 6.5.4, "Remote commands to configure level characteristics", on page 134.

Attenuating the signal....37
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Searching for the signal level....38

Attenuating the signal
You can either determine the attenuation automatically or manually. Signal attenuation is possible in 5 dB steps. The range is specified in the data sheet.

When you select "Auto" mode, the R&S FSMR3 determines the attenuation based on the level of the signal that is applied. Automatic determination of the attenuation makes sure that the ideal attenuation is always selected.

In "Manual" mode, the "Value" field becomes available and you can define an attenuation as required.

NOTICE! Risk of hardware damage due to high power levels.
When you decrease the attenuation manually, make sure that the signal level does not exceed the maximum level allowed at the RF input. Otherwise, an overload of the input mixer can cause hardware damage.

Remote command:
Mode: `INPut<ip>:ATTenuation:AUTO` on page 138
Attenuation: `INPut<ip>:ATTenuation` on page 138

Shifting the level

You can define an arithmetic level offset that is added to the measured level.

Defining a level offset is useful, for example, if you attenuate or amplify the signal before it is fed into the R&S FSMR3. The R&S FSMR3 is then able to display the correct power results.

To determine the required offset, consider the external attenuation or gain applied to the input signal. For attenuation, define a positive offset so the R&S FSMR3 increases the displayed power values. If an external gain is applied, define a negative offset so the R&S FSMR3 decreases the displayed power values.

Remote command:
`[SENSe:]POWer:RLEVel:OFFSet` on page 139

Searching for the signal level

The R&S FSMR3 automatically measures the level of the signal you have applied and keeps track of the measured signal levels.

The currently measured signal level is displayed in the channel bar.

Note that you should attenuate the signal if its level is too high, especially if you have no idea about the signal strength you are measuring. For more information, see "Attenuating the signal" on page 37.

The measurement starts only if the signal level is within the level threshold that you have defined via the "Auto Search" feature.

If the signal level is outside the threshold that you have defined, it is ignored.

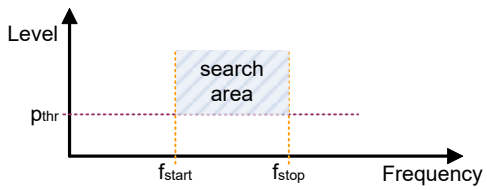


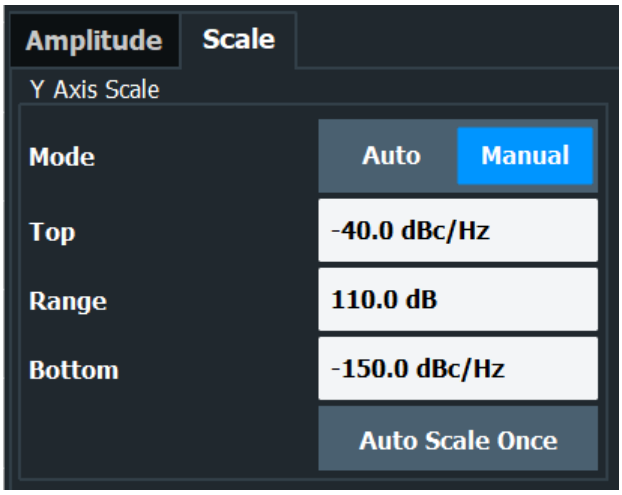
Figure 3-1: Basic principle of the signal search feature

Remote command:
Signal level: `[SENSe:]POWer:RLEVel?` on page 139
Threshold: `[SENSe:]ADJust:CONFigure:LEVel:THReshold` on page 138

3.3.3 Diagram scale

Access: "Overview" > "Amplitude / Scaling" > "Scale"

The scale settings define the scale of the y-axis in graphical result displays.



The remote commands required to configure the amplitude are described in Chapter 6.5.4, "Remote commands to configure level characteristics", on page 134.

Scaling the y-axis 39

Scaling the y-axis
You can scale the y-axis of graphical result displays automatically or manually.

Scaling the axis automatically has the advantage that the application automatically selects the ideal scale for the current measurement results. When you select the "Auto" scale mode, the R&S FSMR3 adjusts the scale of the axis during the measurement.

When you select the "Manual" scale mode, you can select any scale that suits your needs. You can scale the axis by the following logic:

- Define a "Top" and "Bottom" value. The "Range" is adjusted accordingly.
- Define a "Top" value and a "Range". The "Bottom" value is adjusted accordingly.
- Define a "Range" and a "Bottom" value. The "Top" value is adjusted accordingly.
- When you change the "Top" or "Bottom" values only, the "Range" is adjusted.
- When you change the "Range" only, the "Bottom" value is adjusted.

In addition, you can perform a single automatic scale adjustment with the "Auto Scale Once" feature. When you do so, the R&S FSMR3 selects the ideal scale for the current measurement results, but will not update the scale for the next measurement.

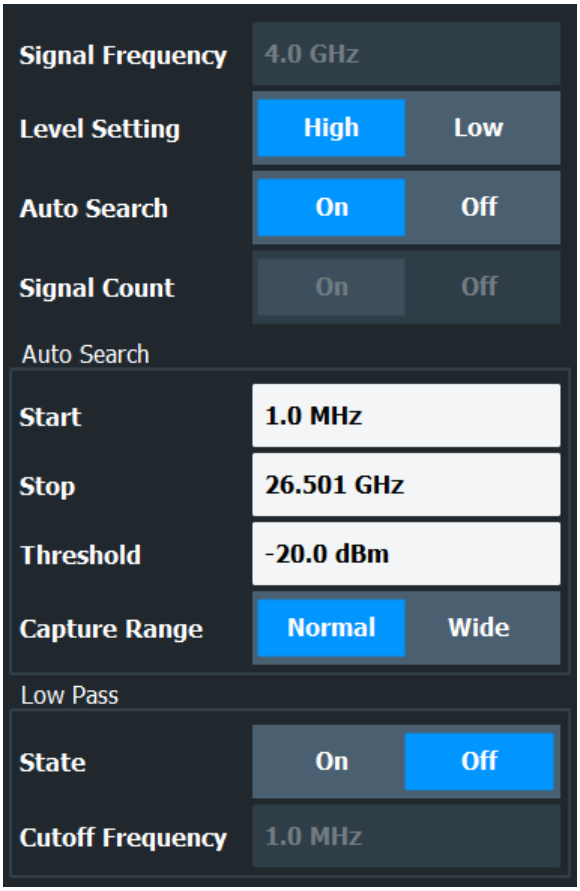
Remote command:
Mode: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO` on page 136
Top: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 137
Bottom: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:LOWer` on page 137
Range: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 136

3.4 Frequency

Access (carrier frequency): "Overview" > "Frequency"

Access (measurement range): "Overview" > "Noise Config" > "Noise Config"

Frequency settings allow you to control the characteristics of the measurement frequency.



The auto search features are available for phase noise measurements.

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Defining the signal frequency

The "Signal Frequency" is the frequency the signal is transmitted with.

You can define it manually in the corresponding input field or let the R&S FSMR3 search for the signal frequency in an automatic frequency search (turn on the "Auto Search" in that case).

Remote command:
`[SENSe:]FREQuency:CENTer` on page 142

Searching for a signal

The R&S FSMR3 automatically scans the frequency spectrum for any signals before a phase noise measurement begins. If it can find a signal on any frequency, it starts a measurement on that frequency.

The current signal frequency is displayed in the channel bar.

In case you already know the signal frequency, you can also turn off the "Auto Search" and define it manually. When you turn off automatic search, the R&S FSMR3 still verifies if a signal is present at the frequency you have defined and, if necessary, adjusts the frequency if the signal is a few Hz off. If you want to skip the signal verification and measure exactly the frequency you have entered manually, turn off the "Signal Count" feature. In that case, the R&S FSMR3 tunes to the frequency you have entered and measures its phase noise characteristics, even if no signal is present. Turning off the frequency counter can improve measurement speed, however.

The measurement starts only if a signal is present within the frequency search limits that you have defined via the "Auto Search" feature. The search range is defined by a minimum and maximum value. The maximum frequency range that you can scan depends on the hardware you are using. Note that a signal must also be within a certain level range for it to be detected.

No measurement will be initiated if no signal can be found in the frequency search range you have defined.

Figure 3-2: Basic principle of the signal search feature

During a frequency scan, the R&S FSMR3 steps through the frequency search range you have defined in a predefined step size (one step usually covers the full I/Q bandwidth).

Signal search is only available for phase noise measurements.

Remote command:
Signal frequency: [SENSe:]FREQuency:CENTer on page 142
Mode: [SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe] on page 140
Signal count: [SENSe:]ADJust:CONFigure:FREQuency:COUNt on page 140
Lower search limit: [SENSe:]ADJust:CONFigure:FREQuency:LIMit:LOW on page 141
Upper search limit: [SENSe:]ADJust:CONFigure:FREQuency:LIMit:HIGH on page 141

Capture Range
The "Capture Range" defines the bandwidth with which the R&S FSMR3 searches for a signal or tracks drifting signals.

Use a "Normal" capture range for stable or slowly drifting DUTs. For fast drifting DUTs, use a "Wide" capture range.

The capture range is available for the phase noise measurement.

Remote command:
[SENSe:]SWEep:CAPTure:RANGe on page 144

Defining the measurement range
Noise measurements determine the noise of a DUT over a certain measurement range. The measurement range is defined by the two offset frequencies that you define ("Start Offset" and "Stop Offset").

The frequency offsets themselves are relative to the carrier frequency of the DUT: a frequency offset of 1 MHz, for example, measures the noise characteristics up to a distance of 1 MHz from the carrier. The maximum offset that you can define depends on the hardware you are using.

The measurement range thus defines the scale of the x-axis in the "Phase Noise" diagram.

The measurement range again is divided into several (logarithmic) decades, or, for configuration purposes, into half decades.

Note: For frequency stability measurements, the start and stop frequency offsets of the phase noise measurement are the reciprocal values of the start and stop values of the observation time ("Tau Start" and "Tau Stop").
Tau Start and Tau Stop thus define the scale of the x-axis in the "Allan Variance" and "Allan Deviation" diagrams.

Remote command:
Start offset: [SENSe:]FREQuency:STARt on page 143
Stop offset: [SENSe:]FREQuency:STOP on page 143
Start Tau: [SENSe:]TIME:STARt on page 151
Stop Tau: [SENSe:]TIME:STOP on page 151

Measuring low frequency and low level signals
The R&S FSMR3 provides functionality to measure the phase noise of signals with a low frequency and / or a low signal level.

- Low frequencies can be measured by applying the low pass filter.

- Low signal levels can be measured by selecting the appropriate level setting.
- Very low signal levels can be measured by selecting the appropriate level setting and applying the low pass filter.

Low signal frequencies ← Measuring low frequency and low level signals
The R&S FSMR3 provides a low pass filter that suppresses the DC offset of the I/Q mixer to measure signal frequencies below 1 MHz. Applying the filter results in a better sensitivity.

When you are measuring such signals, turn on the filter ("State"), and define its "Cutoff Frequency". The cutoff frequency should be the same as the signal frequency. For example, the cutoff frequency to measure a signal frequency of 100 Hz should also be 100 Hz.

Measuring low frequencies and levels is available for phase noise measurements on continuous wave signals.

Note that using the filter has several effects.
- The automatic search for a signal is not supported. Define the signal frequency manually instead.
- A signal count is not possible.
- The stop offset is limited to 30 % of the carrier signal frequency.

For measurements on frequencies below 10 MHz, you must use DC coupling (independent of the low pass filter).

Remote command:
Filter state: `[SENSe:]FILTer:LPASs[:STATe]` on page 142
Cutoff frequency: `[SENSe:]FILTer:LPASs:FREQuency:MANual` on page 141

Low signal levels ← Measuring low frequency and low level signals
The R&S FSMR3 supports different modes to measure signals with different levels.

Depending on the measurement, select the appropriate "Level Setting".
- "High": The R&S FSMR3 works like a traditional phase noise tester with zero IF and is therefore limited in the sensitivity.
- "Low": The R&S FSMR3 uses an IF of 15 MHz. Therefore, the DC offset of the I/Q mixers does not limit the sensitivity. It is recommended to use this level setting for signal levels below -20 dBm.
  For very low signal levels (below approximately -40 dBm), the broadband noise in the demodulator becomes an issue and disables the measurement. To measure such signals, apply the low pass filter, because it reduces the noise bandwidth. The nominal improvement of the sensitivity is 10 dB for 10 MHz, 20 dB for 1 MHz cutoff frequency.

Note that using the filter has several effects.
- The automatic search for a signal is not supported. Define the signal frequency manually instead.
- A signal count is not possible.
- The stop offset is limited to 30 % of the carrier signal frequency.

Remote command:
Filter state: `[SENSe:]FILTer:LPASs[:STATe]` on page 142
Cutoff frequency: `[SENSe:]FILTer:LPASs:FREQuency:MANual` on page 141
Level setting: `[SENSe:]POWer:RLEVel:MODE` on page 143

Multicarrier signals ← Measuring low frequency and low level signals
You can also use the low pass filter when you want to measure the phase noise of a single carrier in a multicarrier signal. In that case, the cutoff frequency of the filter should be the same as the carrier spacing.

3.5 Noise measurement configuration

Noise measurements are performed based on several specific measurement parameters.

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- Noise configuration 45
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- Spur display 53
- Frequency stability configuration 55

3.5.1 Measurement range

Noise measurements determine the noise characteristics of a DUT over a particular measurement range. This **measurement range** is defined by two offset frequencies. The **frequency offsets** themselves are relative to the nominal frequency of the DUT.

The measurement range again is divided into several (logarithmic) decades, or, for configuration purposes, into **half decades**.

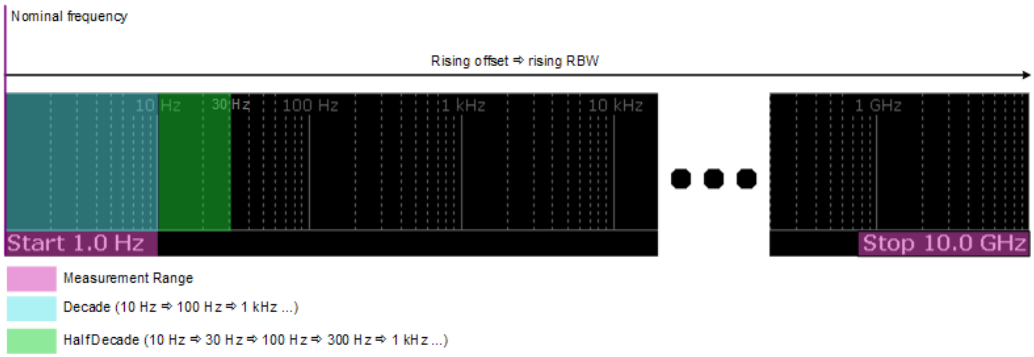

Figure 3-3: Measurement range and half decades

The main issue in this context is the **resolution bandwidth** (RBW) and its effect on the measurement time. In general, it is best to use a resolution bandwidth as small as possible for the most accurate measurement results. However, accuracy comes at the price of measurement speed.

To avoid long measurement times, the application provides only a certain range of RBWs that are available for each half decade.

3.5.2 Noise configuration

Access: "Overview" > "Noise Config" > "Noise Config"

The measurement range parameters define the way the phase noise of a DUT is measured.

Functions to configure the measurement range described elsewhere:

- Start Offset
- Stop Offset
- Capture Range

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Estimating the measurement time

Based on the parameters you have defined for the noise measurement, the application estimates the total measurement time required to measure the noise characteristics over all half decades. It is displayed in the channel bar ("Meas Time" label).

The remaining measurement time of the current measurement is indicated in the progress bar in the status bar (for measurements that last longer than 1 second).

The measurement time is function of the resolution bandwidth, cross-correlation factor and the number of averages defined for the measurement.

Remote command:
[SENSe:]SWEep:TIME on page 149

Defining the resolution bandwidth
The resolution bandwidth (RBW) is the filter bandwidth applied during the noise measurement. Noise measurements apply a different resolution bandwidth to each half decade that is measured: small bandwidths for small frequency offsets and higher bandwidths for larger frequency offsets (to speed up the measurement on larger frequency offsets).

You can define a custom resolution bandwidth for each half decade, or let the application selects an appropriate resolution bandwidth, depending on the "Half Decade Config" mode.

For an **automatic selection**, the resolution bandwidth that is applied to each half decade is a function of the frequency offset. By default, the resolution bandwidth is 10 % of the start offset of the half decade. If the start offset is, for example 10 kHz, the resulting resolution bandwidth is 1 kHz.

If necessary, you can change the resolution bandwidth factor. A selected set of percentages in the range from 0.1 % to 30 % is supported.

For a **manual selection**, you can enter the required resolution bandwidth as an absolute value in the corresponding cells of the half decade table.

Remote command:
Configuration mode: [SENSe:]SWEep:MODE on page 149
RBW factor: [SENSe:]LIST:BWIDth[:RESolution]:RATio on page 145
RBW: [SENSe:]LIST:RANGe<ri>:BWIDth[:RESolution] on page 145

Defining cross-correlation parameters
Cross-correlation is a method to calculate the noise characteristics by routing it through two different signal paths. The signal has correlated noise characteristics in both channels while the oscillators have uncorrelated noise characteristics. Through cross-correlation operations, the noise of the DUT is kept constant while the noise of the signal path is reduced.

You can define a custom number of cross-correlation operations for each half decade, or let the application select an appropriate number, depending on the "Half Decade Config" mode.

For an **automatic selection**, the number of cross-correlation operations that are performed depends on the half decade that is measured. Small offsets (which usually have a higher noise level) require fewer operations to get accurate results, while large offsets (whose noise levels can be very low) require more operations for accurate results.

The base number of the first decade is a fixed value. The number of operations for the other half decades is determined in such a way, that all operations are finished at roughly the same time.

For a **manual selection**, you can enter the required resolution bandwidth as an absolute value in the corresponding cells of the half decade table.

Example:

The operations in the first half decade need 1 s to finish. The number of operations done in the other half decades is calculated with respect to this 1 s timeframe. For example, if the application can perform 10 cross-correlation operations in 1 s in another half decade, it will do so, but no more than that number.

You can control the number of cross-correlations for the first half decade with the cross-correlation factor ("XCORR Factor"). By multiplying this value with the base number of operations for the first half decade, the application calculates the time it takes to perform these operations in the first half decade and then adjusts the number of operations for all other half decades.

When you turn on the "XCORR Optimization" feature, cross-correlation operations are only performed as long as the measurement results still improve. When this is not the case, the R&S FSMR3 stops calculating results, even when the selected number of operations has not yet been reached. This is thus a good tool to speed up the measurement.

The point at which measurement results cannot be improved anymore is defined by the "XCORR Optimization Threshold". The threshold is the distance between the gain indicator and the actual trace. When the distance between those two traces exceeds the threshold in any given half decade, the R&S FSMR3 stops measuring in this half decade and resumes with the next one.

Example:

The number of operations in a half decade is 30. When optimization is on, and the results do not improve any more after 20 operations, the application stops measurements in that half decade.

You can also finish the measurement of a specific half decade manually with the "Finish Segment" softkey available in the "Sweep" menu. The R&S FSMR3 resumes the measurement of the next half decade in that case.

For offsets greater than 30 MHz, each half decade is divided into smaller segments. For these offsets, the "Finish Segment" feature does not resume with the next half decade, but with the next offset segment.

Remote command:
Configuration mode: `[SENSe:]SWEep:MODE` on page 149
XCORR factor: `[SENSe:]SWEep:XFACtor` on page 150
XCORR number: `[SENSe:]LIST:RANGe<ri>:XCOunt` on page 147
Optimization: `[SENSe:]SWEep:XOPTimize[:STATe]` on page 150
Optimization threshold: `[SENSe:]SWEep:XOPTimize:THReshold` on page 150
Finish segment: `[SENSe:]SWEep:FSEGment` on page 148

Turning the display of the cross-correlation gain indicator on and off

The phase noise diagram contains a grey area in its default state. This area represents the cross-correlation gain indicator.

It shows the rejection of uncorrelated noise dependent on the number of correlation averages. If the measurement trace itself lies on the cross-correlation gain indicator, further correlation will reduce the phase noise value. If some distance between the cross-correlation gain indicator and the measurement result is obtained, further correlation will not reduce the phase noise value any more, but only smooth the trace. When you turn on the"Optimize XCORR" feature, the measurement stops automatically when the gap between the cross-correlation gain indicator and the measurement trace exceeds 10 dB.

You can turn the display of the gray area on and off as required.

Remote command:
`DISPlay:XGINdicator[:STATe]` on page 145

Sweep/Average Count
Defines the number of sweeps to be performed in the single sweep mode. Values from 0 to 200000 are allowed. If the values 0 or 1 are set, one sweep is performed.

The sweep count is applied to all the traces in all diagrams.

For "Average" trace mode, the "Sweep Count" also determines the number of individual measurements used to average the trace.

In continuous sweep mode, a "Sweep Count" = 0 (default) calculates a moving average over 10 measurements. A "Sweep Count" = 1 calculates no averages.

Remote command:
`[SENSe:]SWEep:COUNt` on page 147

Selecting the sweep direction
The sweep direction selects the order in which the R&S FSMR3 measures the half decades.

For the reverse sweep ("Sweep Forward" = "Off"), the measurement sequence is:
- Analysis of half decades > 30 MHz
- Analysis of half decades between 30 MHz and 1 MHz
- Analysis of half decades < 1 MHz

For the forward sweep ("Sweep Forward" = "On"), the measurement sequence is:
- Analysis of half decades < 1 MHz
- Analysis of half decades between 30 MHz and 1 MHz
- Analysis of half decades > 30 MHz

Otherwise, the measurements are the are the same and yield the same results, regardless of the sweep direction you select. The difference is that results near the carrier are available faster when you select the forward sweep.

Remote command:
`[SENSe:]SWEep:FORWard` on page 148

Working with the half decade configuration table
The half decade configuration table shows the measurement characteristics for each half decade that is part of the measurement.

The features of the table depend on the "Half Decade Config" mode:

- For the **automatic mode**, the table is read only, the values in the table depend on the settings you have made for the noise measurements (RBW Factor and XCORR Factor).
  The size (number of rows) depends on the number of half decades that you have defined.
  Automatic half decade configuration is designed to yield the optimal measurement times for each half decade.
- For the **manual mode**, you can define custom values for the resolution bandwidth (RBW) and the number of cross-correlation operations.

The table contains the following values.

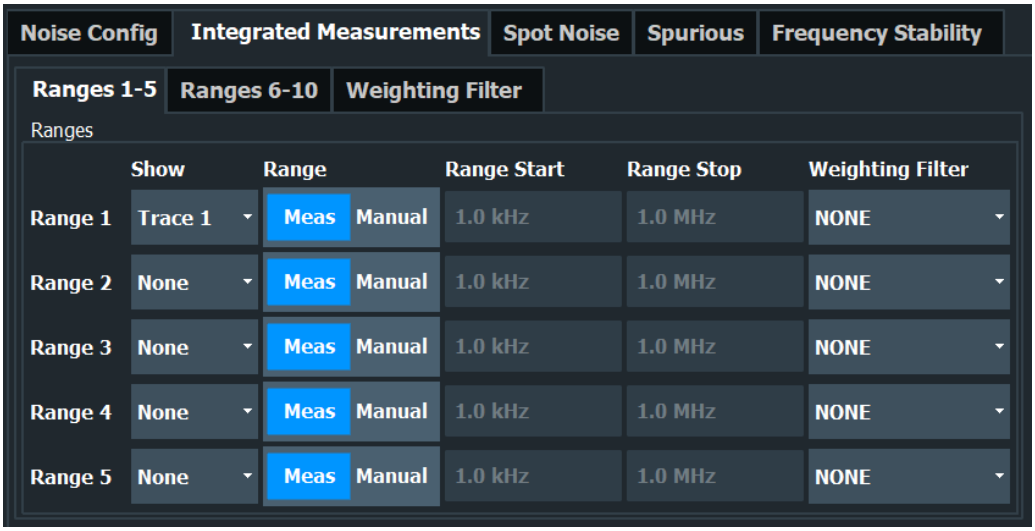
- **Start Offset**
  Start frequency offset of the half decade.
  Depends on the frequency offsets you have defined.
- **Stop Offset**
  Stop frequency offset of the half decade.
  Depends on the frequency offsets you have defined.
- **RBW**
  Resolution bandwidth applied to the corresponding half decade during the measurement.
  Depends on the resolution bandwidth factor you have defined.
  Custom RBWs become available when you are using manual configuration mode.
- **XCORR**
  Shows the number of cross-correlation operations applied in the corresponding half decade.
  Depends on the XCORR factor you have defined.
  Custom cross-correlation operations become available when you are using manual configuration mode.

Remote command:
Configuration mode: `[SENSe:]SWEep:MODE` on page 149
Start offset: `[SENSe:]LIST:RANGe<ri>:FREQuency:STARt?` on page 146
Stop offset: `[SENSe:]LIST:RANGe<ri>:FREQuency:STOP?` on page 146
RBW: `[SENSe:]LIST:RANGe<ri>:BWIDth[:RESolution]` on page 145
XCORR: `[SENSe:]LIST:RANGe<ri>:XCOunt` on page 147

3.5.3 Integrated measurement configuration

Access: "Overview" > "Noise Config" > "Integrated Measurements"

You can control the integration ranges and data source (traces) that the calculations for integrated measurement results are based on.



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└ Designing weighting filters....51

Selecting the trace for residual calculations

Residual calculations are only performed when you select an (active) trace that serves as the data source (when the selected trace is inactive, residual effects are not calculated).

You can select any trace as the data source ("Trace 1" to "Trace 6" in the dropdown menu), and define the frequency range over which the integration is performed.

When you select "None" from the dropdown menu, residuals effects are not calculated.

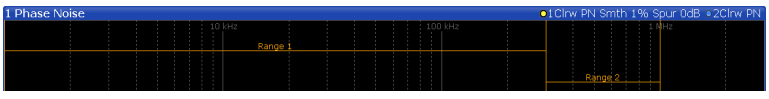
Remote command:
`CALCulate<n>[:RANGe<ri>]:EVALuation:TRACe` on page 152

Defining the integration range

You can define up to 10 integration ranges on different traces.

By default, the R&S FSMR3 integrates over the entire frequency range defined for the measurement (Range = "Meas"). You can, however, also define custom integration ranges (Range = "Manual").

In that case, the input fields next to the "Range" control become available to define a customized integration range. The application shows orange lines ("Range <x>") in the graphical result display to indicate custom ranges.



Remote command:
State: CALCulate<n>[:RANGe<ri>]:EVALuation[:STATe] on page 153
Start: CALCulate<n>[:RANGe<ri>]:EVALuation:STARt on page 152
Stop: CALCulate<n>[:RANGe<ri>]:EVALuation:STOP on page 152

Working with weighting filters
The weighting filter feature provides functionality to correct integrated measurements and thus compensate for external effects that affect the results in certain frequency ranges. A weighting filter is a useful feature if you already know that this is the case and would like to compensate for these effects.

Note that the weighting filter only has an effect on the integrated measurement results and has no effect in the noise diagram or other numerical results.

Applying weighting filters ← Working with weighting filters
When you apply a weighting filter, the R&S FSMR3 takes the correction values defined in the weighting filter into account for the calculation of integrated measurements.

The "Weighting Filter" dropdown menu contains all weighting filters that are available on the internal hard disk of the R&S FSMR3.

Remote command:
CALCulate<n>[:RANGe<j>]:EVALuation:WEIGhting on page 153

Managing weighting filters ← Working with weighting filters
The table in the "Residual Calculations" dialog box shows all currently available weighting filter.

From this dialog box, you have the following options.
- Edit a weighting filter that already exists (→ "Edit").
- Create a new weighting filter (→ "New").
- Create a new weighting filter based on an existing one (→ "Copy").
  If necessary, you can delete the selected filter at any time (→ "Delete").

Each of the options opens a dialog box that contains the functionality to characterize a weighting filter.

Remote command:
Select a filter: [SENSe:]CORRection:WEIGhting:SELect on page 155
Delete: [SENSe:]CORRection:WEIGhting:DELete on page 154

Designing weighting filters ← Working with weighting filters
The R&S FSMR3 provides the following tools to design a weighting filter.

- "Name" / "Comment"
  Defines a name and / or comment of the weighting filter. The name defines the label by which the filter appears in the "Weighting Filter" dropdown menu.
- "Position" and "Value"
  Define the data points of the weighting filter (including a graphical preview). They define by which amount (dB) residual effects are corrected for specific frequencies. For example, you could say that at a frequency of 100 MHz, the residual effects are corrected by 5 dB.
- "Insert Value"

Inserts a weighting filter data point. Alternatively, you can click in the table itself to add a new data point.

- "Delete Value"
  Deletes the currently selected data point. The currently selected data point is highlighted blue.
- "Shift X" / "Shift Y"
  Shifts all data points of the weighting filter horizontally or vertically by a certain amount.
- "Save"
  Saves and stores the weighting filter on the internal hard disk of the R&S FSMR3.

A weighting filter consists of up to 625 data points. Each data point is a pair of values: the first value describes the frequency, the second value describes the level (correction value) for that frequency.

Frequencies must be entered in ascending order and must not overlap.

When you save the filter, the R&S FSMR3 uses the name of the weighting filter as the file name. If a weighting filter of the same name already exists, the R&S FSMR3 asks before it overwrites the existing file.

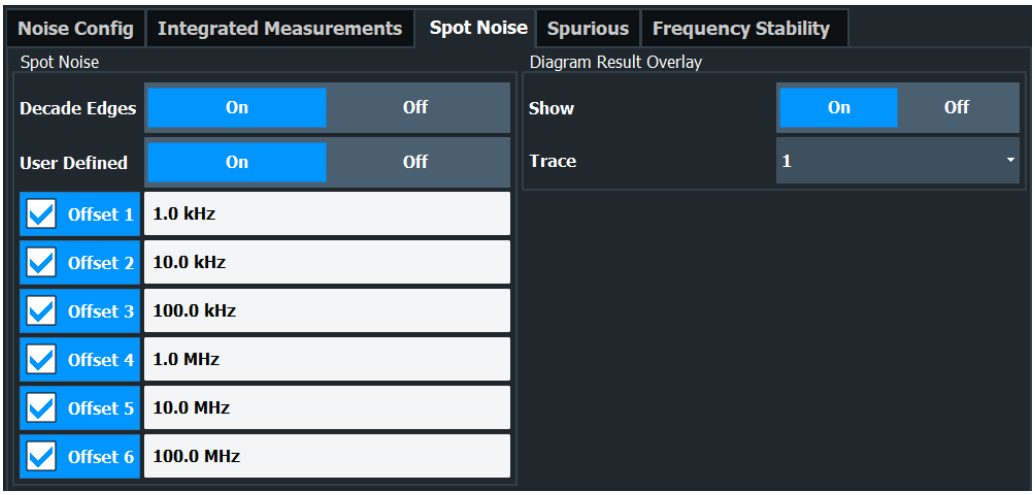
Remote command:
Name: `[SENSe:]CORRection:WEIGhting:NAME` on page 155
Comment: `[SENSe:]CORRection:WEIGhting:COMMent` on page 154
Data: `[SENSe:]CORRection:WEIGhting:DATA` on page 154

3.5.4 Spot noise information

Access: "Overview" > "Noise Config" > "Spot Noise"

Spot noise is the phase noise measured at a certain offset frequency. The information about spot noise is provided in the noise diagram (optionally) and in a separate spot noise information table.

The R&S FSMR3 provides several features to control the spot noise information.



Displaying spot noise information 53
Selecting the spot noise positions 53

Displaying spot noise information
By default, when you perform a measurement, the R&S FSMR3 displays the spot noise information in the diagram area.

You can turn off the displayed spot noise information any time, for example if you want a better view of the measurement results.

You can also select the trace the displayed spot noise information refers to from the "Trace" dropdown menu.

Remote command:
`DISPlay:SNINfo[:STATe]` on page 159
`DISPlay:SNINfo:TRACe` on page 159

Selecting the spot noise positions
The R&S FSMR3 provides several methods to define the positions where the spot noise is measured.

By default, it calculates the spot noise on all "Decade Edges" (10^x offset frequencies) in the measurement range. Therefore, the number of spot noise results depends on the measurement range.

If you want to evaluate the spot noise on positions other than the decade edges, you can add "User Defined" spot noise positions. When you turn on that feature, changes that you make to the "Offset" input fields are considered in the current measurement (by default, user defined spot noise positions are the decade edges).

You can define any offset frequency that is part of the measurement range as a new spot noise position. To exclude an offset frequency, uncheck the checkbox of the current offset.

The results for the user defined spot noise positions are displayed in the spot noise table in addition to the decade edge spot noise results.

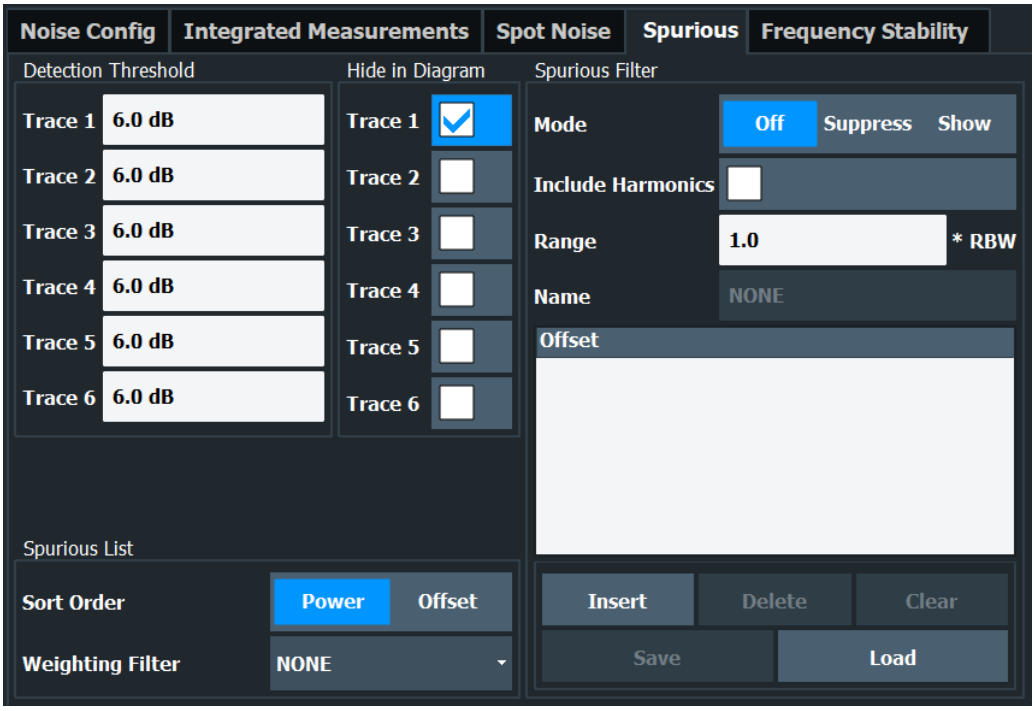
When you turn off the "Decade Edges" spot noise positions, the spot noise table contains only the user defined spot noise positions.

Remote command:
See Chapter 6.5.6.3, "Spot noise configuration", on page 155.

3.5.5 Spur display

Access: "Overview" > "Noise Config" > "Spurious"

Spurs are (usually undesired) peak levels that can occur in the measured frequency range. They are represented by unusually tall spikes on the trace.



Hiding spurs

Hiding spurs is a method to remove displayed peak levels visually.

You can apply spur removal to all active traces individually (spurious removal "Hide In Diagram"), and define a threshold (in dB) that defines when a peak level is recognized as a spur (spurious removal "Detection Threshold").

Remote command:
State: `DISPlay[:WINDow<n>]:TRACe<t>:SPURs:SUPPress` on page 159
Value: `DISPlay[:WINDow<n>]:TRACe<t>:SPURs:THReshold` on page 160

Sorting spurs

The sort order of the spurs in the spurious list result display depends on the "Sort Order" you select.

"Power" Sorts the spurs according to their power (highest to lowest power).

"Offset" Sorts the spurs according to their offset from the carrier (lowest to highest offset).

Remote command:
`[SENSe:]SPURs:SORT` on page 160

Applying a spurious weighting filter

The spurious weighting filter feature provides functionality to apply a weighting filter to spurious analysis. For more information on how to apply, manage and design weighting filters, see "Working with weighting filters" on page 51.

Remote command:
`[SENSe:]SPURs:WEIGhting` on page 161

Filtering spurs
Filtering spurs is a method to show or hide items of the spurious list.

Mode
- "Off": No spurious filter is applied.
- "Suppress": The spurs in the spurious filter are removed from the spurious list, the diagram and dependent calculations.
- "Show": Only the spurs in the spurious filter are displayed in the spurious list, the diagram and dependent calculations.

Include Harmonics
In addition to the spurs in the defined spurious filter list, also their harmonics are displayed or removed in the spurious list.

Range
Defines the filter range as a multiple of the resolution bandwidth.

Name
Displays the name of the currently selected spurious filter.

Spurious Filter Management
The spurious filter configuration table provides several management tools:
- "Insert": Adds a new offset frequency to the spurious filter.
- "Delete": Removes an existing offset frequency from the spurious filter.
- "Clear": Clears the spurious filter.
- "Save": Saves the spurious filter configuration. With this function, the name of the spurious filter can be defined.
- "Load": Loads an existing spurious filter configuration.

Remote command:
`[SENSe:]SPURs:FILTer:MODE` on page 161
`[SENSe:]SPURs:FILTer:HARMonics` on page 161
`[SENSe:]SPURs:FILTer:RANGe` on page 161
`[SENSe:]SPURs:FILTer:NAME?` on page 162
`[SENSe:]SPURs:FILTer:OFFSet` on page 162
`[SENSe:]SPURs:FILTer:CLEar` on page 162
`[SENSe:]SPURs:FILTer:SAVE` on page 162
`[SENSe:]SPURs:FILTer:LOAD` on page 162

3.5.6 Frequency stability configuration

Access: "Overview" > "Noise Config" > "Frequency Stability"

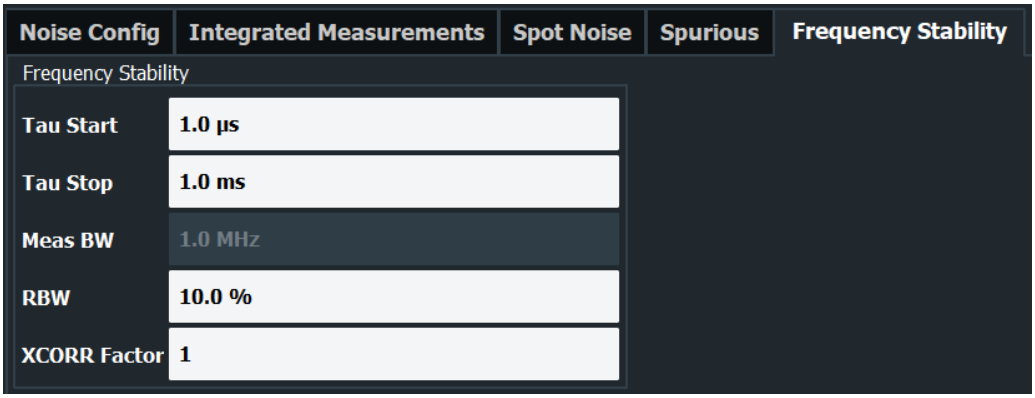
The results of the frequency stability measurements (Allan variance and deviation) are derived from the phase noise measurement. Thus, the frequency stability measurements and the phase noise measurement use the same configuration.

The "Frequency Stability" dialog contains the most important settings for the frequency stability measurements. However, everything that you change in the phase noise configuration is also applied to the frequency stability measurements, and vice versa.

- "Tau Start" and "Tau Stop"
  Tau start and stop define the observation time Tau for the frequency stability measurement. They are coupled to the measurement range. Tau start is the reciprocal value of the stop frequency offset. Tau stop is the reciprocal value of the start frequency offset.

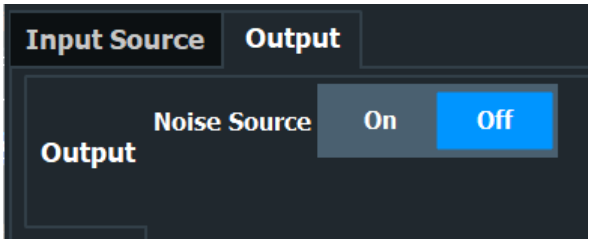
For example, a measurement range from 1 mHz to 1 MHz would result in an observation time from 1 µs to 1000 s and vice versa.

- "RBW" and "XCORR"
  Note that if you define the RBW and number of cross-correlation operations manually, the values of the half decade configuration table are also applied to the frequency stability measurements.
- "Meas BW"
  The measurement bandwidth (or integration bandwidth) is the reciprocal value of "Tau Start".



3.6 Output

The phase noise application is able to provide different kinds of output for various purposes.



3.6.1 Output for noise sources

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSMR3000 itself, for example when measuring the noise level of an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the R&S FSMR3000 and measure the total noise power. From this value you can determine the noise power of the R&S FSMR3000. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

The noise source is controlled in the "Output" settings, see "Noise Source Control" on page 57

3.6.2 Output configuration

Noise Source Control 57

Noise Source Control
Enables or disables the 28 V voltage supply for an external noise source connected to the "Noise source control / Power sensor") connector. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSMR3000 itself, for example when measuring the noise level of an amplifier.

In this case, you can first connect an external noise source (whose noise power level is known in advance) to the R&S FSMR3000 and measure the total noise power. From this value, you can determine the noise power of the R&S FSMR3000. Then when you measure the power level of the actual DUT, you can deduct the known noise level from the total power to obtain the power level of the DUT.

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 132

4 Common analysis and display functions

General methods and basic settings to display and analyze measurements, regardless of the operating mode, are described here. If you are using an application other than the phase noise application, be sure to check the documentation for that application. The settings can deviate from the common settings described here.

- Zoomed displays 58
- Trace configuration 65
- Markers 79
- Limit lines 89

4.1 Zoomed displays

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

Graphical Zoom Versus Measurement Zoom

Graphical zooming is merely a visual tool, it does not change any measurement settings, such as the number of sweep points, the frequency range, or the reference level. Graphical zooming only changes the resolution of the displayed trace points temporarily. You must explicitly activate the graphical zoom function (see Chapter 4.1.2, "Zoom functions", on page 60).

Graphical zoom and the number of sweep points

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

You should increase the number of sweep points before zooming, as otherwise the resolution of the trace in the zoomed region is poor (see Chapter 4.2.1.2, "Trace averaging", on page 66).

When you change the display using touch gestures, however, the corresponding measurement settings are adapted. For example, dragging horizontally in a spectrum display changes the center frequency. Dragging vertically in a spectrum display changes the reference level (for absolute scaling). These changes are permanent for the measurement. This behavior is also referred to as *measurement zoom*, and is active by default in the new R&S FSMR3.However, you can also activate it manually for a display that has already been zoomed graphically. In this case, the temporary changes to the display are replaced by permanent changes to the measurement settings with the same effect.

Example:

Assume you have a spectrum display from a spurious emission measurement. You graphically zoom into the area around a detected spur. If you now activate a measurement zoom, the reference level, the center frequency, the frequency span, and the scaling settings are adapted so that the results of the measurement now indicate only the formerly zoomed area around the detected spur.

- Single zoom versus multiple zoom....59
- Zoom functions....60
- How to zoom into a diagram....62

4.1.1 Single zoom versus multiple zoom

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

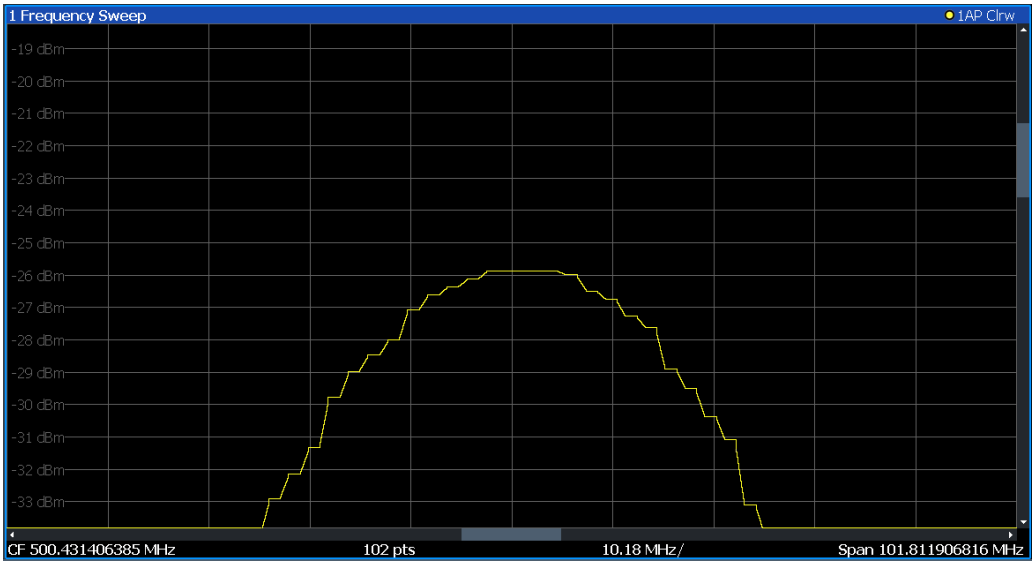


Figure 4-1: Single zoom

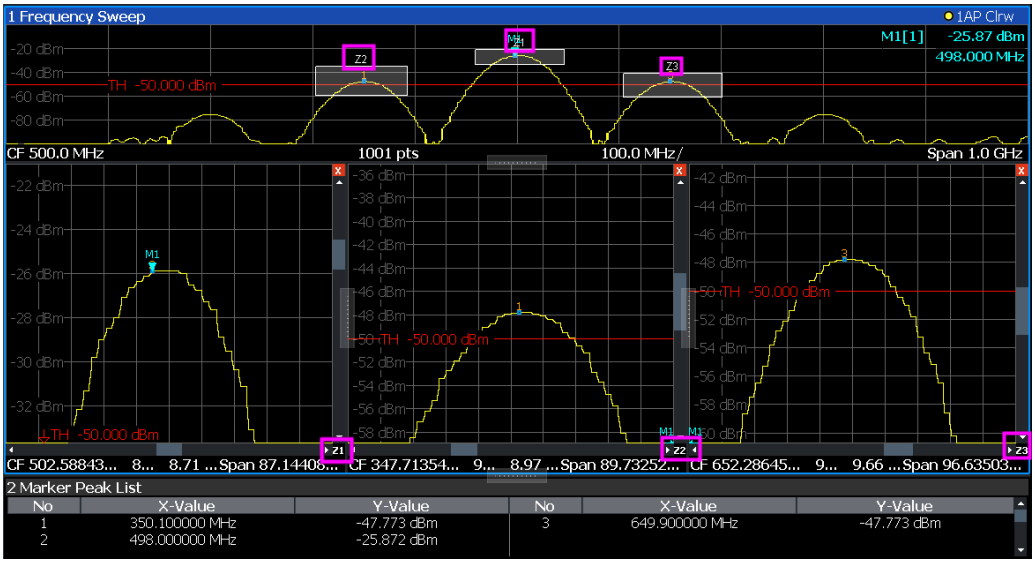


Figure 4-2: Multiple zoom

4.1.2 Zoom functions

Access: "Zoom" icons in toolbar

Single Zoom....60
Multi-Zoom....60
Measurement Zoom....61
└ Level Lock....61
└ X-Lock....61
└ Y-Lock....62
└ Adapt Measurement to Zoom (selected diagram)....62
Restore Original Display....62

Single Zoom

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

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 174

`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA` on page 172

Multi-Zoom

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

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe]`
on page 174
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA`
on page 173

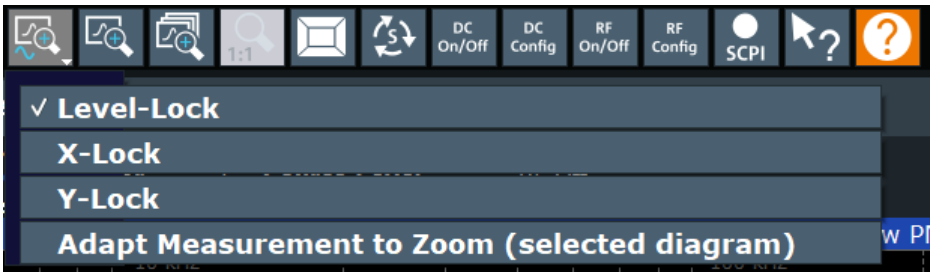
Measurement Zoom
As opposed to the graphical zoom, which is merely a visual tool, the measurement zoom adapts the measurement settings such that the data you are interested in is displayed in the required detail. In measurement zoom mode, you can change the display using touch gestures. This is the default operating mode of the R&S FSMR3.

For details on touch gestures see "Operating Basics" in the R&S FSMR3 Getting Started manual.

Note: The measurement settings are adapted to practical values based on a suitable grid for the current settings, rather than to unwieldy values that reflect precisely the pixel you happen to tap.
If the measurement zoom leads to undesirable results, you can easily return to the original measurement settings using the "UNDO" function.

When you select the "Measurement Zoom" icon, then tap in a diagram, a dotted rectangle is displayed which you can drag to define the zoom area. This allows you to define the zoom area more precisely than by spreading two fingers in the display.

The measurement zoom function provides further options in a context-sensitive menu, which is displayed when you tap the icon for a second or so (or right-click it). These options concern the behavior of the firmware for subsequent touch gestures on the screen. Note that these settings remain unchanged after a channel preset.



Level Lock ← Measurement Zoom
If activated (default), the reference level (and thus the attenuation) is locked, that is: remains unchanged during touch gestures on the screen.

X-Lock ← Measurement Zoom
If activated, the x-axis of the diagram is not changed during subsequent touch gestures.

Y-Lock ← Measurement Zoom
If activated, the y-axis of the diagram is not changed during subsequent touch gestures.

Adapt Measurement to Zoom (selected diagram) ← Measurement Zoom
If you already performed a graphical zoom using the "Single Zoom" on page 60 or "Multi-Zoom" on page 60 functions, this function automatically adapts the measurement settings to maintain the currently zoomed display.

Restore Original Display

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

Note: This function only restores graphically zoomed displays. Measurement zooms, for which measurement settings were adapted, are recalculated based on the adapted measurement settings. In this case, the zoomed display is maintained.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe]` on page 174

4.1.3 How to zoom into a diagram

The following tasks are described here:

- "To zoom into the diagram at one position" on page 62
- "To return to original display" on page 63
- "To zoom into multiple positions in the diagram" on page 63
- "To maintain a zoomed display permanently" on page 64

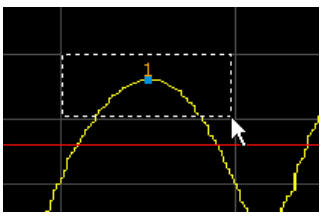
To zoom into the diagram at one position

1. 

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

   Zoom mode is activated.

2. Tap and drag your finger in the diagram to select the area to be enlarged. The selected area is indicated by a dotted rectangle.

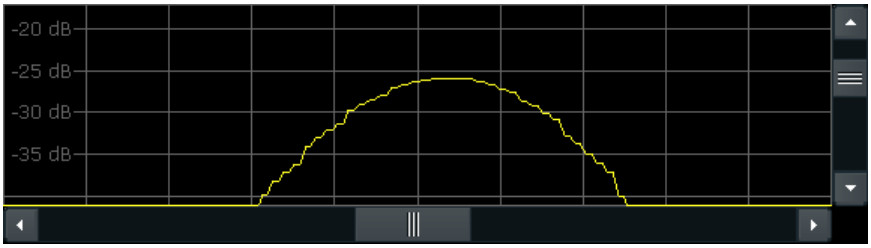


When you leave the touchscreen, the diagram is replaced by the zoomed trace area.

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

Scrolling in the zoomed display

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



To return to original display

▶ 

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

The original trace display is restored. Zoom mode remains active, however.

To zoom into multiple positions in the diagram

1. 

   Click on the "Multi-Zoom" icon in the toolbar.

   Multiple zoom mode is activated.

2. Select the first area in the diagram to be enlarged as described in "To zoom into the diagram at one position" on page 62. 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 Chapter 4.1.1, "Single zoom versus multiple zoom", on page 59.

3. 

   Click on the "Multi-Zoom" icon in the toolbar again.

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

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

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

To move or change zoom areas

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

► To resize a zoom area, tap directly **on** the corresponding frame in the overview window and drag the line to change the size of the frame.
To move a zoom area, tap **inside** the corresponding frame in the overview window and drag the frame to the new position.

The contents of the zoom windows are adapted accordingly.

To maintain a zoomed display permanently

Graphical zooming only changes the resolution of the displayed trace points temporarily. In order to change the display permanently, you must change the corresponding measurement settings.

(Note: Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display, see "To perform a measurement zoom" on page 64).

1. Perform a graphical zoom as described in the previous procedures.

2. Select the "Measurement Zoom" icon from the toolbar.

3. Select "Adapt Hardware to Zoom (selected diagram)".

   The measurement settings are adapted as required to obtain the zoomed result display.

To perform a measurement zoom

Performing a measurement zoom automatically adapts the measurement settings to reflect a graphically zoomed display.

1. Select the "Measurement Zoom" icon from the toolbar.

2. Do one of the following to define the zoom area:
   - Stretch two fingers in the diagram to enlarge the area between them.
   - Tap and drag one finger in the diagram to select the area to be enlarged. The selected area is indicated by a dotted rectangle.

   The measurement settings are adapted as required to obtain the zoomed result display.

4.2 Trace configuration

- Basics on traces....65
- Trace configuration....68
- Trace export and import....71
- Copying traces....76
- Trace math....76
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- How to configure traces....78
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4.2.1 Basics on traces

- Analyzing several traces - trace mode....65
- Trace averaging....66
- Spurs and spur removal....67

4.2.1.1 Analyzing several traces - trace mode

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

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

Each time you change the trace mode, the selected trace memory is cleared.

The R&S FSMR3 supports the following trace modes:

Table 4-1: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting. All available detectors can be selected.
Max Hold	The maximum value is determined over several measurements and displayed. The R&S FSMR3 saves the sweep result in the trace memory only if the new value is greater than the previous one.
Min Hold	The minimum value is determined from several measurements and displayed. The R&S FSMR3 saves the sweep result in the trace memory only if the new value is lower than the previous one.

Trace Mode	Description
Average	The average is formed over several measurements and displayed. The Sweep/Average Count determines the number of averaging procedures.
View	The current contents of the trace memory are frozen and displayed.
Write Hold	The trace is overwritten when new data is available, but only after all cross-correlation operations defined for a half decade are done.

If a trace is frozen ("View" mode), you can change the measurement settings, apart from scaling settings, without impact on the displayed trace. The fact that the displayed trace no longer matches the current measurement settings is indicated by a yellow asterisk on the tab label.

If you change any parameters that affect the scaling of the diagram axes, the R&S FSMR3 automatically adapts the trace data to the changed display range. Thus, you can zoom into the diagram after the measurement to show details of the trace.

4.2.1.2 Trace averaging

The application provides several methods of trace averaging that you can use separately or in any combination.

The order in which averaging is performed is as follows.

1. Cross-correlation
   The application performs a certain number of cross-correlation operations in each half decade.
2. Sweep count.
   The application measures the complete measurement range a particular number of times.
   It again includes the cross-correlation operations as defined.

   After the measurement over the sweep count is finished, the application displays the averaged results.
3. Trace smoothing.
   Calculates the moving average for the current trace.

Sweep count

The sweep count defines the number of sweeps that the application performs during a complete measurements.

A sweep in this context is the measurement over the complete measurement range once. A complete measurement, however, can consist of more than one sweep. In that case, the application measures until the number of sweeps that have been defined are done. The measurement configuration stays the same all the time.

In combination with the average trace mode and cross-correlation operations, the sweep count averages the trace even more.

Trace smoothing

(Software-based) **smoothing** is a way to remove anomalies visually in the trace that can distort the results. The smoothing process is based on a moving average over the complete measurement range. The number of samples included in the averaging process (the *aperture* size) is variable and is a percentage of all samples that the trace consists of.

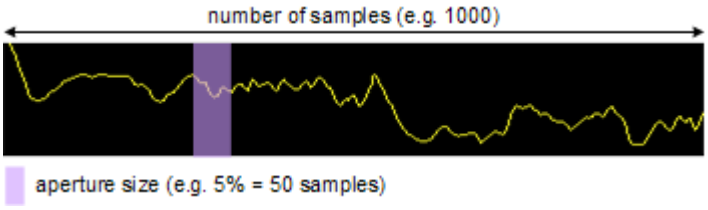


Figure 4-3: Sample size included in trace smoothing

The application smoothes the trace continuously. Smoothing is just an enhancement of the trace display, not of the data itself. It is always applied before trace averaging, max hold, min hold or write hold. For the smoothing process, a median filter is applied on the logarithmic data.

You can turn trace smoothing on and off for all traces individually and compare, for example, the raw and the smooth trace.

The **median** trace smoothing uses a median filter which takes the median value over a sliding window. The window size can be set in the trace menu in percent of the total evaluation range. A median filter suppresses outliers while smoothing the underlying noise curve.

4.2.1.3 Spurs and spur removal

Most phase noise results contain unwanted spurs. Spurs are peak levels at one or more offset frequencies and are caused mostly by interfering signals. For some applications, you might want to identify the location of spurs. For other applications, spurs do not matter in evaluating the results and you might want to remove them from the trace to get a "smooth" phase noise trace.

Spur display

Usually, spurs are visible on the trace as a peak. In addition, the R&S FSMR3 draws a straight, vertical line to represent the position of a spur visually. The length of these lines indicates the level of the spur in dBc and refers to the scale on the right side of the phase noise diagram.

The lines indicating a spur are not part of the trace data. When you export the trace, for example, the spur data is not exported.

Spur suppression

The application allows you to (visually) remove spurs from the trace. Spur removal is based on an algorithm that detects and completely removes the spurs from the trace and fills the gaps with data that has been determined mathematically.

The spur removal functionality separates the actual spur power from the underlying phase noise and displays the latter in a two-stage process. The first stage of spur detection is based on an eigenvalue decomposition during the signal processing.

Spur threshold

During the second stage, the application uses statistical methods to remove a spur. A spur is detected, if the level of the signal is above a certain threshold. The spur threshold is relative to an imaginary median trace that the application calculates.

If parts of the signal are identified as spurs, the application removes all signal parts above that level and substitutes them with the median trace.

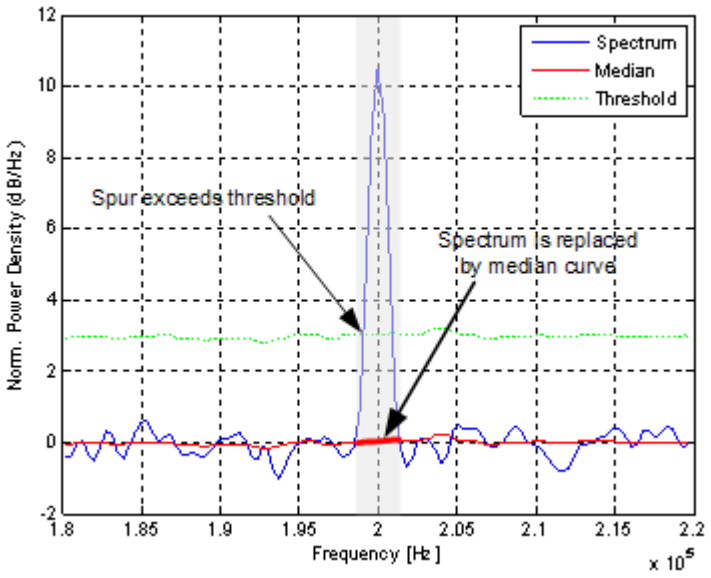
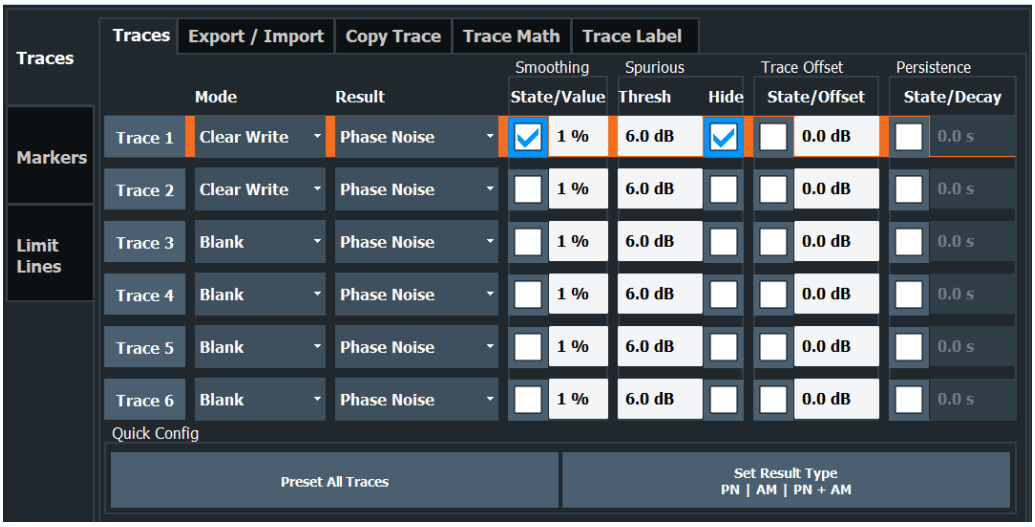


Figure 4-4: Spur detection and removal principle

4.2.2 Trace configuration

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

Traces are the graphical representation of the measurement results. Depending on the trace configuration, they carry different information or evaluate the results differently.



Restoring default traces

The application allows you to easily restore the default trace configuration (Trace 1 and 2 with their respective default characteristics) with the "Preset all Traces" button.

Displaying all result types

Similarly, you can easily display all available result type (PM, AM and overall noise) with the "Set Result Type" button. When you do so, the application displays three traces in the diagram: One for the phase noise, one for the AM noise and the third showing the sum of the phase noise and AM noise (PN + AM).

Functions in the "Traces" dialog box described elsewhere:

- Chapter 4.2.1.3, "Spurs and spur removal", on page 67

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

Remote command:
Selected via numeric suffix of:`TRACe<1...6>` commands
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 178

Trace Mode
Defines the update mode for subsequent traces.

For details, see Chapter 4.2.1.1, "Analyzing several traces - trace mode", on page 65.

"Clear/ Write" Overwrite mode (default): the trace is overwritten by each sweep.

"Max Hold" The maximum value is determined over several sweeps and displayed. The R&S FSMR3 saves each trace point in the trace memory only if the new value is greater than the previous one.

"Min Hold" The minimum value is determined from several measurements and displayed. The R&S FSMR3 saves each trace point in the trace memory only if the new value is lower than the previous one.

"Average"	The average is formed over several sweeps.
"View"	The current contents of the trace memory are frozen and displayed.
"Blank"	Removes the selected trace from the display.
"Write Hold"	The trace is overwritten when new data is available, but only after all cross-correlation operations defined for a half decade are done. (Or when the trace cannot be improved further when "XCORR Optimization" is on). Example: 100 cross-correlation operations are defined for a half decade. The trace is updated when all 100 cross-correlations are done, not after each individual cross-correlation operation.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE` on page 175

Selecting the displayed result
The R&S FSMR3 supports several noise characteristics that you can assign to a trace and thus display in the diagram.

- "Phase Noise"
  Shows the measured phase noise characteristics.
- "AM Noise"
  Shows the measured amplitude noise characteristics.
- "Phase + AM Noise"
  Shows the sum of the phase noise and AM noise characteristics.

The "AM Noise" and "Phase + AM Noise" traces are only available for the "Noise Spectrum" diagram, and not in its variations ("Noise Spectrum L(f)", "Noise Spectrum SΦ(f)", "Noise Spectrum Sv(f)", "Noise Spectrum Sy(f)").

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:RESult[:TYPE]` on page 178

Smoothing traces
The R&S FSMR3 allows you to smooth traces and thus remove unwanted anomalies.

You can apply smoothing to all active traces individually (Smoothing "State"), and define the magnitude of trace smoothing in percent (Smoothing "Value").

The range is from 1% to 20%.

Remote command:
State: `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]` on page 180
Value: `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture` on page 180

Removing spurs
Spur removal is a method to remove displayed peak levels visually.

You can apply spur removal to all active traces individually (spurious removal "State"), and define a threshold (in dB) that defines when a peak level is recognized as a spur (spurious removal "Value").

More information

Remote command:
State: DISPlay[:WINDow<n>]:TRACe<t>:SPURs:SUPPress on page 159
Value: DISPlay[:WINDow<n>]:TRACe<t>:SPURs:THReshold on page 160

Shifting the trace
Shifting the trace can be useful to subtract external noise sources from the results. The trace offset is a visual device that shifts the trace by certain level.

You can apply an offset to all active traces individually (Offset "State"), and define an offset in dB by which the trace should be shifted.

Remote command:
State: DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet:STATe on page 179
Offset: DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 179

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

In the phase noise application, the persistence defines for how long a trace remains visible before it fades away. An event that has occurred a single time is visible for up to 8 seconds. As the statistical frequency of an event gets smaller at coordinates with signal parts that are not constantly there, the trace fades away.

A signal with constant frequency or phase characteristics does not show the effects of persistence on the trace. When the frequency or phase of a signal change slightly, however, the effect of persistence becomes visible through color changes or changes in the shape of the trace.

You can turn on persistence for all traces in the display ("State"). The "Decay" property defines the time that shadows of past traces remain visible in the display before fading away. With a decay of 0 s, all past traces remain visible.

When you change a measurement setting, the R&S FSMR3 resets the persistence effect.

Persistence is supported by phase noise measurements.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:PERSistence[:STATe] on page 178
DISPlay[:WINDow<n>]:TRACe<t>:PERSistence:DECay on page 177

4.2.3 Trace export and import

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

The R&S FSMR3 provides various evaluation methods for the results of a measurement. However, if you want to evaluate the data with external applications, you can export the measurement data to a standard format file (ASCII or XML).

The following data types can be exported (depending on the application):

- Trace data
- Table results, for example result summaries, marker peak lists.

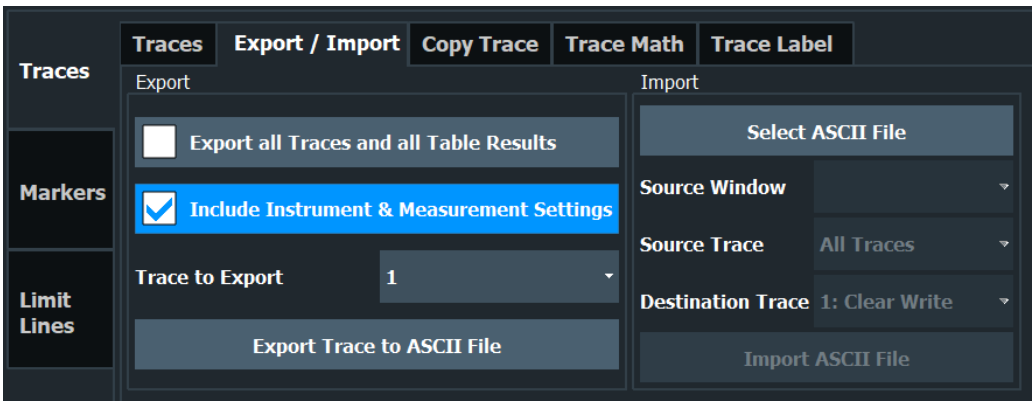
You can also import existing trace data from a file, for example to compare your latest measurement results with results that you have saved some time ago.

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.

The standard data management functions (e.g. saving or loading instrument settings) that are available for all R&S FSMR3 applications are not described here.

See the R&S FSMR3 user manual for a description of the standard functions.



Export all Traces and all Table Results 72
Include Instrument & Measurement Settings 73
Trace to Export 73
Export Trace to ASCII File 73
└ File Type 74
└ Decimal Separator 74
└ Column Separator 74
└ File Explorer 75
Select ASCII File 75
Source Window / Source Trace 75
Destination Trace 75
Import 76

Export all Traces and all Table Results
Selects all displayed traces and result tables (e.g. "Result Summary", marker table etc.) in the current application for export to an ASCII file.

Alternatively, you can select one specific trace only for export (see Trace to Export).

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

Remote command:
FORMat:DEXPort:TRACes on page 184

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

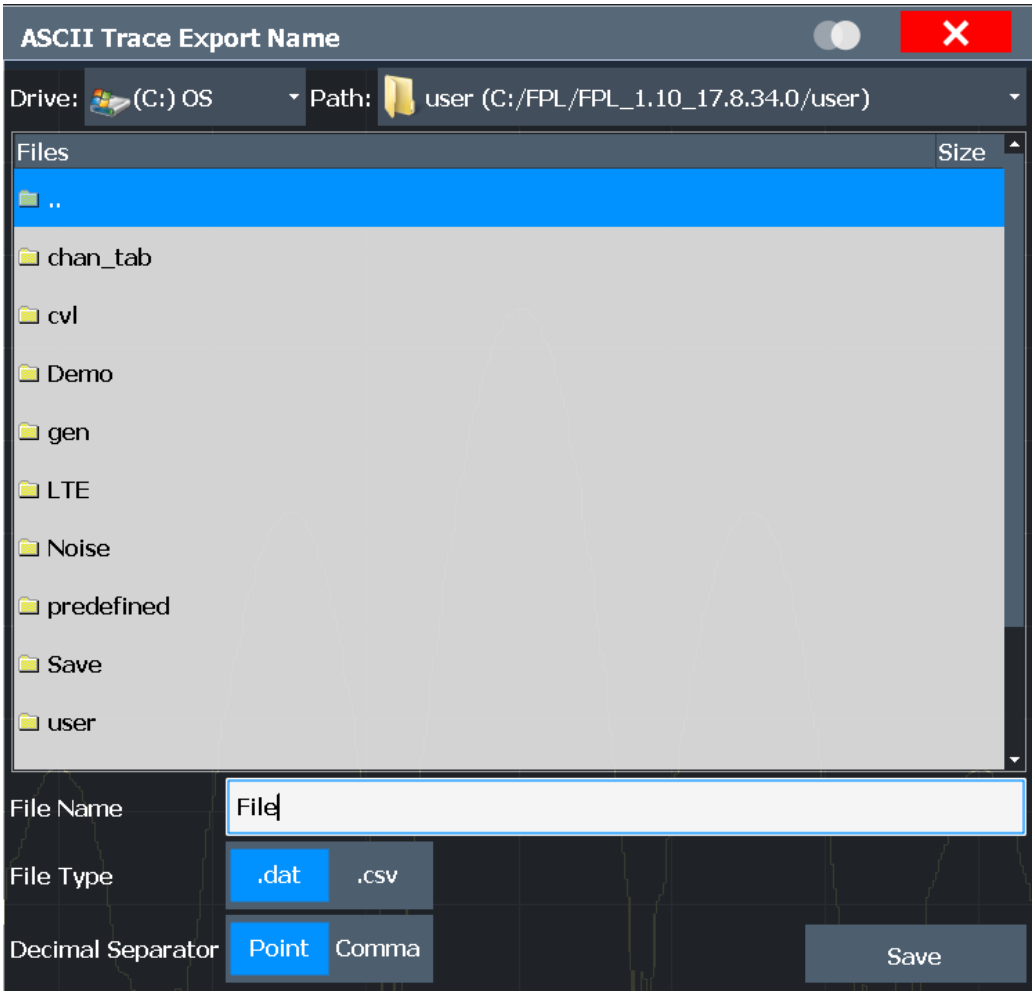
Remote command:
FORMat:DEXPort:HEADer on page 183

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

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

Export Trace to ASCII File
Saves the selected trace or all traces in the currently active result display to the specified file and directory in the selected ASCII format.

"File Explorer": Instead of using the file manager of the R&S FSMR3 firmware, you can also use the Microsoft Windows File Explorer to manage files.



For details on the file format, see Chapter 4.2.8.1, "Reference: ASCII file export format", on page 79.

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSMR3 User Manual.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 185

File Type ← Export Trace to ASCII File
Determines the format of the ASCII file to be imported or exported.

Depending on the external program in which the data file was created or is evaluated, a comma-separated list (`CSV`) or a plain data format (`DAT`) file is required.

Remote command:
`FORMat:DEXPort:FORMat` on page 183

Decimal Separator ← Export Trace to ASCII File
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 183

Column Separator ← Export Trace to ASCII File
Selects the character that separates columns in the exported ASCII file. The character can be either a semicolon, a comma or a tabulator (tab).

Example for semicolon:

```
Type;FSMR3026;Version;1.80;Date;01.Jan 3000;
```

Example for comma:

```
Type,FSMR3026,
Version,1.80,
Date,01.Jan 3000,
```

Example for tabulator (tab after the last column is not visible):

```
Type    FSMR3026
Version    1.80
Date    01.Jan 3000
```

The selected column separator setting remains the same, even after a preset.

Remote command:
`FORMat:DEXPort:CSEParator` on page 182

File Explorer ← Export Trace to ASCII File
Opens the Microsoft Windows File Explorer.

Remote command:
not supported

Select ASCII File
The "Select ASCII File" button opens a dialog box to select results that you want to import.

You can select files with the extensions `.csv` or `.dat`.

Remote command:
`MMEMory:LOAD<n>:TRACe` on page 184

Source Window / Source Trace
Files that contain result data can contain the results of several measurements and result displays. The "Source Window" and "Source Trace" dropdown menus select the data that you would like to import.

The source data must be compatible to a currently active window.

Example:

If you want to import trace 1 of a previously exported noise diagram:
- Select the phase noise measurement and open a noise diagram from the SmartGrid.
- Select "Noise Diagram" from the "Source Window" dropdown menu.
- Select "1" from the "Source Trace" dropdown menu.
  If you select "All Traces", the R&S FSMR3 imports all traces of the selected result type.

Remote command:
`MMEMory:LOAD<n>:TRACe` on page 184

Destination Trace
The "Destination Trace" dropdown menu becomes available when you select to import a single trace only.

In that case, you can select the trace number you want to write the trace data to.

If you select a trace that already exists, the trace import overwrites the currently displayed trace. Imported traces always get the trace mode "View".

Example:

You have selected trace "1" as the trace you want to import from the "Source Trace" dropdown menu.

If you select "1: Clear Write" ("Clear Write" indicates the trace is currently displayed) from the "Destination Trace" dropdown menu, the import overwrites the trace. The trace mode for trace 1 is replaced by trace mode "View".

If you select "5: Blank" ("Blank" indicates that the trace is currently not displayed) from the "Destination Trace" dropdown menu, the imports adds a new trace to the diagram (with trace mode "View". All other traces remain in the diagram.

Remote command:
MMEMory:LOAD<n>:TRACe on page 184

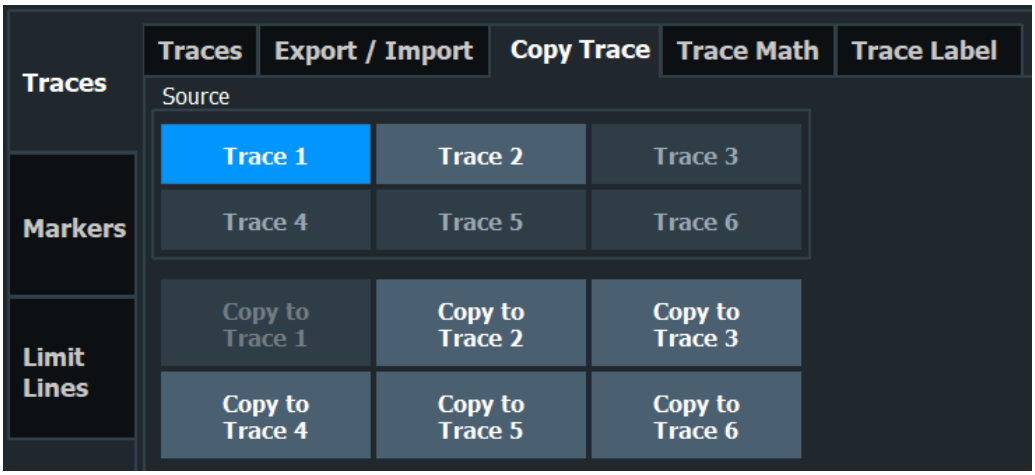
Import
The "Import" button imports the selected trace(s).

THe R&S FSMR3 does not import numeric results associated with the imported trace (spot noise, values from the spurious list etc.)

Remote command:
MMEMory:LOAD<n>:TRACe on page 184

4.2.4 Copying traces

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



Copy Trace.....76

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

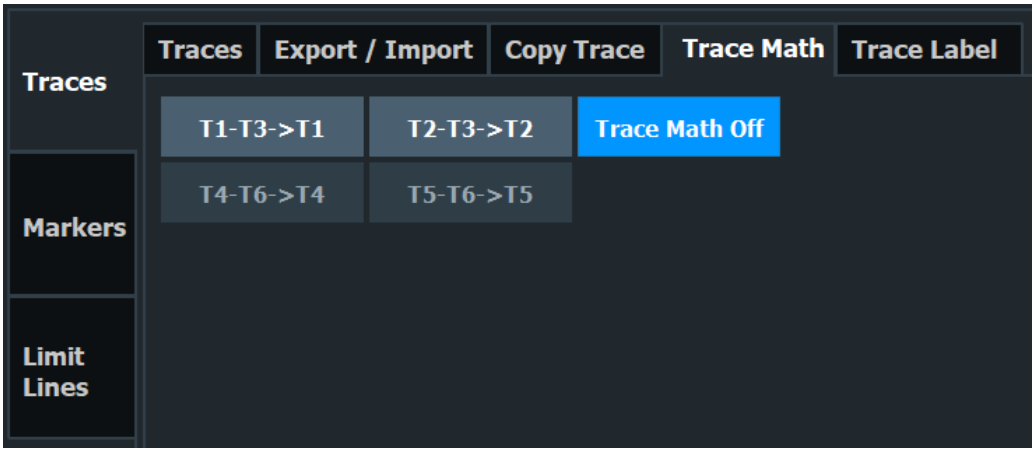
Or: [TRACE] > "Copy Trace"

Copies trace data to another trace.

Remote command:
TRACe<n>:COPY on page 181

4.2.5 Trace math

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



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Selecting the math operation
You can select one of several different math operations.

Each operation subtracts one trace from another as indicated on the corresponding button and writes the result to one of the traces. "T1 - T3 > T1", for example, subtracts trace 3 from trace 1 and writes the result to trace 1. You can apply one operation at a time.

To turn off trace mathematics, use the "Trace Math Off" feature.

Remote command:
Operation: `CALCulate<n>:MATH[:EXPRession][:DEFine]` on page 186
State: `CALCulate<n>:MATH:STATe` on page 186

4.2.6 Trace labels

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

Trace labels are a way to assign a descriptive label to traces instead of the general "Trace <x>" label (default). The labels you use are arbitrary and are displayed in the diagram area. The font color corresponds to the color of the respective trace (for example yellow trace: yellow font).

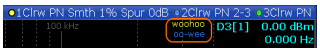
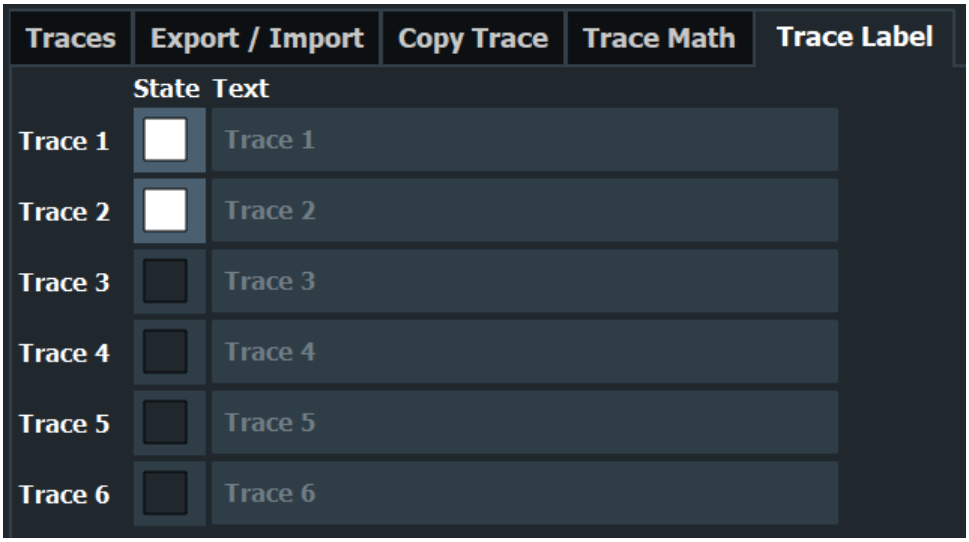


Figure 4-5: Example: the yellow and blue traces have a label.

You can define trace labels in the "Trace Label" tab of the "Trace" dialog box.



How to assign trace labels

Trace labels can be configured via the "Trace Labels" dialog box.

1. Turn on the trace label for a specific trace and assign a label in the corresponding input field.
   Note that a trace must be active. Otherwise assigning a label is not possible.
2. Move the trace label to any position on the display by dragging it to the new position.

Remote command:

State: `DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe]` on page 176

Label: `DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT` on page 177

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4.2.7.1 How to export trace data and numerical results

The measured trace data and numerical measurement results in tables can be exported to an ASCII file. For each sweep point, the measured trace position and value are output. The file is stored with a `.DAT` extension. For details on the storage format, see Chapter 4.2.8.1, "Reference: ASCII file export format", on page 79.

To export trace data and table results

Trace data can be exported from the "Trace" menu.

1. Press the [Trace] key, then select the "Trace Config" softkey and switch to the "Trace / Data Export" tab.

2. Select "Export all Traces and all Table Results" to export all available measurement result data for the current application. Alternatively, select a specific "Trace to Export".
3. Optionally, select the "Include Instrument & Measurement Settings" option to insert additional information in the export file header.
4. If necessary, change the decimal separator used in the ASCII export file.
5. Select the "Export Trace to ASCII File" button.
6. In the file selection dialog box, select the storage location and file name for the export file.
7. Select "Save" to close the dialog box.
8. Export the data to the file.

4.2.8 References

- Reference: ASCII file export format..... 79

4.2.8.1 Reference: ASCII file export format

Trace data can be exported to a file in ASCII format for further evaluation in other applications. This reference describes in detail the format of the export files for result data.

(For details see Chapter 4.2.7.1, "How to export trace data and numerical results", on page 78).

The file consists of the header information (general configuration of the measurement) and the measurement results. Optionally, the header can be excluded from the file.

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

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

Generally, the format of this ASCII file can be processed by spreadsheet calculation programs, e.g. MS Excel. Different language versions of evaluation programs can require a different handling of the decimal point. Thus, you can define the decimal separator to use (decimal point or comma).

4.3 Markers

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display.

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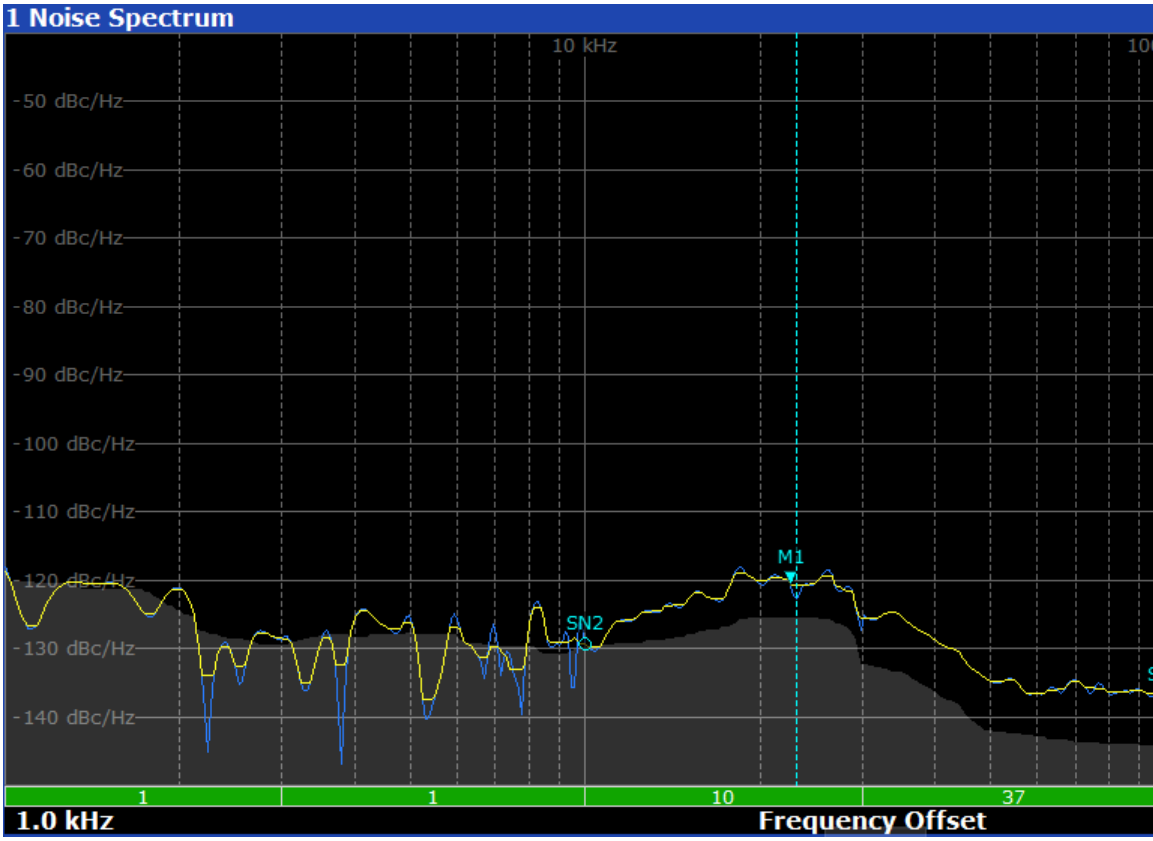
- Marker settings 82
- Marker search settings and positioning functions 86

4.3.1 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 FSMR3 provides 16 markers per display window. In the Phase Noise application, markers across measurement windows are independent from each other - thus you can move a marker in one window without moving it in another window.

- The easiest way to work with markers is using the touchscreen. 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.
- You can also set an active marker to a new position by defining its position on the x-axis 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 touchscreen 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 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.

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).

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- Marker results....81

4.3.1.1 Activating markers

Only active markers are displayed in the diagram and in the marker table.

Active markers are indicated by a highlighted softkey.

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

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

4.3.1.2 Marker results

Normal markers point to a trace point on the x-axis and display the associated numeric value for that trace point. Delta markers indicate an offset between the level at the delta marker position and the level at the position of the assigned reference marker, in dB.

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

Marker information in marker table

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

Table 4-2: Contents of the marker table in the Phase Noise application

Window	Window the marker is in (only if you have opened more than one Phase Noise diagram)
Type	Marker type: N (normal), D (delta), T (temporary, internal) and number
Ref	Reference marker for delta markers
Trc	Trace to which the marker is assigned
X-value	X-value of the marker
Y-value	Y-value of the marker

4.3.2 Marker settings

For more information about marker search, see Chapter 4.3.3, "Marker search settings and positioning functions", on page 86

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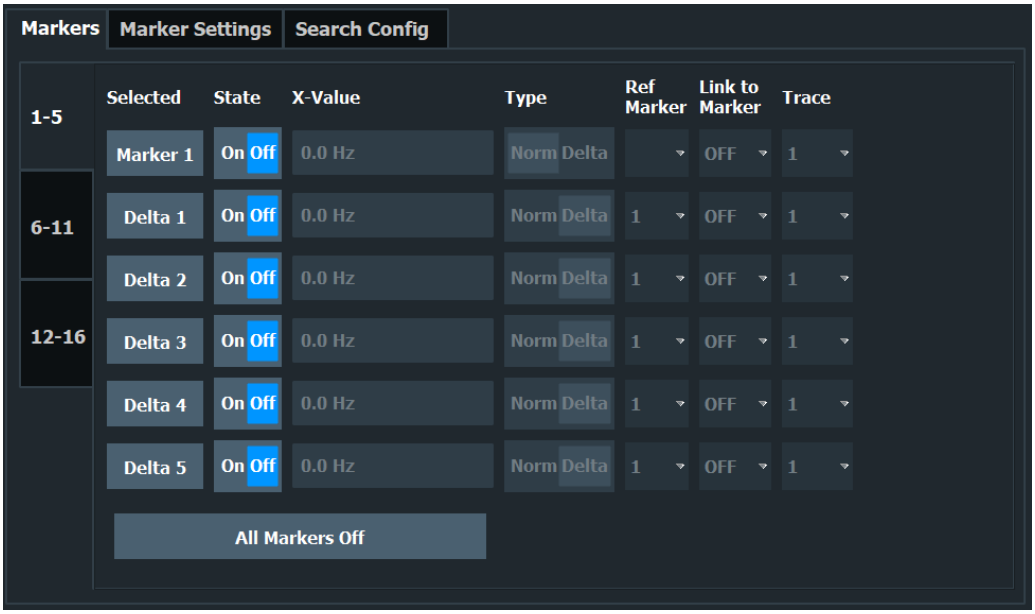
4.3.2.1 Individual marker setup

Access: "Overview" > "Analysis" > "Markers" > "Markers"

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

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



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Select Marker....85
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Selected Marker
Marker name. The marker which is currently selected for editing is highlighted orange.

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

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 192
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 190

Marker Position X-value
Defines the position (x-value) of the marker in the diagram. For normal markers, the absolute position is indicated. For delta markers, the position relative to the reference marker is provided.

Remote command:
CALCulate<n>:MARKer<m>:X on page 193
CALCulate<n>:DELTamarker<m>:X on page 191

Marker Type
Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 192
CALCulate<n>:DELTamarker<m>[:STATe] on page 190

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

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

Remote command:
CALCulate<n>:DELTamarker<m>:MREFerence on page 190

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

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

Remote command:
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> on page 191
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> on page 189
CALCulate<n>:DELTamarker<m>:LINK on page 188

Assigning the Marker to a Trace
The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

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

Remote command:
CALCulate<n>:MARKer<m>:TRACe on page 192

Select Marker
The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 192
CALCulate<n>:DELTamarker<m>[:STATe] on page 190

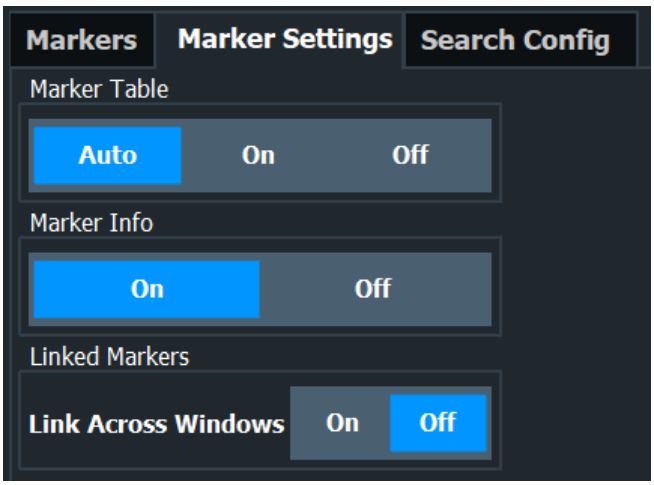
All Markers Off
Deactivates all markers in one step.

Remote command:
CALCulate<n>:MARKer<m>:AOFF on page 191

4.3.2.2 General marker settings

Access: "Overview" > "Analysis" > "Markers" > "Settings"

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



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Marker Table Display
Defines how the marker information is displayed.

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

"Off" No separate marker table is displayed.

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 193

Linked Markers
If enabled, the markers in all diagrams with the same x-axis are linked, i.e. when you move a marker in one window, the markers in all other windows are moved to the same x-value.

Remote command:
`CALCulate<n>:MARKer<m>:LINK` on page 194

4.3.3 Marker search settings and positioning functions

Several functions are available to set the marker to a specific position quickly and easily, or to use the current marker position to define another characteristic value. In order to determine the required marker position, searches can 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).

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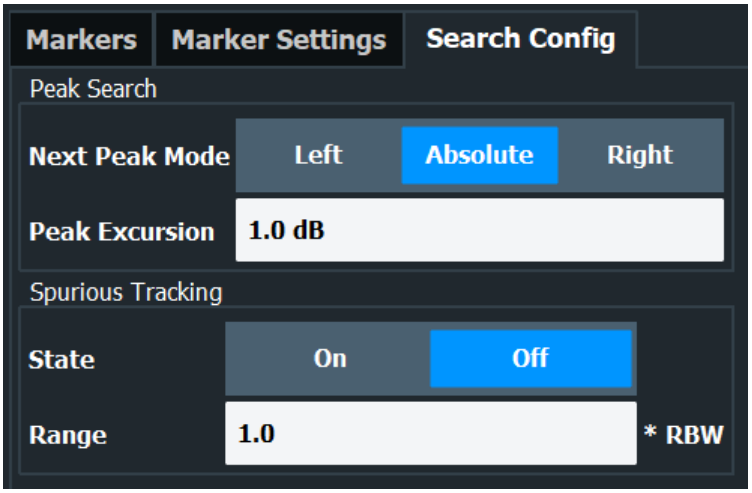
- Positioning functions....88

4.3.3.1 Marker search settings

Access: "Overview" > "Analysis" > "Markers" > "Search"

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



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Peak Excursion 87
Spurious Tracking 88

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

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

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

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

Remote command:
Find a list of remote commands in Chapter 6.6.4.4, "Positioning markers", on page 195.

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

Entries from 0 dB to 60 dB are allowed; the resolution is 0.1 dB. The default setting for the peak excursion is 1 dB.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 194

Spurious Tracking
Spurs can be unstable regarding their frequency characteristics. In such cases, markers would not remain on the spur, but on the frequency you have set them on initially.

You can avoid this situation using spurious tracking. Spur tracking makes sure that the marker remains on the spur, even if the spur changes its frequency. When you turn on spur tracking, you can define a frequency range within which the R&S FSMR3 tracks the spur and adjusts the marker position automatically.

The tracking "Range" defines an area around the marker position and is a function of the resolution bandwidth (RBW) used in the half decade the marker is in. Note that the tracking range is dynamic and always relative to the latest marker position, not the initial marker position.

Example:

You are measuring with an RBW of 10 kHz and place the marker on a spur.

The tracking range is defined as 1 * RBW = 10 kHz.

If the spur changes its position by up to ±10 kHz, the R&S FSMR3 changes the marker position along with the spur.

Note that the spurious list contains the tracked spurs and always shows the latest position of the spur.

Remote command:
State: `CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking[:STATe]` on page 195
Range: `CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking:RANGe` on page 194

4.3.3.2 Positioning functions

Access: [MKR →]

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

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Search Next Minimum....89

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

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 198
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 196

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

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 198
CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 198
CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 198
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 196
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 196
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 196

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

Remote command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 199
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 197

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

Remote command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 199
CALCulate<n>:MARKer<m>:MINimum:LEFT on page 199
CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 199
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 197
CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 197
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 197

4.4 Limit lines

Limit lines help you analyze a measurement trace.

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- How to define limit lines 98

4.4.1 Basics on limit lines

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

The R&S FSMR3 supports limit lines with a maximum of 200 data points. Eight of the limit lines stored in the instrument can be activated simultaneously. The number of limit lines stored in the instrument is only limited by the capacity of the storage device used.

Limit line data can also be exported to a file in ASCII (CSV) format for further evaluation in other applications. Limit lines stored in the specified ASCII (CSV) format can also be imported to the R&S FSMR3 for other measurements.

Compatibility

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

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

Validity

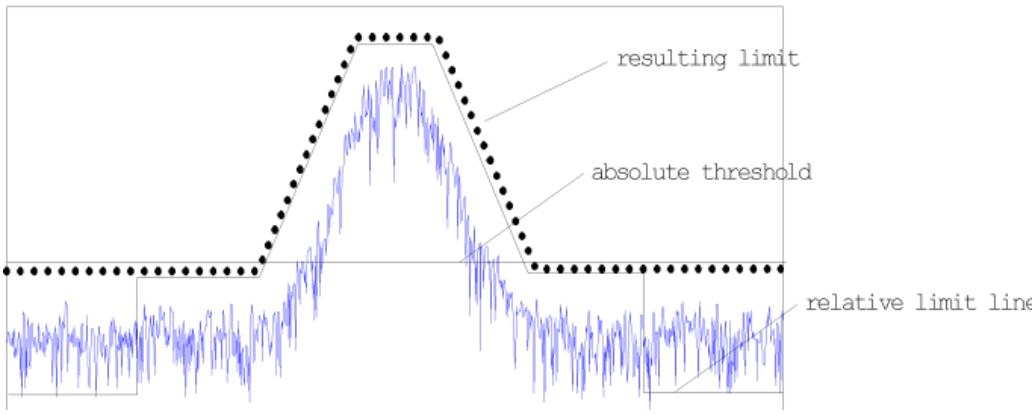
Only limit lines that fulfill the following conditions can be activated:

- 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 FSMR3. A limit line may also exceed the specified frequency or time range. The minimum frequency for a data point is -200 GHz, the maximum frequency is 200 GHz. For the time range representation, negative times may also be entered. The allowed range is -1000 s to +1000 s.

Figure 4-6: Example for an upper limit line

Thresholds

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



Offsets and Shifting

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

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

- Defining a **shift** width for the values or position of the individual data points changes the line configuration, thus changing the position of the line in the diagram.

Limit Check Results

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

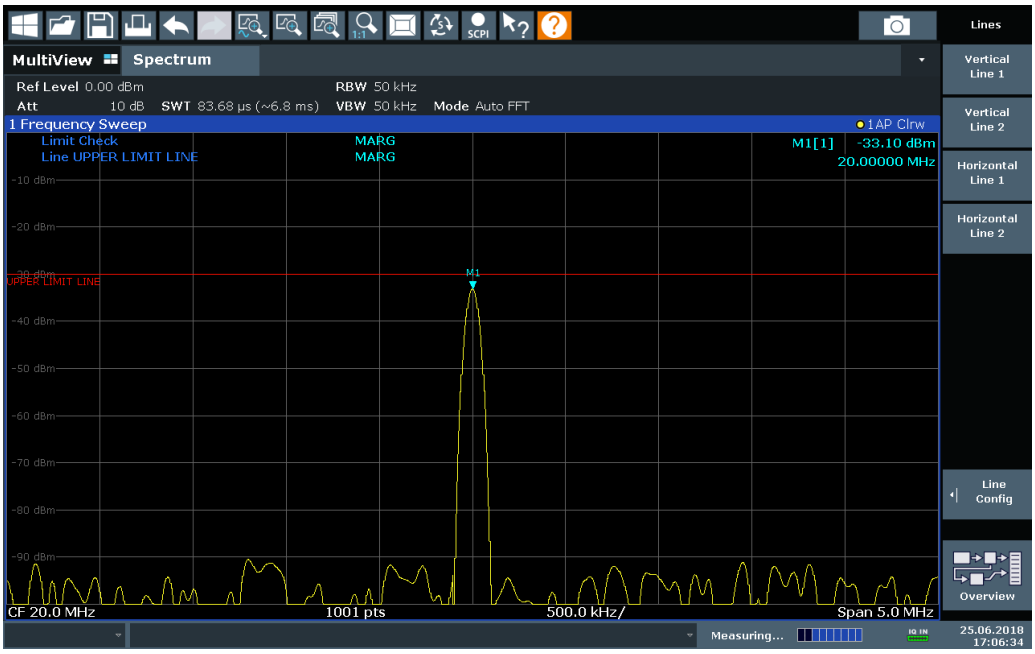


Figure 4-7: Margin violation for limit check

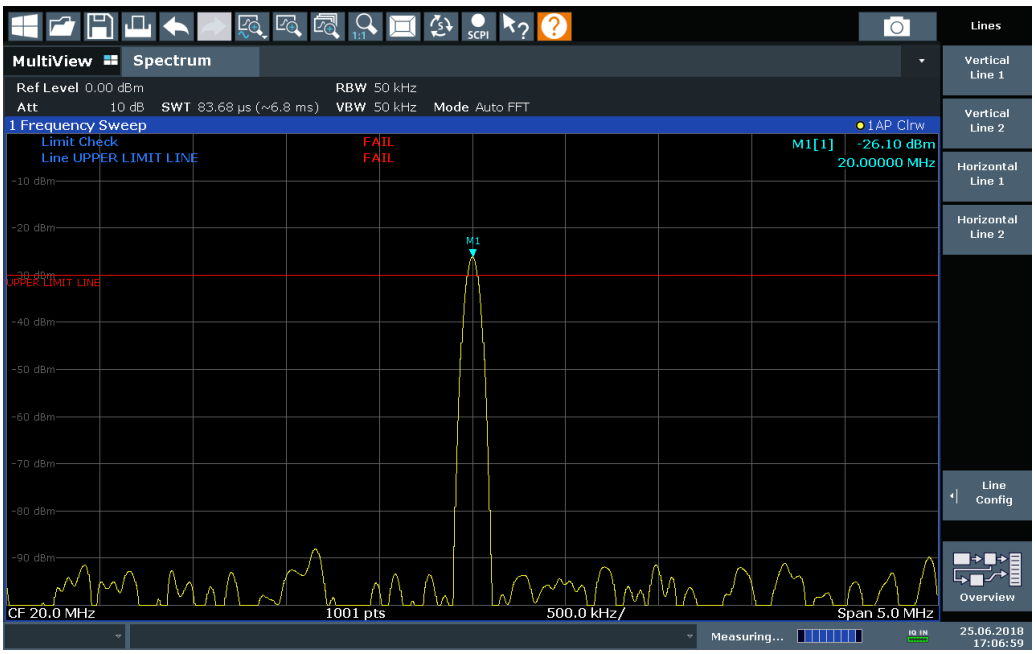


Figure 4-8: Limit violation for limit check

Storing and Recalling Limit Lines

Limit lines can be stored with the configuration settings so they can be recalled for other measurements at a later time. Note, however, that any changes made to the limit lines *after* storing the configuration file cannot be restored and will be overwritten by the stored values when the configuration file is recalled. Always remember to store the settings again after changing the limit line values.

After recalling measurement settings, the limit line values applied to the measurement may be different to those displayed in the "Limit Lines" dialog box.

For more information see the R&S FSMR3 User Manual, chapter "Data Management".

4.4.2 Limit line settings and functions

Access: "Overview" > "Analysis" > "Lines"

or: [LINES] > "Line Config"

Up to 8 limit lines can be displayed simultaneously in the R&S FSMR3. Many more can be stored on the instrument.

Stored limit line settings

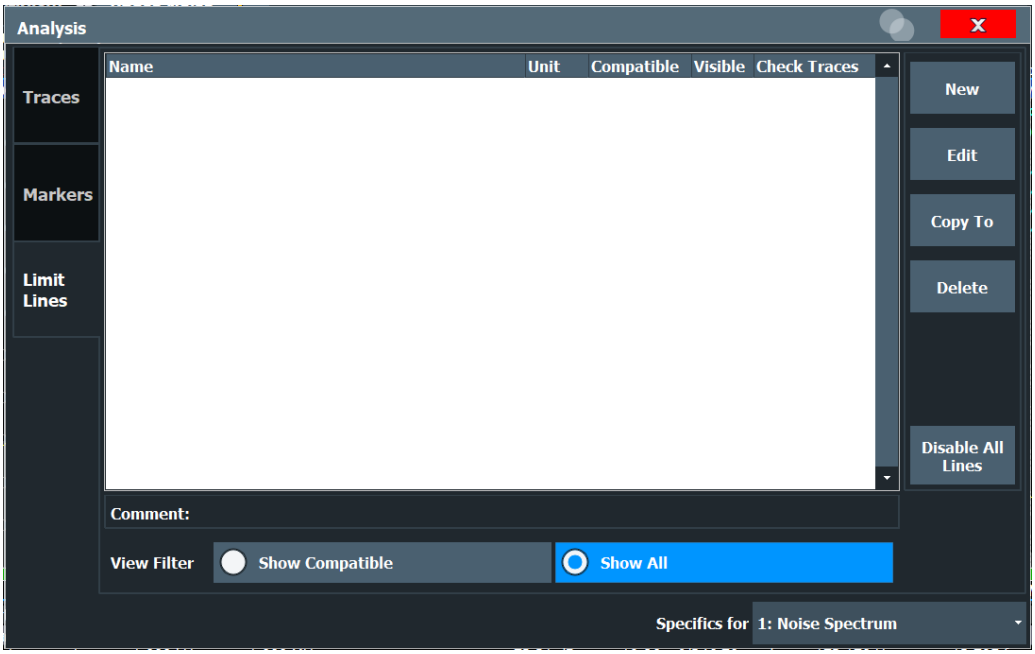
When storing and recalling limit line settings, consider the information provided in the Data Management chapter of the R&S FSMR3 User Manual.

- Limit line management 94
- Limit line details 96

4.4.2.1 Limit line management

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines"

or: [LINES] > "Line Config" > "Limit Lines"



For the limit line overview, the R&S FSMR3 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 Chapter 4.4.2.2, "Limit line details", on page 96.

For more basic information on limit lines see Chapter 4.4.1, "Basics on limit lines", on page 89.

Name....94
Unit....95
Compatibility....95
Visibility....95
Traces to be Checked....95
Comment....95
Included Lines in Overview (View Filter)....95
Create New Line....95
Edit Line....95
Copy Line....95
Delete Line....96
Disable All Lines....96

Name
The name of the stored limit line.

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

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

For more information on which conditions a limit line must fulfill to be compatible, see "Compatibility" on page 90.

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

Remote command:
`CALCulate<n>:LIMit<li>:LOWer:STATe` on page 203
`CALCulate<n>:LIMit<li>:UPPer:STATe` on page 205
`CALCulate<n>:LIMit<li>:ACTive?` on page 201

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

Remote command:
`CALCulate<n>:LIMit<li>:TRACe<t>:CHECk` on page 204

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).

Create New Line
Creates a new limit line.

Edit Line
Edit an existing limit line configuration.

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

Remote command:
`CALCulate<n>:LIMit<li>:COPY` on page 202

Delete Line
Delete the selected limit line configuration.

Remote command:
CALCulate<n>:LIMit<li>:DELete on page 202

Disable All Lines
Disable all limit lines in one step.

Remote command:
CALCulate<n>:LIMit<li>:STATe on page 203

4.4.2.2 Limit line details

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines" > "New" / "Edit" / "Copy To"

or: [LINES] > "Line Config" > "Limit Lines" > "New" / "Edit" / "Copy To"

Name....96
Comment....96
X-Axis....96
Y-Axis....97
Data Points....97
Insert Value....97
Delete Value....97
Shift x....97
Shift y....97
Save....98

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

Remote command:
CALCulate<n>:LIMit<li>:NAME on page 209

Comment
Defines an optional comment for the limit line.

Remote command:
CALCulate<n>:LIMit<li>:COMMent on page 205

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

- Unit:
  - "Hz": for frequency domain
  - "s": for time domain
- Scaling mode: absolute or relative values
  Not supported
- Scaling: linear or logarithmic

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:MODE on page 207
CALCulate<n>:LIMit<li>:CONTrol:DOMain on page 206
CALCulate<n>:LIMit<li>:CONTrol:SPACing on page 207

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 center frequency (frequency diagram) or the reference value (phase diagram).
- Limit type: upper or lower limit; values must stay above the lower limit and below the upper limit to pass the limit check

Remote command:
CALCulate<n>:LIMit<li>:UNIT on page 209
CALCulate<n>:LIMit<li>:LOWer:MODE on page 208
CALCulate<n>:LIMit<li>:UPPer:MODE on page 210
CALCulate<n>:LIMit<li>:LOWer:MODE on page 208
CALCulate<n>:LIMit<li>:UPPer:MODE on page 210

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

Remote command:
CALCulate<n>:LIMit<li>:CONTrol[:DATA] on page 206
CALCulate<n>:LIMit<li>:LOWer[:DATA] on page 208
CALCulate<n>:LIMit<li>:UPPer[:DATA] on page 210

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.

Remote command:
CALCulate<n>:LIMit<li>:CONTrol:SHIFt on page 207

Shift y
Shifts the y-value of each data point vertically by the defined shift width.

Remote command:
CALCulate<n>:LIMit<li>:LOWer:SHIFt on page 208
CALCulate<n>:LIMit<li>:UPPer:SHIFt on page 210

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

4.4.3 How to define limit lines

Access: "Overview" > "Analysis" > "Lines" > "Limit Lines"

or: [LINES] > "Line Config" > "Limit Lines"

The following tasks are described here:

- "How to find compatible limit lines" on page 98
- "How to activate and deactivate a limit check" on page 98
- "How to edit existing limit lines" on page 98
- "How to copy an existing limit line" on page 99
- "How to delete an existing limit line" on page 99
- "How to configure a new limit line" on page 99
- "How to move the limit line vertically or horizontally" on page 100

How to find compatible limit lines

► In the "Line Config" dialog box, select the "View Filter" option: "Show Compatible".

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

How to activate and deactivate a limit check

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

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

   The specified traces to be checked are compared with the active limit lines. The status of the limit check is indicated in the diagram.

2. To deactivate a limit line, deactivate all "Traces to be Checked" for it.
   To deactivate all limit lines at once, select 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 99.
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 dialog box, select the limit line.
2. Select the"Line Config" "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 99.
5. Save the new configuration by selecting the "Save" button.

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

How to delete an existing limit line

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

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

How to configure a new limit line

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

   The "Edit Limit Line" dialog box is displayed. The current line configuration is displayed in the preview area of the dialog box. The preview is updated after each change to the configuration.
2. Define a "Name" and, optionally, a "Comment" for the new limit line.
3. Define the x-axis configuration:
   - Time domain or frequency domain
   - Absolute or relative limits
   - Linear or logarithmic scaling
4. Define the y-axis configuration:
   - Level unit
   - Absolute or relative limits
   - Upper or lower limit line
5. Define the data points: minimum 2, maximum 200:

   a) Select "Insert Value".
   b) Define the x-value ("Position") and y-value ("Value") of the first data point.

c) Select "Insert Value" again and define the second data point.
d) Repeat this to insert all other data points.
To insert a data point before an existing one, select the data point and then "Insert Value".
To insert a new data point at the end of the list, move the focus to the line after the last entry and then select "Insert Value".
To delete a data point, select the entry and then "Delete Value".

6. Check the current line configuration in the preview area of the dialog box. If necessary, correct individual data points or add or delete some.
If necessary, shift the entire line vertically or horizontally by selecting the "Shift x" or "Shift y" button and defining the shift width.

7. Optionally, define a "Margin" at a fixed distance to the limit line.
The margin must be within the valid value range and is not displayed in the diagram or preview area.

8. Optionally, if the y-axis uses relative scaling, define an absolute "Threshold" as an additional criteria for a violation.

9. Save the new configuration by selecting the "Save" button.

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

How to move the limit line vertically or horizontally

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

1. In the "Line Config" dialog box, select the limit line.

2. To shift the complete limit line parallel in the horizontal direction, select the "X-Offset" button and enter an offset value.
To shift the complete limit line parallel in the vertical direction, select the "Y-Offset" button and enter an offset value.

3. To shift the individual data points of a limit line by a fixed value (all at once):

a) Select the "Edit" button.
b) In the "Edit Limit Line" dialog box, select the "Shift x" or "Shift y" button and define the shift width.
c) Save the shifted data points by selecting the "Save" button.

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

5 How to configure phase noise measurements

- Performing a basic phase noise measurement 101
- Customizing the measurement range 102

5.1 Performing a basic phase noise measurement

1. In the Measuring Receiver application, define the center frequency of the DUT.
2. Enter the "Phase Noise" application.

   The R&S FSMR3 starts the measurement with the default configuration. The default configuration defines most settings automatically.
   If you need any custom configuration, define them after entering the Phase Noise application.
3. Layout the display as required via the SmartGrid.
4. Open the "Overview" dialog box to configure the measurement.
5. Configure the frontend (frequency, level etc.) via the "Frontend" dialog box.
6. Define the measurement range via the "Phase Noise" dialog box.
7. Turn on frequency and level tracking via the "Control" dialog box.
8. Run a single sweep.
9. Turn on a marker and read out the results.
10. Read out the residual noise over the measurement range.
11. Customize a residual noise range and read out the results.
12. Freeze trace 1 and 2 (trace mode: View).
13. Turn on trace 3 and 4 (trace mode: Clear/Write).
14. Switch the measurement mode to "IQ FFT" in the "Phase Noise" dialog box.
15. Repeat the measurement.

5.2 Customizing the measurement range

The application provides several ways to customize. Each method features a different level of details you can define.

1. Open the "Phase Noise" configuration via the "Overview" dialog box or the "Meas Config" softkey menu.
2. Define the frequency offset range you'd like to measure in the corresponding fields.
3. Select the "Sweep Type".
   a) Select sweep types "Fast", "Normal" or "Averaged" for automatic measurement configuration.

   For a custom configuration, proceed to set up each measurement parameter separately.
4. Define the "RBW", number of "Averages", sweep "Mode" and "I/Q Window" function.
   a) Define the parameters globally for all (half) decades covered by the measurement range.
   b) Define the parameters for each individual (half) decade covered by the measurement range in the "Half Decade Configuration Table".

6 Remote commands

The following remote control commands are required to configure and perform phase noise measurements in a remote environment. The R&S FSMR3 must already be set up for remote operation in a network as described in the base unit manual.

Universal functionality

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FSMR3 User Manual.

In particular, this includes:

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

SCPI Recorder - automating tasks with remote command scripts

The phase noise application also supports the SCPI Recorder functionality.

Using the SCPI Recorder functions, you can create a SCPI script directly on the instrument and then export the script for use on the controller. You can also edit or write a script manually, using a suitable editor on the controller. For manual creation, the instrument supports you by showing the corresponding command syntax for the current setting value.

For details see the "Network and Remote Operation" chapter in the R&S FSMR3 User Manual.

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- Introduction 104
- Selecting the operating mode and application 109
- Measurements and result displays 116
- Common measurement settings 127
- Common analysis and display functions 163
- Using the status register 213

6.1 Common suffixes

In the phase noise application, the following common suffixes are used in remote commands:

Table 6-1: Common suffixes used in remote commands in the phase noise application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 16	Window (**in the currently selected channel**)

Suffix	Value range	Description
<t>	1 to 6	Trace
	1 to 8	Limit line

6.2 Introduction

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

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

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

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the user manual of the R&S FSMR3.

Remote command examples

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

6.2.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**

Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSMR3 follow the SCPI syntax rules.

- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  The default unit is used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

6.2.2 Long and short form

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

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

Example:

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

6.2.3 Numeric suffixes

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

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

If you do not quote a suffix for keywords that support one, a 1 is assumed.

Example:

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

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

6.2.4 Optional keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

6.2.5 Alternative keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

6.2.6 SCPI parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters can have different forms of values.

- Numeric values 107
- Boolean 107
- Character data 108
- Character strings 108
- Block data 108

6.2.6.1 Numeric values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

Sometimes, numeric values are returned as text.

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

6.2.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

6.2.6.3 Character data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information, see Chapter 6.2.2, "Long and short form", on page 105.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

6.2.6.4 Character strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

6.2.6.5 Block data

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

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

6.3 Selecting the operating mode and application

6.3.1 Selecting mode and applications

DISPlay:ATAB 109
INSTrument:CREate:DUPLicate 109
INSTrument:CREate[:NEW] 109
INSTrument:CREate:REPLace 110
INSTrument:DELete 110
INSTrument:REName 111
INSTrument:LIST? 111
INSTrument[:SELect] 112
SYSTem:PRESet:CHANnel[:EXEC] 112

DISPlay:ATAB <State>

This command switches between the MultiView tab and the most recently displayed channel. If only one channel is active, this command has no effect.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

INSTrument:CREate:DUPLicate

This command duplicates the currently selected channel, i.e creates a new channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer 2").

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

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

Usage: Event

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

This command adds a measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 111.

<ChannelName> String containing the name of the channel.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds a spectrum display named "Spectrum 2".

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

This command replaces a channel with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 111.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 111).
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example:
```
INST:CRE:REPL 'Measuring Receiver
2',MREC,'Measuring Receiver 3'
```
Replaces the channel named "Measuring Receiver 2" by a new channel of type "Measuring Receiver" named "Measuring Receiver 3".

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a channel.

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

Setting parameters:

<ChannelName> String containing the name of the channel you want to delete.
A channel must exist to delete it.

Example: `INST:DEL 'Measuring Receiver 2'`
Deletes the channel with the name 'Measuring Receiver 2'.

Usage: Setting only

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a channel.

Setting parameters:

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

<ChannelName2> String containing the new channel name.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:REN 'Measuring Receiver 2','Measuring Receiver 3'`
Renames the channel with the name 'Measuring Receiver 2' to 'Measuring Receiver 3'.

Usage: Setting only

INSTrument:LIST?

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

Return values:

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

Example: `INST:LIST?`
Result for 2 channels:
`'MREC','Measuring Receiver','MREC','Measuring Receiver 2'`

Usage: Query only

Table 6-2: Available channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Measuring Receiver	MREC eiver	Measuring Receiver
Spectrum (R&S FSMR3-B1)	SANalyzer	Spectrum
I/Q Analyzer (R&S FSMR3-B1)	IQ	IQ Analyzer
Phase Noise (R&S FSMR3-B60)	PNOise	Phase Noise
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> Parameter	Default Channel Name*)
Pulse (R&S FSMR3-K6)	PULSE	Pulse
Avionics (R&S FSMR3-K15)	AVIonics	Avionics
Vector Signal Analysis (VSA, R&S FSMR3-K70)	DDEM	VSA
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new channel with the defined channel type, or selects an existing channel with the specified name.

Also see

- `INSTrument:CREate[:NEW]` on page 109

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 111.

<ChannelName> String containing the name of the channel.

Example:
```
INST IQ
```
Activates a channel for the I/Q Analyzer application (evaluation mode).
```
INST 'MyIQSpectrum'
```
Selects the channel named 'MyIQSpectrum' (for example before executing further commands for that channel).

SYSTem:PRESet:CHANnel[:EXEC]

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

Use `INST:SEL` to select the channel.

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

Usage: Event

Manual operation: See "Preset Channel" on page 34

6.3.2 Performing a sequence of measurements

INITiate:SEQuencer:ABORt....113
INITiate:SEQuencer:IMMediate....113
INITiate:SEQuencer:MODE....113
SYSTem:SEQuencer....114

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements.

You can start a new sequence any time using `INITiate:SEQuencer:IMMediate` on page 113.

Usage: Event

Manual operation: See "Sequencer State" on page 17

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 114).

Example:
`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement is performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Manual operation: See "Sequencer State" on page 17

INITiate:SEQuencer:MODE <Mode>

Defines the capture mode for the entire measurement sequence and all measurement groups and channels it contains.

Note: To synchronize to the end of a measurement sequence using `*OPC`, `*OPC?` or `*WAI`, use `SINGle` Sequencer mode.

Parameters:

<Mode>

SINGle
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence is finished.

CONTinuous
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence restarts with the first one and continues until it is stopped explicitly.

*RST: CONTinuous

Manual operation: See "Sequencer Mode" on page 17

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error occurs.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single Sequencer mode so each active measurement is performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.
```
SYST:SEQ OFF
```

Manual operation: See "Sequencer State" on page 17

6.3.3 Programming example: performing a sequence of measurements

This example demonstrates how to perform several measurements in a sequence in a remote environment.

Note that it is based on the optional Spectrum application. Doing this for the Phase Noise application, however, works the same way.

```
//2xSpectrumanalyzer + 2xIQ, start Sequencer at the end, test OPC?
// ----------------------------------------------------------------------
```

```
//------Preparing the instrument and first channel -----------
*RST
//Activate new IQ channel
INSTrument:CREate:NEW IQ,'IQ 1'
//Set sweep count for new IQ channel
SENS:SWEEP:COUNT 6
//Change trace modes for IQ channel
DISP:TRAC1:MODE BLANK
DISP:TRAC2:MODE MAXH
DISP:TRAC3:MODE MINH
//Switch to single sweep mode
INIT:CONT OFF
//switch back to first (default) analyzer channel
INST:SEL 'Spectrum';*WAI
//Switch into SEM
SENSe:SWEep:MODE ESPectrum
//Load Sem standard file for W-CDMA
SENSe:ESPectrum:PRESet:STANdard 'WCDMA\3GPP\DL\3GPP_DL.xml'
//Set sweep count in Spectrum channel
SENS:SWEEP:COUNT 5

//----------Creating a second measurement channel ----------------

//Create second IQ channel
INSTrument:CREate:NEW IQ,'IQ 2'
//Set sweep count
SENS:SWEEP:COUNT 2
//Change trace modes
DISP:TRAC1:MODE MAXH
DISP:TRAC2:MODE MINH
//Create new analyzer channel
INSTrument:CREate:NEW SANalyzer,'Spectrum 2'
//Activate ACLR measurement in channel 'Spectrum 2'
CALCulate:MARKer:FUNCtion:POWer:SELect ACPower
//Load W-CDMA Standard
CALCulate:MARKer:FUNCtion:POWer:PRESet FW3Gppcdma
//Change trace modes
DISP:TRAC2:MODE MAXH
DISP:TRAC1:MODE MINH

//--------Performing a sweep and retrieving results----------------

//Change sweep count
SENS:SWEep:COUNt 7
//Single Sweep mode
INIT:CONT OFF
//Switch back to first IQ channel
INST:SEL 'IQ 1';*WAI
```

```
//Perform a measurement
INIT:IMM;*OPC?
//Retrieve results
CALC:MARK:Y?
//Activate Multiview
DISPlay:ATAB     ON

//---------Performing a sequence of measurements with the Sequencer------------
//Activate Sequencer
SYSTem:SEQuencer ON
//Start sweep in Sequencer
INITiate:SEQuencer:IMMediate;*OPC?
//Switch into first IQ channel to get results
INST:SEL 'IQ 1';*WAI
CALCulate:MARKer:MAXimum
CALC:MARK:Y?
//Change sweep time in IQ
SENS:SWE:TIME 300us
//Switch to single Sequencer mode
INITiate:SEQuencer:MODE SINGle
//Sweep all channels once, taking the sweep count in each channel into account
INITiate:SEQuencer:IMMediate;*OPC?
//Set marker to maximum in IQ1 and query result
CALCulate:MARKer:MAXimum
CALC:MARK:Y?
//Switch to second IQ channel and retrieve results
INST:SEL 'IQ 2';*WAI
CALCulate:MARKer:MIN
CALC:MARK:Y?
//Switch to first Spectrum channel
INST:SEL 'Spectrum';*WAI
//Query one of the SEM results
CALCulate:MARKer:FUNCtion:POWer:RESult? CPOWer
//Switch to second Spectrum channel
INST:SEL 'Spectrum 2';*WAI
//Query channel power result
CALCulate:MARKer:FUNCtion:POWer:RESult? ACPower
```

6.4 Measurements and result displays

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6.4.1 Measurement selection

CONFigure:PNOise:MEASurement <Measurement>

This command selects the measurement.

Parameters:

<Measurement>

BASeband
Selects the Baseband Noise measurement.

PNOise
Select the Phase Noise measurement.

*RST: PNOise

Example: //Select the phase noise measurement
`CONF:PNO:MEAS PNO`

Manual operation: See "Phase noise measurement" on page 23
See "Selecting the noise measurement type" on page 34

6.4.2 Performing measurements

ABORt 117
INITiate<n>:CONMeas 118
INITiate<n>:CONTinuous 118
INITiate<n>[:IMMediate] 119

ABORt

This command aborts the measurement in the current channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details on overlapping execution see Remote control via SCPI.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSMR3000 is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSMR3000 on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the ABORt command on the remote channel performing the measurement.

Example: ABOR;:INIT:IMM
Aborts the current measurement and immediately starts a new one.

Example: ABOR;*WAI
INIT:IMM
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using ABORt) or finished in single sweep mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to INITiate<n>[:IMMediate], this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Suffix:
<n> irrelevant

Example: INIT:CONT OFF
Switches to single sweep mode.
DISP:WIND:TRAC:MODE AVER
Switches on trace averaging.
SWE:COUN 20
Setting the sweep counter to 20 sweeps.
INIT;*WAI
Starts the measurement and waits for the end of the 20 sweeps.
INIT:CONM;*WAI
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.

Manual operation: See "Continue Single Sweep" on page 22

INITiate<n>:CONTinuous <State>

This command controls the sweep mode for an individual channel.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous sweep

OFF | 0
Single sweep

*RST: 1

Example: `INIT:CONT OFF`
Switches the sweep mode to single sweep.
`INIT:CONT ON`
Switches the sweep mode to continuous sweep.

Manual operation: See "Continuous Sweep / Run Cont" on page 22

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

With sweep count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Manual operation: See "Single Sweep / Run Single" on page 21

6.4.3 Querying results

FETCh<n>[:RANGe<ri>]:PNOise<t>:DUT:GAIN? 120
FETCh<n>:PNOise<t>:SPURs? 120
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MMEMory:STORe<n>:SPURs 124
[SENSe:]BWIDth:MEASurement? 124

TRACe<n>[:DATA]? 125
TRACe<n>[:DATA]:LINear? 125
TRACe<n>:POINts? 126

FETCh<n>[:RANGe<ri>]:PNOise<t>:DUT:GAIN?

This command queries the DUT gain.

The DUT gain is the ratio of the power measured at the DUT output and the power applied to the DUT input.

Suffix:

<n> irrelevant

<ri> irrelevant

<t> irrelevant

Return values:

<values> <numeric value>

Default unit: dB

Example: //Query DUT gain

```
FETC:RANG:PNO:DUT:GAIN?
```

would return, e.g.

```
2.28
```

Usage: Query only

FETCh<n>:PNOise<t>:SPURs?

This command queries the location and level of all spurs that have been detected.

Suffix:

<n> Window

<t> Trace

Return values:

<SpurCoordinates> Returns two values (frequency and level) for each each spur that has been detected.

Example: //Query spur characteristics

```
FETC:PNO:SPUR?
```

would return, e.g.

```
1999.232666,-0.639974,6494.312500,-0.760579,
19992.324219,-0.639974
```

Usage: Query only

Manual operation: See "Spurious List" on page 25

FETCh<n>:PNOise<t>:SPURs:DISCrete?

This command queries the discrete jitter result.

Suffix:
<n> Window

<t> Trace

Return values:
<Jitter> <numeric value>
Default unit: s

Example: //Query discrete jitter
`FETC:PNO:SPUR:DISC?`
would return, e.g.
`2.3e-08`

Usage: Query only

Manual operation: See "Spurious List" on page 25

FETCh<n>:PNOise<t>:SPURs:JITTer?

This command queries the jitter of the measured spurs.

Suffix:
<n> Window

<t> Trace

Return values:
<Jitter> <numeric value>
Default unit: s

Example: //Query jitter of spurs
`FETC:PNO:SPUR:JITT?`
would return, e.g.
`+2.199886328E+004,+2.440125142E-012,`
`+7.332938281E+004,[...]`

Usage: Query only

Manual operation: See "Spurious List" on page 25

FETCh<n>:PNOise<t>:SPURs:RANDom?

This command queries the random jitter result.

Suffix:
<n> Window

<t> Trace

Return values:
<arg0> <numeric value>
Default unit: s

Example: //Query random jitter
`FETC:PNO:SPUR:RAND?`
would return, e.g.
`3.59e-09`

Usage: Query only

Manual operation: See "Spurious List" on page 25

FETCh<n>[:RANGe<ri>]:PNOise<t>:IPN?

This command queries the integrated phase noise.

Suffix:
<n> Window

<ri> Integration range

<t> Trace

Return values:
<Level> <numeric value>
Default unit: dBc

Example: //Query integrated phase noise
`FETC:RANG2:PNO2:IPN?`
would return, e.g.
`-16.79`

Usage: Query only

Manual operation: See "Integrated Measurements" on page 24

FETCh<n>[:RANGe<ri>]:PNOise<t>:RAM?

This command queries the residual AM.

Suffix:
<n> Window

<ri> Integration range

<t> Trace

Return values:
<Am> <numeric value>
Default unit: PCT

Example: //Query residual AM
`FETC:RANG2:PNO:RAM?`
would return, e.g.
`0.01196555513888597`

Usage: Query only

Manual operation: See "Integrated Measurements" on page 24

FETCh<n>[:RANGe<ri>]:PNOise<t>:RFM?

This command queries the residual FM.

Suffix:

<n> Window

<ri> Integration range

<t> Trace

Return values:

<Frequency> <numeric value>

Default unit: Hz

Example: //Query residual FM
`FETC:RANG2:PNO:RFM?`
would return, e.g.
`88110000`

Usage: Query only

Manual operation: See "Integrated Measurements" on page 24

FETCh<n>[:RANGe<ri>]:PNOise<t>:RMS?

This command queries the residual RMS jitter.

Suffix:

<n> Window

<ri> Integration range

<t> Trace

Return values:

<Jitter> <numeric value>

Default unit: s

Example: //Query RMS jitter
`FETC:RANG2:PNO2:RMS?`
would return, e.g.
`0.02175`

Usage: Query only

Manual operation: See "Integrated Measurements" on page 24

FETCh<n>[:RANGe<ri>]:PNOise<t>:RPM?

This command queries the residual PM.

Suffix:

<n> Window

<ri> Integration range

<t> Trace

Return values:

<Phase> <numeric value>

Default unit: deg

Example: //Query residual PM
`FETC:RANG2:PNO:RPM?`
would return, e.g.
`11.73`

Usage: Query only

Manual operation: See "Integrated Measurements" on page 24

MMEMory:STORe<n>:SPURs <FileName>[, <Trace>]

This command exports the spur information to a file.

Suffix:

<n> 1..n
Window

Setting parameters:

<FileName> String containing the path and name of the target file.

<Trace> <numeric value> (integer only)

Trace from which the spur information is collected.
If you do not define a trace, all spurs over all traces are exported.

Example: //Store spur information of trace 1
`MMEM:STOR:SPUR 'c:\spurs.asc',1`

Usage: Setting only

[SENSe:]BWIDth:MEASurement?

This command queries the measurement bandwidth of the frequency stability measurements (Allan variance and deviation).

Return values:

<Bandwidth> <numeric value>

Default unit: Hz

Example: //Query measurement bandwidth
`BWID:MEAS?`

Usage: Query only

Manual operation: See "Allan Variance / Allan Deviation" on page 26

TRACe<n>[:DATA]? <Trace>

This command queries the trace data (measurement results).

Suffix:
<n> 1..n
Window

Query parameters:
<Trace> **TRACE1 | ... | TRACE6**
Queries the data of one of the colored line traces.

XGINdicator
Queries the data of the cross-correlation gain indicator (grey area).

Return values:
<Result> • Phase noise measurements
Coordinates of the trace as list of comma-separated values, beginning at the nearest offset frequency.

Example: //Query trace data
```
TRAC? TRACE1
```
would return the data of trace 1, e.g.:
```
1000.000000,-82.326393,1011.579712,-82.411499,
1023.292969,-82.538643,[...]
```

Usage: Query only

Manual operation: See "Noise Diagram" on page 23
See "Allan Variance / Allan Deviation" on page 26

TRACe<n>[:DATA]:LINear? <Trace>, <Points>[, <Start>, <Stop>]

This command queries the trace data with linear interpolation.

Suffix:
<n> 1..n
Window

Query parameters:
<Trace> **TRACE1 | ... | TRACE6**
Queries the data of one of the colored line traces.

XGINdicator
Queries the data of the cross-correlation gain indicator (grey area).

<Points> <numeric value> (integer only)
Defines the number of linearily spaced measurement points that are returned within the specified frequency range (defined by the start and stop values).

<Start> <numeric value>

Defines the start offset of the frequency range whose trace data you like to query.
The start offset must be within the measurement range you have defined. If you do not define a start and stop offset, the command returns the trace data for the complete measurement range that was defined.
Minimum start offset is 0 Hz.

Default unit: Hz

<Stop> <numeric value>

Defines the stop offset of the frequency range whose trace data you like to query.
The stop offset must be within the measurement range you have defined. If you do not define a start and stop offset, the command returns the trace data for the complete measurement range that was defined.
Maximum stop offset depends on the measurement range.

Default unit: Hz

Return values:

<Result> String that contains the trace data as comma-separated values. Each data point consists of two values: offset frequency in Hz and level in dBc/Hz.
The number of value pairs depends on the number of points you have defined.

Example: //Query linear trace data

```
TRAC:LIN? TRACE1,5,100,100000
```

would return, e.g.

```
100.000000,0.000000,25075.000000,-139.424408,
50050.000000,-140.380112,75025.000000,
-139.754211,100000.000000,-141.686478
```

Usage: Query only

TRACe<n>:POINts? <Trace>

This command queries the number of measurement points of a specific trace.

Suffix:

<n> 1..n
Window

Query parameters:

<Trace> TRACe1 | TRACe2 | TRACe3 | TRACe4 | TRACe5 | TRACe6 | XGINdicator

"XGINdicator" only available for phase noise measurements.

Return values:

<Points> <numeric value> (integer)

Example: //Query number of measurement points of a trace in window 2
`TRAC2:POIN? TRACE1`

Usage: Query only

6.4.4 Programming examples

Performing a phase noise measurement

```
//Preset
*RST
//Select single sweep mode
INIT:CONT OFF
// Configure start and stop offset
SENS:FREQ:START 1kHz
SENS:FREQ:STOP  1MHZ
// Configure RBW in %
LIST:BWID:RAT 10
// Configure cross correllation factor
SWE:XFAC 1
// Start synchronized measurement
INIT:IMM;*OPC?
// Turn on marker 1 in window 1
CALC1:MARK1:STAT ON
// Set marker 1 stimulus
CALC1:MARK1:X 300 kHz
// Query marker 1 result
CALC1:MARK1:Y?
```

6.5 Common measurement settings

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6.5.1 Remote commands to configure the input source

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6.5.1.1 RF input

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INPut<ip>:SELect....128
INPut<ip>:LOSCillator:SOURce....128
INPut<ip>:LOSCillator:SOURce:EXTernal:LEVel....129

INPut<ip>:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Manual operation: See "Input Coupling" on page 35

INPut<ip>:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSMR3.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<Source> **RF**
Radio Frequency ("RF INPUT" connector)

*RST: RF

Manual operation: See "Radio Frequency State" on page 35

INPut<ip>:LOSCillator:SOURce <Location>

This command selects the type of local oscillator in the test setup.

Prerequisites for this command

- Select additive noise measurement (`CONFigure:PNOise:MEASurement`).

Suffix:
<ip> 1..n
irrelevant

Parameters:
<Location> **EXTernal**
External local oscillator connected to the "LO AUX Input" of the R&S FSMR3.

INTernal
Internal local oscillator of the R&S FSMR3.

*RST: INTernal

Example: //Select external oscillator
```
CONF:PNO:MEAS RES
INP:LOSC:SOUR EXT
```

INPut<ip>:LOSCillator:SOURce:EXTernal:LEVel <Level>

This command selects the level of an external LO signal that is fed into the R&S FSMR3.

Prerequisites for this command

- Select additive noise measurement (`CONFigure:PNOise:MEASurement`).
- Select an external local oscillator (`INPut<ip>:LOSCillator:SOURce`).

Suffix:
<ip> 1..n
irrelevant

Parameters:
<Level> **HIGH**
LO signal with high level characteristics.

LOW
LO signal with low level characteristics.

*RST: HIGH

Example: //Select an external LO with low signal level
```
CONF:PNO:MEAS RES
INP:LOSC:SOUR EXT
INP:LOSC:SOUR:EXT:LEV LOW
```

6.5.1.2 Baseband input

INPut<ip>:CONNector 129

INPut<ip>:CONNector <Mode>

This command selects the measurement channel for baseband noise measurements.

Suffix:
<ip> 1..n
irrelevant

Parameters:
<Mode> **CH1**
Measurement on baseband channel 1.

CH2
Measurement on baseband channel 2.

XCOR
Measurement on both baseband channels (cross-correlation measurements).

Example: //Perform measurement on baseband channel 1
`INP:CONN CH1`

6.5.2 Output

- Signal source 130
- Miscellaneous output 132

6.5.2.1 Signal source

SOURce:GENerator:DUTBypass 130
SOURce:GENerator:CHANnel:COUPling 131
SOURce:GENerator:FREQuency 131
SOURce:GENerator:FREQuency:STEP 131
SOURce:GENerator:LEVel 131
SOURce:GENerator[:STATe] 132

SOURce:GENerator:DUTBypass <State>

This command turns the DUT bypass on and off.

When you turn on the bypass, the application measures the noise characteristics of the R&S FSMR3.

The DUT bypass is available with the optional Signal Source hardware component.

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on DUT bypass
`SOUR:GEN:DUTB ON`

SOURce:GENerator:CHANnel:COUPling <State>

This command couples or decouples the signal source configuration across measurement channels.

Parameters:

<State>

ON | 1
Signal source configuration is the same across all measurement channels.

OFF | 0
Signal source configuration is different for each measurement channel.

*RST: ON

Example:

//Use the same signal source configuration across all channels
```
SOUR:GEN:CHAN:COUP ON
```

SOURce:GENerator:FREQuency <Frequency>

This command defines the frequency of the signal that is generated by the signal source.

Parameters:

<Frequency>

<numeric value>

Default unit: Hz

Example:

See SOURce:GENerator[:STATe] on page 132.

SOURce:GENerator:FREQuency:STEP <Stepsize>

This command defines the frequency stepsize of the signal generated by the optional signal source.

Parameters:

<Stepsize>

1 mHz | 1 Hz | 1 kHz | 1 MHz | 1 GHz

*RST: 1 MHz
Default unit: Hz

Example:

//Define signal source stepsize
```
SOUR:GEN:FREQ:STEP 1KHZ
```

SOURce:GENerator:LEVel <Level>

This command defines the level of the signal that is generated by the signal source.

Parameters:

<Level>

<numeric value>

Default unit: dBm

Example:

See SOURce:GENerator[:STATe] on page 132.

SOURce:GENerator[:STATe] <State>

This command turns the optional signal source output on and off.

When you turn on the signal source, the R&S FSMR3 generates a signal with the frequency and level defined with `SOURce:GENerator:FREQuency` and `SOURce:GENerator:LEVel`.

Parameters:

<State> ON | OFF | 1 | 0
*RST: OFF

Example:
```
//Turn on the signal source output
SOUR:GEN:FREQ 100MHZ
//Generate a signal at 100 MHz and a level of -10 dBm.
SOUR:GEN:LEV -10
SOUR:GEN ON
```

6.5.2.2 Miscellaneous output

DIAGnostic:SERVice:NSOurce....132

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled [noise source control] on the R&S FSMR3000 on and off.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
DIAG:SERV:NSO ON
```

Manual operation: See "Noise Source Control" on page 57

6.5.3 Remote commands to configure user ports

INPut<ip>:UPORt:STATe....132
INPut<ip>:UPORt[:VALue]....133
OUTPut<up>:UPORt:STATe....133
OUTPut<up>:UPORt[:VALue]....133

INPut<ip>:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSMR3.

See the R&S FSMR3 Getting Started manual for details.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<State> **ON | 1**
User port is switched to INPut
OFF | 0
User port is switched to OUTPut
*RST: 1

INPut<ip>:UPORt[:VALue]

This command queries the control lines of the user ports.

For details see OUTPut<up>:UPORt[:VALue] on page 133.

Suffix:
<ip> 1 | 2
irrelevant

Return values:
<Level> bit values in hexadecimal format
TTL type voltage levels (max. 5V)
Range: #B00000000 to #B00111111

Example:
```
INP:UPOR?
//Result: #B00100100
```
Pins 5 and 7 are active.

OUTPut<up>:UPORt:STATe <State>

This command toggles the control lines of the user ports for the **AUX PORT** connector. This 9-pole SUB-D male connector is located on the rear panel of the R&S FSMR3.

Suffix:
<up> irrelevant

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
User port is switched to INPut
ON | 1
User port is switched to OUTPut

Example:
```
OUTP:UPOR:STAT ON
```

OUTPut<up>:UPORt[:VALue] <Value>

This command sets the control lines of the user ports.

The assignment of the pin numbers to the bits is as follows:

Bit	7	6	5	4	3	2	1	0
Pin	N/A	N/A	5	3	4	7	6	2

Bits 7 and 6 are not assigned to pins and must always be 0.

The user port is written to with the given binary pattern.

If the user port is programmed to input instead of output (see `INPut<ip>:UPORt:STATe` on page 132), the output value is temporarily stored.

Suffix:
<up> irrelevant

Parameters:
<Value> bit values in hexadecimal format
TTL type voltage levels (max. 5V)
Range: #B00000000 to #B00111111

Example: `OUTP:UPOR #B00100100`
Sets pins 5 and 7 to 5 V.

6.5.4 Remote commands to configure level characteristics

Functions to configure level characteristics described elsewhere:

- `INPut<ip>:COUPling`
- `[SENSe:]POWer:RLEVel:MODE`

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe] 134
DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:AUTO 135
DISPlay[:WINDow<n>]:TRACe<t>:X:SPACing? 135
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] 136
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO 136
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel 137
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:LOWer 137
INPut<ip>:ATTenuation 138
INPut<ip>:ATTenuation:AUTO 138
[SENSe:]ADJust:CONFigure:LEVel:THReshold 138
[SENSe:]POWer:RLEVel? 139
[SENSe:]POWer:RLEVel:OFFSet 139

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe] <Range>

This command defines the display range of the x-axis.

Prerequisites for this command

- Turn off automatic scaling of the x-axis (`DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:AUTO`).

Suffix:
<n> 1..n
Window

<t> 1..n
irrelevant

Parameters:
<Range> Default unit: Depending on the selected diagram

Example: //Define a value range of 100 MHz.
```
DISP:TRAC:X:AUTO OFF
DISP:TRAC:X 100 MHz
```

DISPlay[:WINDow<n>]:TRACe<t>:X[:SCALe]:AUTO <Mode>

This command turns automatic configuration of the horizontal axis on and off.

Suffix:
<n> 1..n
Window

<t> 1..n
irrelevant

Parameters:
<Mode> **ON | 1**
Scales the x-axis after each measurement.

OFF | 0
Allows you to define the scale manually.

ONCE
Scales the x-axis once. The scale remains the same for subsequent measurements.

*RST: ON

Example: //Select manual scaling of the x-axis.
```
DISP:TRAC:X:AUTO OFF
```

DISPlay[:WINDow<n>]:TRACe<t>:X:SPACing?

This command queries the scale of the x-axis in any measurement window.

Suffix:
<n> 1..n
Window

<t> 1..n
irrelevant

Return values:
<Spacing> **LINear**
X-axis has a linear scale.

LOGarithmic
X-axis has a logarithmic scale.

Example: //Query scale of the x-axis in the second measurement window
`DISP:WIND2:TRAC:X:SPAC?`

Usage: Query only

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the value range displayed on the y-axis.

Prerequisites for this command

- Turn off automatic scaling of the y-axis (`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO`).

Suffix:
<n> 1..n
Window

<t> 1..n
irrelevant

Parameters:
<Range> <numeric value>
Default unit: Depending on the selected diagram

Example: //Define a value range of 100 dB.
`DISP:TRAC:Y:AUTO OFF`
`DISP:TRAC:Y 100`

Manual operation: See "Scaling the y-axis" on page 39

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO <Mode>

This command turns automatic scaling of the y-axis in graphical result displays on and off.

Suffix:
<n> 1..n
Window

<t> 1..n
irrelevant

Parameters:
<Mode> **ON | 1**
Scales the y-axis after each measurement.

OFF | 0
Allows you to define the scale manually.

ONCE
Scales the y-axis once. The scale remains the same for subsequent measurements.

*RST: ON

Example: //Select manual scaling of the y-axis.
`DISP:TRAC:Y:AUTO OFF`

Manual operation: See "Scaling the y-axis" on page 39

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <Level>

This command defines the maximum level displayed on the y-axis.

Prerequisites for this command

- Turn off automatic scaling of the y-axis (`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO`).

Suffix:

<n> 1..n
Window

<t> 1..n
irrelevant

Parameters:

<Level> <numeric value>
Default unit: Depending on the selected diagram

Example: //Define maximum level on the y-axis
`DISP:TRAC:Y:RLEV -20`

Manual operation: See "Scaling the y-axis" on page 39

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:LOWer <Level>

This command defines the minimum level displayed on the y-axis.

Prerequisites for this command

- Turn off automatic scaling of the y-axis (`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO`).

Suffix:

<n> 1..n
Window

<t> 1..n
irrelevant

Parameters:

<Level> <numeric value>
Default unit: Depending on the selected diagram

Example: //Query minimum level on the y-axis
`DISP:TRAC:Y:RLEV:LOW?`
would return, e.g.
`-135`

Manual operation: See "Scaling the y-axis" on page 39

INPut<ip>:ATTenuation <Attenuation>

This command defines the RF attenuation for the RF input.

Prerequisites for this command

- Turn off automatic attenuation configuration (`INPut<ip>:ATTenuation:AUTO`).

Suffix:
<ip> 1..n
irrelevant

Parameters:
<Attenuation> <numeric value> (integer only)
Range: See data sheet
Increment: 5
Default unit: dB

Example: //Defines an attenuation of 10 dB
```
INP:ATT:AUTO OFF
INP:ATT 10
```

Manual operation: See "Attenuating the signal" on page 37

INPut<ip>:ATTenuation:AUTO <State>

This command turns automatic configuration of the attenuation on and off.

Suffix:
<ip> 1..n
irrelevant

Parameters:
<State> **ON | 1**
Automatically defines the ideal attenuation based on the current signal level.
OFF | 0
Allows you to define the attenuation manually with `INPut<ip>:ATTenuation`
*RST: ON

Example: //Turn on automatic configuration of the attenuation
```
INP:ATT:AUTO ON
```

Manual operation: See "Attenuating the signal" on page 37

[SENSe:]ADJust:CONFigure:LEVel:THReshold <Level>

This command defines the threshold of the signal search.

Prerequisites for this command

- Turn on the automatic signal search with `[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe]`

Parameters:

<Level> <numeric value>
Default unit: dBm

Example: //Define a threshold of -10 dBm
`ADJ:CONF:LEV:THR -10`

Manual operation: See "Searching for the signal level" on page 38

[SENSe:]POWer:RLEVel?

This command queries the currently measured signal level.

Return values:

<Level> <numeric value>
Default unit: dBm

Example: //Query signal level
`POW:RLEV?`
would return, e.g.
`-9.28192`

Usage: Query only

Manual operation: See "Searching for the signal level" on page 38

[SENSe:]POWer:RLEVel:OFFSet <Offset>

This command defines an arithmetic level offset. The offset is applied to the signal level.

The level offset takes external attenuation or gain into account.

Parameters:

<Offset> <numeric value>
Range: -100 to 200
*RST: 0
Default unit: dB

Example: //Define a level offset of 20 dB
`POW:RLEV:OFFS 20`

Manual operation: See "Shifting the level" on page 38

6.5.5 Remote commands to configure the frequency

[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe] 140
[SENSe:]ADJust:CONFigure:FREQuency:COUNt 140
[SENSe:]ADJust:CONFigure:FREQuency:LIMit:HIGH 141
[SENSe:]ADJust:CONFigure:FREQuency:LIMit:LOW 141
[SENSe:]FILTer:LPASs:FREQuency:MANual 141
[SENSe:]FILTer:LPASs[:STATe] 142
[SENSe:]FREQuency:CENTer 142
[SENSe:]FREQuency:STARt 143
[SENSe:]FREQuency:STOP 143
[SENSe:]POWer:RLEVel:MODE 143
[SENSe:]SWEep:CAPTure:RANGe 144

[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe] <State>

This command turns the automatic (carrier) frequency search on and off.

When you turn of the automatic frequency search, you can define the signal frequency with `[SENSe:]FREQuency:CENTer`.

Parameters:

<State> ON | OFF | 1 | 0

Example: //Define a signal frequency of 100 MHz

```
ADJ:CONF:FREQ:AUT OFF
FREQ:CENT 100MHZ
```

Manual operation: See "Searching for a signal" on page 41

[SENSe:]ADJust:CONFigure:FREQuency:COUNt <State>

This command turns verification of the signal frequency on and off.

Prerequisites for this command

- Turn off automatic signal search (`[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe]`).

Parameters:

<State>

OFF | 0
Turns off the frequency counter and measures the frequency you have entered without verifiying it.

ON | 1
Turns on the frequency counter and verfifies the frequency you have entered.

*RST: OFF (automatic signal search is on)

Example: //Turn off the frequency counter

```
ADJ:CONF:FREQ:AUT OFF
ADJ:CONF:FREQ:COUN OFF
FREQ:CENT 93.423MHZ
```

Manual operation: See "Searching for a signal" on page 41

[SENSe:]ADJust:CONFigure:FREQuency:LIMit:HIGH <Frequency>

This command defines the upper limit of the frequency search range.

Prerequisites for this command

- Turn on the automatic signal search with `[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe]`

Parameters:

<Frequency> <numeric value>

Range: See data sheet
*RST: 8 GHz
Default unit: Hz

Example: //Define a frequency search range from 10 MHz to 500 MHz

```
ADJ:CONF:FREQ:LIM:LOW 10MHZ
ADJ:CONF:FREQ:LIM:HIGH 500MHZ
```

Manual operation: See "Searching for a signal" on page 41

[SENSe:]ADJust:CONFigure:FREQuency:LIMit:LOW <Frequency>

This command defines the lower limit of the frequency search range.

Prerequisites for this command

- Turn on the automatic signal search with `[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe]`

Parameters:

<Frequency> <numeric value>

Range: See data sheet
*RST: 1 MHz
Default unit: Hz

Example: //Define a frequency search range from 10 MHz to 500 MHz

```
ADJ:CONF:FREQ:LIM:LOW 10MHZ
ADJ:CONF:FREQ:LIM:UPP 500MHZ
```

Manual operation: See "Searching for a signal" on page 41

[SENSe:]FILTer:LPASs:FREQuency:MANual <Frequency>

This command defines the cutoff frequency of the low pass filter you can use to measure small carrier frequencies.

Prerequisites for this command

- Turn on low pass filter (`[SENSe:]FILTer:LPASs[:STATe]`).

Parameters:

<Frequency> <numeric value>

*RST: 1 MHz
Default unit: Hz

Example: //Configure low pass filter
```
FILT:LPAS ON
FILT:LPAS:FREQ:MAN 500KHZ
```

Manual operation: See "Low signal frequencies" on page 43
See "Low signal levels" on page 43

[SENSe:]FILTer:LPASs[:STATe] <State>

This command turns a low pass filter for measurements on small carrier frequencies on and off.

Effects of using thelow pass filter:

- Auto search feature is turned off (`[SENSe:]ADJust:CONFigure:FREQuency:AUTosearch[:STATe]`).
- Signal count is turned off (`[SENSe:]ADJust:CONFigure:FREQuency:COUNt`).
- The stop offset is limited to 20 % of the filter cut-off frequency (`[SENSe:]FREQuency:STOP`).
- DC coupling should be used for measurements on carrier frequencies below 1 MHz (`INPut<ip>:COUPling`).

Parameters:

<State> ON | OFF | 1 | 0

When you turn on the filter, you can define a cutoff frequency with `[SENSe:]FILTer:LPASs:FREQuency:MANual`.

*RST: OFF

Example: //Turn on low pass filter
```
FILT:LPAS ON
```

Manual operation: See "Low signal frequencies" on page 43
See "Low signal levels" on page 43

[SENSe:]FREQuency:CENTer <Frequency>

This command defines or queries (in case of automatic frequency search) the current signal frequency.

Parameters:

<Frequency> <numeric value>

Default unit: Hz

Example: //Query signal frequency
```
FREQ:CENT?
```

Example: //Define center frequency
```
FREQ:CENT 1GHZ
```

Manual operation: See "Defining the signal frequency" on page 41
See "Searching for a signal" on page 41

[SENSe:]FREQuency:STARt <Frequency>

This command defines the start frequency offset of the measurement range.

Parameters:

<Frequency> Offset frequencies in half decade steps.

Range: See data sheet
*RST: 1 kHz
Default unit: Hz

Example: //Define a start offset of 10 kHz
```
FREQ:STAR 10KHZ
```

Example: //Define a span of 500 MHz from 500 MHz to 1 GHz
```
FREQ:STAR 500MHZ
FREQ:STOP 1GHZ
```

Manual operation: See "Defining the measurement range" on page 42

[SENSe:]FREQuency:STOP <Frequency>

This command defines the stop frequency offset of the measurement range.

Parameters:

<Frequency> Offset frequencies in half decade steps.

Range: See data sheet
*RST: 1 MHz
Default unit: Hz

Example: //Define a stop offset of 10 MHz
```
FREQ:STOP 10MHZ
```

Example: //Define a span of 500 MHz from 500 MHz to 1 GHz
```
FREQ:STAR 500MHZ
FREQ:STOP 1GHZ
```

Manual operation: See "Defining the measurement range" on page 42

[SENSe:]POWer:RLEVel:MODE <Level>

This command selects the level measurement mode.

Parameters:

<Level>

AUTO
The R&S FSMR3 automatically selects the level setting that is best suited for the current measurement.

HIGH
Use this mode to measure normal signal levels.

LOW
Use this mode to measure low signal levels.
When you select this mode, apply a low pass filter and define its characteristics with:
- `[SENSe:]FILTer:LPASs[:STATe]`
- `[SENSe:]FILTer:LPASs:FREQuency:MANual`

*RST: HIGH

Example: //Measure low level signal
```
POW:RLEV:MODE LOW
```

Manual operation: See "Low signal levels" on page 43

[SENSe:]SWEep:CAPTure:RANGe <CaptureRange>

This command selects the signal capture range.

Parameters:
<CaptureRange>

NORMal
Normal capture range for stable DUTs or DUTs whose frequency drifts slowly over a short distance.

WIDE
Wide capture range for DUTs whose frequency drifts quickly and over big distances.

*RST: NORMal

Example: //Select a wide signal capture range
```
SWE:CAPT:RANG WIDE
```

Manual operation: See "Capture Range" on page 42

6.5.6 Phase noise measurement configuration

- Noise configuration 144
- Residual calculation configuration 151
- Spot noise configuration 155
- Spur display 159

6.5.6.1 Noise configuration

Remote commands to configure the measurement range described elsewhere:

- `[SENSe:]FREQuency:STARt` on page 143
- `[SENSe:]FREQuency:STOP` on page 143

DISPlay:XGINdicator[:STATe] 145
[SENSe:]LIST:BWIDth[:RESolution]:RATio 145
[SENSe:]LIST:RANGe<ri>:BWIDth[:RESolution] 145
[SENSe:]LIST:RANGe<ri>:FREQuency:STARt? 146
[SENSe:]LIST:RANGe<ri>:FREQuency:STOP? 146

[SENSe:]LIST:RANGe<ri>:XCOunt 147
[SENSe:]SWEep:COUNt 147
[SENSe:]SWEep:FORWard 148
[SENSe:]SWEep:FSEGment 148
[SENSe:]SWEep:MODE 149
[SENSe:]SWEep:TIME 149
[SENSe:]SWEep:XFACtor 150
[SENSe:]SWEep:XOPTimize[:STATe] 150
[SENSe:]SWEep:XOPTimize:THReshold 150
[SENSe:]TIME:STARt 151
[SENSe:]TIME:STOP 151

DISPlay:XGINdicator[:STATe] <State>

This command turns the cross-correlation gain indicator (gray area in the Noise Spectrum result display) on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: ON

Example: //Remove the gray area from the diagram area.

```
DISP:XGIN OFF
```

Manual operation: See "Turning the display of the cross-correlation gain indicator on and off" on page 47

[SENSe:]LIST:BWIDth[:RESolution]:RATio <Percentage>

This command defines the factor that the resolution bandwidth applied to each half decade is based on.

More information

Parameters:

<Percentage> <numeric value>

Range: 0.1 to 30
*RST: 10
Default unit: PCT

Example: //Define an RBW factor of 3 %

```
LIST:BWID:RAT 3
```

Manual operation: See "Defining the resolution bandwidth" on page 46

[SENSe:]LIST:RANGe<ri>:BWIDth[:RESolution] <BandWidth>

This command defines the resolution bandwidth applied in a half decade.

The application of the command depends on the half decade configuration mode ([SENSe:]SWEep:MODE):

- Automatic mode: The RBW can only be queried, because it is calculated based on an RBW factor.
- Manual mode: The RBW can be defined directly as an absolute value.

Suffix:
<ri> 1..n
Half decade

Parameters:
<BandWidth> <numeric value>
*RST: Automatic configuration mode is on.
Default unit: Hz

Example: //Define an RBW of 1 kHz for the fifth half decade
```
SWE:MODE MAN
LIST:RANG5:BWID 1KHZ
```

Manual operation: See "Defining the resolution bandwidth" on page 46
See "Working with the half decade configuration table" on page 48

[SENSe:]LIST:RANGe<ri>:FREQuency:STARt?

This command queries the start frequency offset of a half decade.

Suffix:
<ri> 1..n
Half decade

Return values:
<Frequency> <numeric value>
Default unit: Hz

Example: //Query start frequency for fifth half decade
```
LIST:RANG5:FREQ:STAR?
```
would return, e.g.
```
100000
```

Usage: Query only

Manual operation: See "Working with the half decade configuration table" on page 48

[SENSe:]LIST:RANGe<ri>:FREQuency:STOP?

This command queries the stop frequency offset of a half decade.

Suffix:
<ri> 1..n
Half decade

Return values:

<Frequency> <numeric value>
Default unit: Hz

Example: //Query stop frequency offset for fifth half decade
`LIST:RANG5:FREQ:STOP?`
would return, e.g.
`300000`

Usage: Query only

Manual operation: See "Working with the half decade configuration table" on page 48

[SENSe:]LIST:RANGe<ri>:XCOunt <Count>

This command defines the number of cross-correlation operations done in a half decade.

The application of the command depends on the half decade configuration mode (`[SENSe:]SWEep:MODE`):

- Automatic mode: The number of cross-correlations can only be queried, because it is calculated based on an RBW factor.
- Manual mode: The number of cross-correlations can be defined directly as an absolute value.

Suffix:

<ri> 1..n
Half decade

Parameters:

<Count> <numeric value> (integer only)
*RST: Automatic configuration mode is on.
Default unit: ---

Example: //Define 50 cross-correlation operations for the fifth half decade
`SWE:MODE MAN`
`LIST:RANG5:XCO 50`

Manual operation: See "Defining cross-correlation parameters" on page 46
See "Working with the half decade configuration table" on page 48

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of sweeps that the application uses to average traces.

In continuous sweep mode, the application calculates the moving average over the average count.

In single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<SweepCount> When you set a sweep count of 0 or 1, the R&S FSMR3 performs one single sweep in single sweep mode.
In continuous sweep mode, if the sweep count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 200000
*RST: 0

Example: `SWE:COUN 64`
Sets the number of sweeps to 64.
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.

Manual operation: See "Sweep/Average Count" on page 48

[SENSe:]SWEep:FORWard <SweepForward>

This command selects the sweep direction.

Parameters:

<SweepForward> **ON**
Measurement in forward direction.

OFF
Measurement in reverse direction.

*RST: OFF

Example: //Sweep in forward direction
`SWE:FORW ON`

Manual operation: See "Selecting the sweep direction" on page 48

[SENSe:]SWEep:FSEGment

This command stops a measurement in any given half decade and resumes the measurement of the next half decade.

Usage: Event

Manual operation: See "Defining cross-correlation parameters" on page 46

[SENSe:]SWEep:MODE <Mode>

This command selects the configuration mode of the half decade table.

Parameters:

<Mode>

MANual
Manual mode: allows you to select a custom resolution bandwidth and number of cross-correlations for each half decade.
• Define the RBW for a half decade with `[SENSe:]LIST:RANGe<ri>:BWIDth[:RESolution]`.
• Define the number of cross-correlations for a half decade with `[SENSe:]LIST:RANGe<ri>:XCOunt`.

NORMal
Automatic mode: the application selects the resolution bandwidth and number of cross-correlations based on the RBW and XCORR factors.
• Define the RBW factor with `[SENSe:]LIST:BWIDth[:RESolution]:RATio`.
• Define the XCORR factor with `[SENSe:]SWEep:XFACtor`.

FAST
Sets mode to NORMal and XCORR Count to 1. Only available remote.

AVERaged
Sets mode to NORMal and XCORR Count to 10. Only available remote.

*RST: NORMal

Example:

//Automatically select RBW and XCORR based on an RBW factor of 5 % and an XCORR factor of 1.5.
```
SWE:MODE NORM
LIST:BWID:RAT 5
LIST:RANG5:XCO 1.5
```

Manual operation:

See "Defining the resolution bandwidth" on page 46
See "Defining cross-correlation parameters" on page 46
See "Working with the half decade configuration table" on page 48

[SENSe:]SWEep:TIME <Time>

This command queries the estimated measurement time.

Parameters:

<Time>

<numeric value>

Default unit: s

Example:

//Query measurement time
```
SWE:TIME?
```
would return, e.g.
```
0.050432
```

Example: //Define measurement time
`SWE:TIME 2S`

Manual operation: See "Estimating the measurement time" on page 45

[SENSe:]SWEep:XFACtor <Factor>

This command defines the cross-correlation factor (XCORR factor) that defines the cross-correlation operations in each half decade.

Parameters:
<Factor> <numeric value>
Range: 1

Example: //Define an XCORR factor of 10
`SWE:XFAC 10`

Manual operation: See "Defining cross-correlation parameters" on page 46

[SENSe:]SWEep:XOPTimize[:STATe] <State>

This command turns optimization of the cross-correlation operations on and off.

Parameters:
<State> ON | OFF | 1 | 0
*RST: ON

Example: `SWE:XOPT OFF`
Turns off optimization (always performs the full number of operations).

Manual operation: See "Defining cross-correlation parameters" on page 46

[SENSe:]SWEep:XOPTimize:THReshold <Threshold>

This command defines the threshold for the cross-correlation optimization feature.

When the threshold (distance between measured values and gain indicator) is reached in any given half decade, the measurement in that half decade stops and resumes to measure the next one.

Prerequisites for this command

- Turn on XCORR optimization (`[SENSe:]SWEep:XOPTimize[:STATe]` on page 150).

Parameters:
<Threshold> <numeric value>
Default unit: dB

Example: //Define a threshold of 15 dB
`SWE:XOPT:THR 15`

Manual operation: See "Defining cross-correlation parameters" on page 46

[SENSe:]TIME:STARt <Tau>

This command defines the start time for the frequency stability measurements.

Effects of this command

- The start time is coupled to the stop frequency offset of the measurement range of the phase noise measurement (`[SENSe:]FREQuency:STOP`).
  If you change the start time, the R&S FSMR3 adjusts the stop frequency offset accordingly. For example, 1 MHz stop offset corresponds to 1 µs.

Parameters:

<Tau> <numeric value>

*RST: 1 ms
Default unit: s

Example: //Define start time for frequency stability measurement
`TIME:STAR 1US`

Manual operation: See "Defining the measurement range" on page 42

[SENSe:]TIME:STOP <Tau>

This command defines the stop time for the frequency stability measurements.

Effects of this command

- The stop time is coupled to the start frequency offset of the measurement range of the phase noise measurement (`[SENSe:]FREQuency:STARt`).
  If you change the stop time, the R&S FSMR3 adjusts the start frequency offset accordingly. For example, 1 mHz start offset corresponds to 1000 s.

Parameters:

<Tau> <numeric value>

*RST: 1 ms
Default unit: s

Example: //Define stop time for frequency stability measurement
`TIME:STAR 1000S`

Manual operation: See "Defining the measurement range" on page 42

6.5.6.2 Residual calculation configuration

CALCulate<n>[:RANGe<ri>]:EVALuation:STARt....152
CALCulate<n>[:RANGe<ri>]:EVALuation:STOP....152
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[SENSe:]CORRection:WEIGhting:DATA....154
[SENSe:]CORRection:WEIGhting:DELete....154
[SENSe:]CORRection:WEIGhting:NAME....155
[SENSe:]CORRection:WEIGhting:SELect....155

CALCulate<n>[:RANGe<ri>]:EVALuation:STARt <Frequency>

This command defines the start frequency of a custom integration range for residual effects calculation.

Prerequisites for this command

- Turn off integration over the complete measurement range (`CALCulate<n>[:RANGe<ri>]:EVALuation[:STATe]`).

Suffix:
<n> Window

<ri> Integration range

Parameters:
<Frequency> <numeric value>

Range: Depends on the measurement range.
*RST: 1 MHz
Default unit: Hz

Example: See `CALCulate<n>[:RANGe<ri>]:EVALuation[:STATe]`.

Manual operation: See "Defining the integration range" on page 50

CALCulate<n>[:RANGe<ri>]:EVALuation:STOP <Frequency>

This command defines the stop frequency of a custom integration range for residual effects calculation.

Prerequisites for this command

- Turn off integration over the complete measurement range (`CALCulate<n>[:RANGe<ri>]:EVALuation[:STATe]`).

Suffix:
<n> Window

<ri> Integration range

Parameters:
<Frequency> <numeric value>

Range: Depends on the measurement range.
*RST: 1 kHz
Default unit: Hz

Example: See `CALCulate<n>[:RANGe<ri>]:EVALuation[:STATe]`.

Manual operation: See "Defining the integration range" on page 50

CALCulate<n>[:RANGe<ri>]:EVALuation:TRACe <Trace1>

This command selects the trace for calculation of residual effects.

Suffix:
<n> Window

<ri> Integration range

Parameters:

<Trace1> **TRACE1 | ... | TRACE6**
Selects the trace. You can select a trace that is inactive, but for residual effect calculation, it must be active.

NONE
Turns off residual calculation for the respective range.

*RST: Depends on the range.

Example: //Use trace 1 as the data source for range 2
```
CALC:RANG2:EVAL:TRAC TRACE1
```

Manual operation: See "Selecting the trace for residual calculations" on page 50

CALCulate<n>[:RANGe<ri>]:EVALuation[:STATe] <State>

This command turns integration of the entire measurement range for residual calculations on and off.

Suffix:

<n> Window

<ri> Integration range

Parameters:

<State> **ON | 1**
Integrates over the complete measurement range.

OFF | 0
Integrates over a custom measurement range.

Example: //Define an integration range from 1 kHz to 3 kHz in range 2
```
CALC:RANG2:EVAL OFF
CALC:RANG2:EVAL:STAR 100000
CALC:RANG2:EVAL:STOP 300000
```

Manual operation: See "Defining the integration range" on page 50

CALCulate<n>[:RANGe<j>]:EVALuation:WEIGhting <Name>

This command selects a weighting filter whose values are applied to the calculation of residual effects.

Suffix:

<n> Window

<j> Integration range

Setting parameters:

<Name> String containing the name of the filter.

*RST: NONE

Example: //Apply a weighting filter to the residual calculations in integration range 1
`CALC:RANG1:EVAL:WEIG 'A FILTER'`

Manual operation: See "Applying weighting filters" on page 51

[SENSe:]CORRection:WEIGhting:COMMent <Name>

This command defines a comment for a weighting filter whose values are applied to the calculation of residual effects.

Setting parameters:
<Name> String containing the comment.

Example: See `[SENSe:]CORRection:WEIGhting:NAME` on page 155.

Manual operation: See "Designing weighting filters" on page 51

[SENSe:]CORRection:WEIGhting:DATA {<freq>, <level>}...

This command defines the shape of the weighting filter whose values are applied to the calculation of residual effects.

The shape of the weighting filter is defined by two or more pairs of frequency and level values.

Parameters:
<freq> <numeric value>
Default unit: Hz

<level> <numeric value>
Default unit: dB

Example: See `[SENSe:]CORRection:WEIGhting:NAME` on page 155.

Manual operation: See "Designing weighting filters" on page 51

[SENSe:]CORRection:WEIGhting:DELete

This command deletes the currently selected weighting filter.

Prerequisites for this command

- Select a weighting filter with `[SENSe:]CORRection:WEIGhting:SELect` on page 155.

Example: //Delete the currently selected weighting filter
`CORR:WEIG:DEL`

Usage: Event

Manual operation: See "Managing weighting filters" on page 51

[SENSe:]CORRection:WEIGhting:NAME <Name>

This command defines the name for a weighting filter whose values are applied to the calculation of residual effects.

Setting parameters:

<Name> String containing the name of the filter.

Example: //Create a weighting filter called "FILTER", with a comment and a few data points

```
CORR:WEIG:NAME 'FILTER'
CORR:WEIG:COMM 'Here's an example for a filter.'
CORR:WEIG:DATA 10MHZ,0DB,20MHZ,2DB,40MHZ,5DB
```

Manual operation: See "Designing weighting filters" on page 51

[SENSe:]CORRection:WEIGhting:SELect <Name>

This command selects a weighting filter whose values are applied to the calculation of residual effects.

Setting parameters:

<Name> String containing the name of the weighting filter.

Example: //Select a weighting filter called "filter"

```
CORR:WEIG:SEL 'FILTER'
```

Manual operation: See "Managing weighting filters" on page 51

6.5.6.3 Spot noise configuration

CALCulate<n>:SNOise<ri>:AOFF 155
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DISPlay:SNINfo:TRACe 159

CALCulate<n>:SNOise<ri>:AOFF

This command turns all spot noise information off (custom and 10^x information). It also turns user defined spot noise markers off.

Suffix:

<n> irrelevant

<ri> irrelevant

Example: //Turn off all spot noise information
`CALC:SNO:AOFF`

Usage: Event

CALCulate<n>:SNOise<ri>:STATe <State>

This command turns a custom spot noise position on and off.

Suffix:
<n> irrelevant

<ri> Spot noise marker

Parameters:
<State> ON | OFF | 1 | 0
*RST: All ON

Example: See `CALCulate<n>:SNOise<ri>[:TRACe<t>]:USERdefined[:STATe]`.

CALCulate<n>:SNOise<ri>:X <Frequency>...

This command defines the horizontal position of a custom spot noise position. The position is changed in all windows.

Suffix:
<n> irrelevant

<ri> Spot noise marker

Parameters:
<Frequency> For minimum and maximum offsets, refer to the data sheet. The default values are the decade edges (1 kHz, 10 kHz etc.)
Default unit: Hz

Example: See `CALCulate<n>:SNOise<ri>[:TRACe<t>]:USERdefined[:STATe]`.

CALCulate<n>:SNOise<ri>[:TRACe<t>]:DECades:X?

This command queries the horizontal position of the 10^x offset frequency spot noise information.

Suffix:
<n> irrelevant

<ri> irrelevant

<t> irrelevant

Return values:

<Frequency> List of offset frequencies, one for each 10^x spot noise position. The number of return values depends on the measurement range.

Default unit: Hz

Example: //Query spot noise information
`CALC:SNO:DEC:X?`
would return, e.g.
`1000,10000,100000,1000000`

Usage: Query only

Manual operation: See "Spot Noise" on page 26

CALCulate<n>:SNOise<ri>[:TRACe<t>]:DECades:Y?

This command queries the vertical position of the 10^x offset frequency spot noise information.

Suffix:

<n> Window

<ri> irrelevant

<t> Trace

Return values:

<Level> List of phase noise level values, one for each 10^x spot noise positions.
The number of return values depends on the measurement range.

Default unit: dBc/Hz

Example: //Query spot noise information
`CALC:SNO:DEC:Y?`
would return, e.g.
`-152.560974121094,-136.443389892578,`
`-145.932891845703,-152.560974121094`

Usage: Query only

Manual operation: See "Spot Noise" on page 26

CALCulate<n>:SNOise<ri>[:TRACe<t>]:DECades[:STATe] <State>

This command turns the spot noise calculation on every 10^x offset frequency on and off.

Suffix:

<n> irrelevant

<ri> irrelevant

<t> irrelevant

Parameters:

<State> ON | OFF | 1 | 0

*RST: ON

Example: //Turn on the spot noise calculation for all decade edges.

```
CALC:SNO:DEC ON
```

CALCulate<n>:SNOise<ri>[:TRACe<t>]:USERdefined[:STATe] <State>

This command turns calculation of custom spot noise positions on and off

Suffix:

<n> irrelevant

<ri> irrelevant

<t> irrelevant

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on user defined spot noise positions

```
CALC:SNO:USER ON
```

//Turn on custom spot noise marker 2 at an offset of 500 kHz

```
CALC:SNO3:STAT ON
CALC:SNO3:X 500000
```

//Query spot noise

```
CALC:SNO3:Y?
```

would return, e.g.

```
-90.1154022217
```

CALCulate<n>:SNOise<ri>[:TRACe<t>]:Y?

This command queries the level measured for a custom spot noise position.

Prerequisites for this command

- Use custom spot noise positions (`CALCulate<n>:SNOise<ri>[:TRACe<t>]:USERdefined[:STATe]`).

Suffix:

<n> Window

<ri> Spot noise marker

<t> Trace

Return values:

<Level> Phase noise level at the spot noise position.

Default unit: dBc/Hz

Example: See `CALCulate<n>:SNOise<ri>[:TRACe<t>]:USERdefined[:STATe]`.

Usage: Query only

Manual operation: See "Spot Noise" on page 26

DISPlay:SNINfo[:STATe] <State>

This command turns the display of spot noise information in the diagram area on and off.

Parameters:

<State> ON | OFF | 1 | 0

*RST: ON

Example: //Display the spot noise information

```
DISP:SNIN ON
```

Manual operation: See "Displaying spot noise information" on page 53

DISPlay:SNINfo:TRACe <Trace>

This command selects the trace for which spot noise information is evaluated.

Parameters:

<Trace> Range: 1 to 6

*RST: 1

Example: //Evaluate spot noise for trace 2.

```
DISP:SNIN:TRAC 2
```

Manual operation: See "Displaying spot noise information" on page 53

6.5.6.4 Spur display

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DISPlay[:WINDow<n>]:TRACe<t>:SPURs:SUPPress <State>

This command turns spur removal for a specific trace on and off.

Suffix:
<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Manual operation: See "Hiding spurs" on page 54
See "Removing spurs" on page 70

DISPlay[:WINDow<n>]:TRACe<t>:SPURs:THReshold <Threshold>

This command defines a level threshold for spur removal.

Prerequisites for this command

- Turn on spur removal (`DISPlay[:WINDow<n>]:TRACe<t>:SPURs:THReshold`).

Suffix:
<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<Threshold> <numeric value>
*RST: 0
Default unit: dB

Example: See `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]`.

Manual operation: See "Hiding spurs" on page 54
See "Removing spurs" on page 70

[SENSe:]SPURs:SORT <Order>

This command selects the sort order of the spurs in the spur list.

Parameters:
<Order> **POWer**
Sorts spurs according to their power.
OFFSet
Sorts spurs according to their offset from the carrier.
*RST: POWer

Example: //Select spur sort order
```
SPUR:SORT POW
```

Manual operation: See "Sorting spurs" on page 54

[SENSe:]SPURs:WEIGhting <Weightingfilter>

This command selects a spurious weighting filter.

Setting parameters:
<Weightingfilter>

Example: //Select no defined weighting filter
```
SENS:SPUR:WEIG NONE
```

Manual operation: See "Applying a spurious weighting filter" on page 54

[SENSe:]SPURs:FILTer:MODE <Mode>

This command defines the spurious filter mode

Parameters:
<Mode> OFF | SUPPress | SHOW

OFF
No spurious filter is applied.

SUPPress
The spurs in the spurious filter are removed from the spurious list, the diagram and dependent calculations.

SHOW
Only the spurs in the spurious filter are displayed in the spurious list, the diagram and dependent calculations.

Example:
```
SENS:SPUR:FILT:MOD OFF
```

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:HARMonics <State>

This command defines if harmonics are included in the spurious filter.

Parameters:
<State>

Example: //Exclude harmonics from the spurious filter
```
SENS:SPUR:FILT:HARM OFF
```

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:RANGe <Range>

This command defines the range of the spurious filter. The range is defined as a multiple of the resolution bandwidth.

Parameters:
<Range>

Example: `SENS:SPUR:FILT:RANG 1`

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:NAME?

This command returns the name of the selected spurious filter.

Example: `SENS:SPUR:FILT:NAME?`

Usage: Query only

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:OFFSet <OffsetValues>...

This command creates a new offset table with defined frequency ranges.

Parameters:
<OffsetValues> Default unit: Hz

Example: `SENS:SPUR:FILT:OFFS 1.3e3, 2.6e5`

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:CLEar

This command clears the currently selected spurious filter.

Example: `SENS:SPUR:FILT:CLE`

Usage: Event

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:SAVE <Filename>

This command saves the spurious filter configuration to a file. The spurious filter name can be defined.

Location of filter files: `C:\R_S\instr\SpuriousFilter\`

Setting parameters:
<Filename>

Example: `SENS:SPUR:FILT:SAVE "MyFile"`

Usage: Setting only

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:FILTer:LOAD <Filename>

This command loads an existing spurious filter configuration from a file.

Location of filter files: `C:\R_S\instr\SpuriousFilter\`

Setting parameters:
<Filename>

Example: `SENS:SPUR:FILT:LOAD "MyFile"`

Usage: Setting only

Manual operation: See "Filtering spurs" on page 55

[SENSe:]SPURs:COLor <Color>

Provides functionality to enable an automatic shift of the color of the displayed spurious lines.

Parameters:
<Color> TRACe | SHIFted

Example: `SENS:SPUR:COL TRAC`

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6.6.1 Display configuration

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DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example:
```
DISP:FORM SPL
```

DISPlay:WSELect?

This command queries the currently active window (the one that is focused) *in the currently selected measurement channel*.

Return values:

<SelectedWindow> Index number of the currently active window.

Range: 1 to 16

Usage: Query only

DISPlay[:WINDow<n>][:SUBWindow<w>]:SELect

This command sets the focus on the selected result display window.

This window is then the active window.

For measurements with multiple results in subwindows, the command also selects the subwindow. Use this command to select the (sub)window before querying trace data.

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

Example: //Put the focus on window 1
```
DISP:WIND1:SEL
```

Example: //Put the focus on subwindow 2 in window 1
```
DISP:WIND1:SUBW2:SEL
```

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 168).

Suffix:
<n> Window

Parameters:
<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example:
```
DISP:WIND2:SIZE LARG
```

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

This command adds a window to the display in the active channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Query parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:ADD? '1',LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See "Marker Table" on page 27

Table 6-3: <WindowType> parameter values for the phase noise application

Parameter value	Window type
ADEViation	Allan deviation
AMNoise	PN Noise spectrum
AVARiance	Allan variance
DIAGram	Noise spectrum
HARMonic	Harmonic power
INOise	Integrated noise
LF	Noise spectrum L(f)
MTABle	Marker table
PNOise	PN Noise spectrum
RNOise	Integrated noise
SNOise	Spot noise
SNU	Noise spectrum Sv(f)
SPHI	Noise spectrum SΦ(f)
SPURs	Spurious list
SY	Noise spectrum Sy(f)

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**

Index of the window.

Example: `LAY:CAT?`

Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:IDEN:WIND? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Setting parameters:

<WindowName> String containing the name of an existing window that is to be moved.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowName> String containing the name of an existing window the selected window is placed next to or replaces.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | REPLace

Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active channel.

Setting parameters:

<WindowName> String containing the name of the window. In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Setting parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 165 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

Usage: Setting only

LAYout:SPLitter <Index1>, <Index2>, <Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 164 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command does not work, but does not return an error.

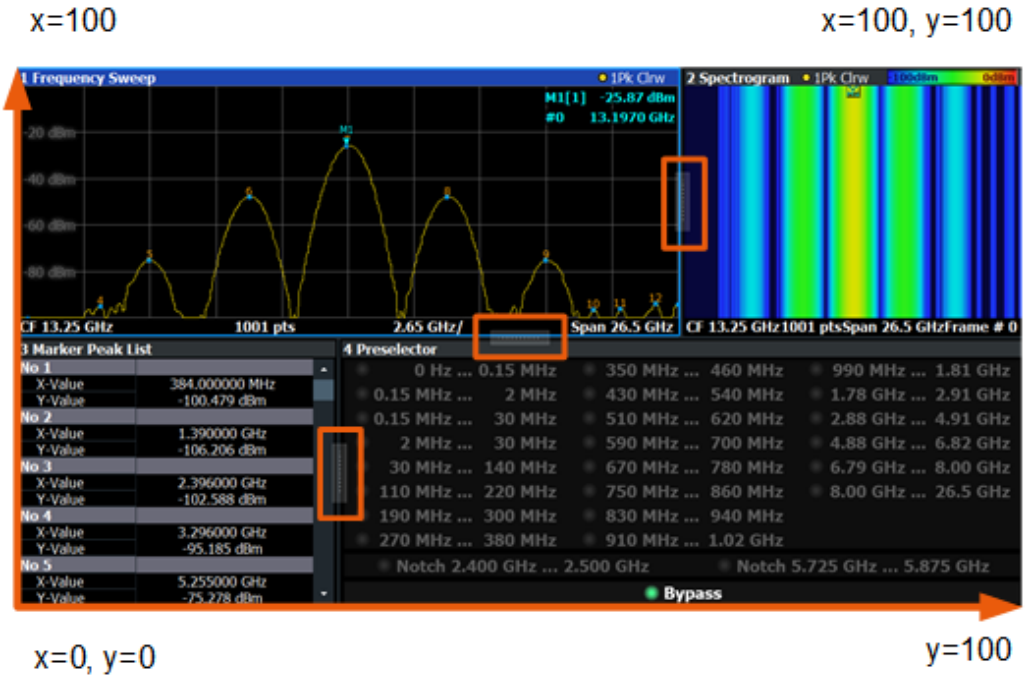


Figure 6-1: SmartGrid coordinates for remote control of the splitters

Setting parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 6-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Table"') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: LAY:SPL 1,4,70
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Peak List"') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70

Usage: Setting only

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added. Unlike LAYout:ADD[:WINDow]?, for which the existing window is defined by a parameter.

To replace an existing window, use the LAYout:WINDow<n>:REPLace command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:
<n> Window

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See LAYout:ADD[:WINDow]? on page 165 for a list of available window types.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: LAY:WIND1:ADD? LEFT,MTAB
Result:
'2'
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel.

Note: to query the **index** of a particular window, use the LAYout:IDENtify[:WINDow]? command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active channel.

The effect of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 165 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

Usage: Setting only

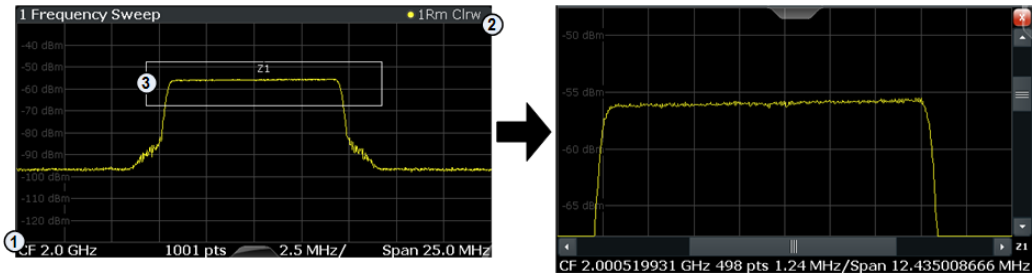
6.6.2 Zoom

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA 172
DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA 173
DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe] 174
DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe] 174

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

Parameters:

<x1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

<y1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

<x2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

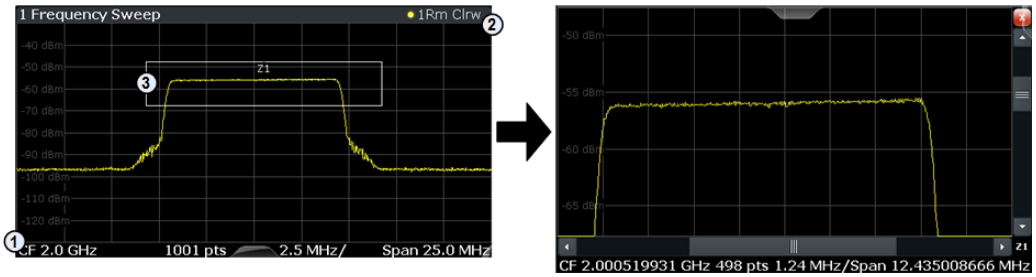
Range: 0 to 100
Default unit: PCT

Manual operation: See "Single Zoom" on page 60

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>:AREA
<x1>,<y1>,<x2>,<y2>

This command defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

<zn> Selects the zoom window.

Parameters:

<x1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

<y1> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

<x2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

<y2> Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

Manual operation: See "Multi-Zoom" on page 60

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM:MULTiple<zn>[:STATe] <State>

This command turns the multiple zoom on and off.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

<zn> Selects the zoom window.
If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See "Multi-Zoom" on page 60

DISPlay[:WINDow<n>][:SUBWindow<w>]:ZOOM[:STATe] <State>

This command turns the zoom on and off.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:ZOOM ON`
Activates the zoom mode.

Manual operation: See "Single Zoom" on page 60
See "Restore Original Display" on page 62

6.6.3 Trace configuration

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- Trace export and import 181
- Trace mathematics 186
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6.6.3.1 Trace characteristics

Commands to configure traces described elsewhere.

- `DISPlay[:WINDow<n>]:TRACe<t>:SPURs:SUPPress`
- `DISPlay[:WINDow<n>]:TRACe<t>:SPURs:THReshold`

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE 175
DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] 176
DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT 177
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DISPlay[:WINDow<n>]:TRACe<t>:RESult[:TYPE] 178
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] 178
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet 179
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet:STATe 179
DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture 180
DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe] 180

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE <Mode>

This command selects the trace mode. If necessary, the selected trace is also activated.

For max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNt`. Note that synchronization to the end of the measurement is possible only in single sweep mode.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

<t> Trace

Parameters:

<Mode>

WRITe
(default:) Overwrite mode: the trace is overwritten by each sweep.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSMR3 saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSMR3 saves the sweep result in the trace memory only if the new value is lower than the previous one.

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

BLANk
Hides the selected trace.

WRHold
The trace is overwritten when new data is available, but only after all cross-correlation operations defined for a half decade are done.

*RST: Depends on the trace.

Example:

```
INIT:CONT OFF
```
Switching to single sweep mode.
```
SWE:COUN 16
```
Sets the number of measurements to 16.
```
DISP:TRAC3:MODE WRIT
```
Selects clear/write mode for trace 3.
```
INIT;*WAI
```
Starts the measurement and waits for the end of the measurement.

Manual operation: See "Trace Mode" on page 69

DISPlay[:WINDow<n>]:TRACe<t>:LABel[:STATe] <State>

This command turns the display of the trace label for a specific trace on and off.

The command can only be applied to active traces.

Suffix:

<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on the label for trace 2
```
DISP:TRAC2:LAB ON
```

DISPlay[:WINDow<n>]:TRACe<t>:LABel:TEXT <Label>

This command defines the contents of a trace label.

Suffix:
<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<Label> String containing the trace label.

Example: //Assign a label to trace 2.
```
DISP:TRAC2:LAB:TEXT 'A YELLOW TRACE'
```

DISPlay[:WINDow<n>]:TRACe<t>:PERSistence:DECay <Decay>

This command defines the time period that an event remains visible until it fades away (decay).

Prerequisites for this command

- Turn on persistence (`DISPlay[:WINDow<n>]:TRACe<t>:PERSistence[:STATe]`).

Suffix:
<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<Decay> <numeric value>
Range: 0 s to 8 s
*RST: 0
Default unit: s

Example: //Turn on persistence for trace 2 with a decay of 2 seconds
```
DISP:TRAC2:PERS ON
DISP:TRAC2:PERS:DEC 2s
```

Manual operation: See "Displaying persistence" on page 71

DISPlay[:WINDow<n>]:TRACe<t>:PERSistence[:STATe] <State>

This command turns persistence for a trace on and off.

Suffix:
<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Turn on persistence for trace 2
`DISP:TRAC2:PERS ON`

Manual operation: See "Displaying persistence" on page 71

DISPlay[:WINDow<n>]:TRACe<t>:RESult[:TYPE] <Resulttype>

This command selects the type of noise represented by the trace.

Suffix:
<n> 1..n
Window

<t> 1..n
Trace

Parameters:
<Resulttype> **PN**
Phase noise results.

AM
AM noise results.

PNAM
Sum of phase noise and AM noise.

Example: //Show AM noise characteristics on trace 2
`DISP:TRAC2:RES AM`

Manual operation: See "Selecting the displayed result" on page 70

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

<t> Trace

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:TRAC3 ON`

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6" on page 69

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines the amount by which a trace is shifted.

Prerequisites for this command

- Turn on trace offset (`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet:STATe`).

Suffix:

<n> 1..n
irrelevant

<t> 1..n
irrelevant

Parameters:

<Offset> <numeric value>

*RST: 0
Default unit: dB

Example: //Define a level offset of 10 dB
`DISP:TRAC:Y:RLEV:OFFS 10`

Manual operation: See "Shifting the trace" on page 71

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet:STATe <State>

This command turns the offset for a trace on and off.

When you turn that feature on, the trace is shifted vertically by a certain amount.

Suffix:

<n> 1..n
Window

<t> 1..n
Trace

Parameters:

<State> ON | OFF | 1 | 0
*RST: OFF

Example: //Shift trace 2 vertically by 10 dB.
```
DISP:TRAC2:Y:RLEV:OFFS:STAT ON
DISP:TRAC2:Y:RLEV:OFFS 10
```

Manual operation: See "Shifting the trace" on page 71

DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture <Aperture>

This command defines the magnitude (aperture) of trace smoothing.

Prerequisites for this command

- Turn on trace smoothing (`DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]`).

Suffix:

<n> 1..n
Window

<t> 1..n
Trace

Parameters:

<Aperture> <numeric value>
Range: 1 to 20
*RST: 1
Default unit: PCT

Example: See `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe]`.

Manual operation: See "Smoothing traces" on page 70

DISPlay[:WINDow<n>]:TRACe<t>:SMOothing[:STATe] <State>

This command turns trace smoothing for a specific trace on and off.

When you turn on trace smoothing, you can define the smoothing magnitude with `DISPlay[:WINDow<n>]:TRACe<t>:SMOothing:APERture`.

Suffix:

<n> 1..n
Window

<t> 1..n
Trace

Parameters:

<State> ON | OFF | 1 | 0
*RST: Depends on the trace.

Example: //Turns on trace 3 (average mode based on 10 measurements) to display the AM noise results

```
DISP:TRAC3:MODE AVER
SWE:COUN 10
DISP:TRAC3:RES AM
```

//Smooth the trace by a magnitude of 10 %

```
DISP:TRAC3:SMO ON
DISP:TRAC3:SMO:APER 10
```

//Remove spurs from trace 3

```
DISP:TRAC3:SPUR:SUPP ON
DISP:TRAC3:SPUR:THR 5
```

Manual operation: See "Smoothing traces" on page 70

6.6.3.2 Trace copy

TRACe<n>:COPY 181

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Suffix:
<n> Window

Parameters:
<TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
The first parameter is the destination trace, the second parameter is the source.
(Note the 'e' in the parameter is required!)

Example:

```
TRAC:COPY TRACE1,TRACE2
```

Copies the data from trace 2 to trace 1.

Manual operation: See "Copy Trace" on page 76

6.6.3.3 Trace export and import

FORMat[:DATA] 181
FORMat:DEXPort:CSEParator 182
FORMat:DEXPort:DSEParator 183
FORMat:DEXPort:FORMat 183
FORMat:DEXPort:HEADer 183
FORMat:DEXPort:TRACes 184
MMEMory:LOAD<n>:TRACe 184
MMEMory:STORe<n>:TRACe 185

FORMat[:DATA] <Format>[, <BitLength>]

This command selects the data format that is used for transmission of trace data from the R&S FSMR3 to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSMR3. The R&S FSMR3 automatically recognizes the data it receives, regardless of the format.

For details on data formats, see Chapter 6.6.3.5, "Formats for returned values: ASCII format and binary format", on page 187.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats can be.

REAL
Floating-point numbers (according to IEEE 754) in the "definite length block format".
The format setting `REAL` is used for the binary transmission of trace data.

<BitLength>

Length in bits for floating-point results

16
16-bit floating-point numbers.
Compared to `REAL,32` format, half as many numbers are returned.

32
32-bit floating-point numbers
For I/Q data, 8 bytes per sample are returned for this format setting.

64
64-bit floating-point numbers
Compared to `REAL,32` format, twice as many numbers are returned.

Example:

```
FORM REAL,32
```

FORMat:DEXPort:CSEParator <Separator>

This command selects the column separator for exported trace data.

The selected value is not affected by a preset. The command therefore has no reset value.

Parameters:

<Separator>

COMMa
Selects a comma as a separator.

SEMicolon
Selects a semicolon as a separator.

TAB
Selects a tabulator as a separator.

*RST: n/a

Example: //Select column separator
`FORM:DEXP:CSEP TAB`

Manual operation: See "Column Separator" on page 74

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:
<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 74

FORMat:DEXPort:FORMat <FileFormat>

Determines the format of the ASCII file to be imported or exported. Depending on the external program that creates the data file or evaluates it, a comma-separated list (CSV) or a plain data format (DAT) file is required.

Parameters:
<FileFormat> CSV | DAT

*RST: DAT

Example: `FORM:DEXP:FORM CSV`

Manual operation: See "File Type" on page 74

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Manual operation: See "Include Instrument & Measurement Settings" on page 73

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 185).

Parameters:

<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Manual operation: See "Export all Traces and all Table Results" on page 72

MMEMory:LOAD<n>:TRACe <FileName>[, <Window>, <Trace>, <Trace>]

This commans imports a previously recorded trace.

Suffix:

<n> 1..n
Destination Window

Parameters:

<FileName> String that contains the location of the ASCII file you want to import.
Supported file types are `.dat` and `.csv`.

<Window> <numeric value> (integer only)

Optional.
Selects the source window of the trace that you want to import. Because the ASCII file can contain trace information for several result windows, you can select a specfic result window whose trace(s) are imported.
The selected window must be compatible to the destination windows selected by the suffix at the `LOAD<n>` syntax element. For example if you want to import the data of a phase noise trace, a phase noise diagram must be active.
If you omit the source window, the R&S FSMR3 checks if the import data is compatible to the diagram that you have selected. If not, the command throws an error and the data is not imported.

Range: 1 to 16

<Trace> <numeric value> (integer only)
Optional.
Selects the number of the source trace. The source trace is the trace you want to import.
Range: 1 to 6

<Trace> <numeric value> (integer only)
Optional.
Selects the number of the destination trace. The destination trace is the trace you want to write the imported trace to.
Range: 1 to 6

Example: //Import all compatible traces from an ASCII file into window 2
```
MMEM:LOAD2:TRAC 'c:\trace.dat'
```

Example: //Import all traces stored as window 1 into window 2
```
MMEM:LOAD2:TRAC 'c:\trace.dat',1
```

Example: //Import a single trace from ASCII file
```
MMEM:LOAD:TRAC 'c:\trace.dat',2,1,5
```

Manual operation: See "Select ASCII File" on page 75
See "Source Window / Source Trace" on page 75
See "Destination Trace" on page 75
See "Import" on page 76

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

For details on the file format, see Chapter 4.2.8.1, "Reference: ASCII file export format", on page 79.

Secure User Mode

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the R&S FSMR3 User Manual.

Suffix:
<n> Window

Parameters:
<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example:
```
MMEM:STOR1:TRAC 1,'C:\TEST.ASC'
```
Stores trace 1 from window 1 in the file `TEST.ASC`.

Manual operation: See "Export Trace to ASCII File" on page 73

6.6.3.4 Trace mathematics

CALCulate<n>:MATH:STATe 186
CALCulate<n>:MATH[:EXPRession][:DEFine] 186

CALCulate<n>:MATH:STATe <State>

This command turns trace mathematics on and off.

Suffix:
<n> 1..n
Window

Parameters:
<State> **ON | 1**
Turns trace mathematics on and selects the operation that has been selected last (or `(TRACE1-TRACE3)` if you have not yet selected one).

OFF | 0
Turns trace mathematics off.

*RST: OFF

Example: //Turn on trace 3, subtract it from trace 2 and write the result to trace 2
```
DISP:TRAC3:MODE WRIT
CALC:MATH (TRACE2-TRACE3)
```
//Turn off trace mathematics
```
CALC:MATH:STAT OFF
```
//Turn them on again and selects the operation (TRACE2-TRACE3).
```
CALC:MATH:STAT ON
```

Manual operation: See "Selecting the math operation" on page 77

CALCulate<n>:MATH[:EXPRession][:DEFine] <Operation>

This command selects the operation for trace mathematics.

Suffix:
<n> 1..n
Window

Setting parameters:
<Operation> Depending on the operation you select, one trace is subtracted from another. The result is written to the first trace indicated in the operation.
An operation is only available if both traces are actually turned on.

(TRACE1-TRACE3)

(TRACE2-TRACE3)
(TRACE4-TRACE6)
(TRACE5-TRACE6)
*RST: Trace mathematics are off.

Example: //Subtract trace 2 from trace 1 and write the result to trace 1
`CALC:MATH (TRACE1-TRACE2)`

Manual operation: See "Selecting the math operation" on page 77

6.6.3.5 Formats for returned values: ASCII format and binary format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMat[:DATA]` on page 181. The possible formats are described here.

- ASCII Format (FORMat ASCII):
  The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.
- Binary Format (FORMat REAL,16/32/64):
  The data is stored as binary data (definite length block data according to IEEE 488.2), each measurement value being formatted in 16-bit/32-bit/64-bit IEEE 754 floating-point-format.
  The schema of the result string is as follows:
  `#<Length of length><Length of data><value1><value2>…<value n>`
  with:

<Length of length>	Number of digits of the following number of data bytes
<Length of data>	Number of following data bytes
<Value>	2-byte/4-byte/8-byte floating point value

Example: `#41024`<Data>... contains 1024 data bytes

Data blocks larger than 999,999,999 bytes

According to SCPI, the header of the block data format allows for a maximum of 9 characters to describe the data length. Thus, the maximum REAL 32 data that can be represented is 999,999,999 bytes. However, the R&S FSMR3 is able to send larger data blocks. In this case, the length of the data block is placed in brackets, e.g.
`#(1234567890)`<value1><value2>…

Reading out data in binary format is quicker than in ASCII format. Thus, binary format is recommended for large amounts of data.

6.6.4 Marker

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6.6.4.1 Individual marker setup

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CALCulate<n>:DELTamarker<m>:LINK....188
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>....189
CALCulate<n>:DELTamarker<m>:MODE....189
CALCulate<n>:DELTamarker<m>:MREFerence....190
CALCulate<n>:DELTamarker<m>[:STATe]....190
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CALCulate<n>:MARKer<m>[:STATe]....192
CALCulate<n>:MARKer<m>:TRACe....192
CALCulate<n>:MARKer<m>:X....193

CALCulate<n>:DELTamarker<m>:AOFF

This command turns off *all* delta markers.

Suffix:

<n> Window

<m> irrelevant

Example: `CALC:DELT:AOFF`
Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2:LINK ON`

Manual operation: See "Linking to Another Marker" on page 84

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

This command links the delta source marker <ms> to any active destination marker <md> (normal or delta marker).

Suffix:
<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See "Linking to Another Marker" on page 84

CALCulate<n>:DELTamarker<m>:MODE <Mode>

This command defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker. Note that this setting applies to *all* windows.

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see `CALCulate<n>:DELTamarker<m>:X` on page 191)!

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<Mode>

ABSolute
Delta marker position in absolute terms.

RELative
Delta marker position in relation to a reference marker.

*RST: RELative

Example: `CALC:DELT:MODE ABS`
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREFerence <Reference>

This command selects a reference marker for a delta marker other than marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<Reference>

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 84

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 83
See "Marker Type" on page 84
See "Select Marker" on page 85

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window

<m> Marker

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:
<n> Window

<m> Marker

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker Position X-value" on page 83

CALCulate<n>:MARKer<m>:AOFF

This command turns off all markers.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Manual operation: See "All Markers Off" on page 85

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

This command links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:
<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See "Linking to Another Marker" on page 84

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 83
See "Marker Type" on page 84
See "Select Marker" on page 85

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n> Window

<m> Marker

Parameters:

<Trace>

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See "Assigning the Marker to a Trace" on page 84

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:
<n> Window

<m> Marker

Parameters:
<Position> Numeric value that defines the marker position on the x-axis. The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 27
See "Marker Position X-value" on page 83

6.6.4.2 General marker settings

DISPlay[:WINDow<n>]:MTABle 193
CALCulate<n>:MARKer<m>:LINK 194

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

This command turns the marker table on and off.

Suffix:
<n> irrelevant

Parameters:
<DisplayMode> **ON | 1**
Turns on the marker table.

OFF | 0
Turns off the marker table.

AUTO
Turns on the marker table if 3 or more markers are active.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 86

CALCulate<n>:MARKer<m>:LINK <State>

This command defines whether the markers in all diagrams with the same x-axis are linked. If enabled, and you move one marker along the x-axis, all other markers are moved to the same x-axis position.

Suffix:
<m> irrelevant

<n> irrelevant

Parameters:
<State> ON | OFF | 1 | 0
*RST: 0

Example: `CALC2:MARK:LINK ON`
Links all markers across all diagrams. The window selection `2` is irrelevant.

Manual operation: See "Linked Markers" on page 86

6.6.4.3 Marker search

CALCulate<n>:MARKer<m>:PEXCursion 194
CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking:RANGe 194
CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking[:STATe] 195

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Suffix:
<n> irrelevant

<m> irrelevant

Example: `CALC:MARK:PEXC 10dB`
Defines peak excursion as 10 dB.

Manual operation: See "Peak Excursion" on page 87

CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking:RANGe <Range>

This command defines the frequency range in which spur tracking takes place.

Prerequisites for this command

- Turn on spur tracking (`CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking[:STATe]`).

Suffix:

<n> 1..n
irrelevant

<m> 1..n
irrelevant

Parameters:

<Range> <numeric value>

Number without unit that defines the frequency range as a function of the resolution bandwidth.
Tracking range = x * RBW

*RST: 1.0

Example: //Turn on spur tracking and define a tracking range of 2 x RBW

```
CALC:MARK:FUNC:SPTR ON
CALC:MARK:FUNC:SPTR:RANG 2
```

Manual operation: See "Spurious Tracking" on page 88

CALCulate<n>:MARKer<m>:FUNCtion:SPTRacking[:STATe] <State>

This command turns spurious tracking on and off.

Suffix:

<n> 1..n
irrelevant

<m> 1..n
irrelevant

Parameters:

<State> ON | OFF | 1 | 0

*RST: OFF

Example: //Turn on spur tracking

```
CALC:MARK:FUNC:SPTR ON
```

Manual operation: See "Spurious Tracking" on page 88

6.6.4.4 Positioning markers

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT 196
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT 196
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt 196
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] 196
CALCulate<n>:DELTamarker<m>:MINimum:LEFT 197
CALCulate<n>:DELTamarker<m>:MINimum:NEXT 197
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt 197

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] 197
CALCulate<n>:MARKer<m>:MAXimum:LEFT 198
CALCulate<n>:MARKer<m>:MAXimum:NEXT 198
CALCulate<n>:MARKer<m>:MAXimum:RIGHt 198
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] 198
CALCulate<n>:MARKer<m>:MINimum:LEFT 199
CALCulate<n>:MARKer<m>:MINimum:NEXT 199
CALCulate<n>:MARKer<m>:MINimum:RIGHt 199
CALCulate<n>:MARKer<m>:MINimum[:PEAK] 199

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next positive peak value.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 88

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next positive peak value.

Suffix:
<n> 1..n
Window

<m> 1..n
Marker

Manual operation: See "Search Next Peak" on page 88

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next positive peak value on the trace.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 88

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Peak Search" on page 88

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Minimum" on page 89

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next minimum peak value.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Minimum" on page 89

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Minimum" on page 89

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 89

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next positive peak.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 88

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next positive peak.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 88

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next positive peak.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 88

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Peak Search" on page 88

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 89

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum peak value.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 89

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 89

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 89

6.6.4.5 Retrieving marker positions

Commands useful to retrieve marker positions described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X`
- `CALCulate<n>:MARKer<m>:X`

CALCulate<n>:DELTamarker<m>:X:RELative? 200
CALCulate<n>:DELTamarker<m>:Y? 200
CALCulate<n>:MARKer<m>:Y? 200

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:

<n> Window

<m> Marker

Return values:

<Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

CALCulate<n>:DELTamarker<m>:Y?

Queries the result at the position of the specified delta marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.

Default unit: DBM

Usage: Query only

CALCulate<n>:MARKer<m>:Y?

Queries the result at the position of the specified marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:
<Result> Default unit: DBM

Usage: Query only

6.6.5 Limit lines

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6.6.5.1 Managing limit lines

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CALCulate<n>:LIMit<li>:COMPatible?....201
CALCulate<n>:LIMit<li>:COPY....202
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CALCulate<n>:LIMit<li>:STATe....203
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CALCulate<n>:LIMit<li>:TRACe<t>:CHECk....204
CALCulate<n>:LIMit<li>:UPPer:STATe....205

CALCulate<n>:LIMit<li>:ACTive?

This command queries the names of *all* active limit lines.

Suffix:
<n> irrelevant

 irrelevant

Return values:
<LimitLines> String containing the names of all active limit lines in alphabetical order.

Example: `CALC:LIM:ACT?`
Queries the names of all active limit lines.

Usage: Query only

Manual operation: See "Visibility" on page 95

CALCulate<n>:LIMit<li>:COMPatible?

This command queries if the currently selected limit line is compatible to the current measurement configuration.

Suffix:

<n> 1..n
irrelevant

 1..n
Limit line

Return values:

<MkrIndex> **1**
Limit line is compatible to the current measurement settings.

0
Limit line is not compatible to the current measurement settings.

Example: //Query limit line compatibility
```
CALC:LIM:NAME 'Limit'
CALC:LIM:COMP?
```

Usage: Query only

CALCulate<n>:LIMit<li>:COPY <Line>

This command copies a limit line.

Suffix:

<n> Window

 Limit line

Parameters:

<Line> **1 to 8**
number of the new limit line

<name>
String containing the name of the limit line.

Example:
```
CALC:LIM1:COPY 2
```
Copies limit line 1 to line 2.
```
CALC:LIM1:COPY 'FM2'
```
Copies limit line 1 to a new line named FM2.

Manual operation: See "Copy Line" on page 95

CALCulate<n>:LIMit<li>:DELete

This command deletes a limit line.

Suffix:

<n> Window

 Limit line

Manual operation: See "Delete Line" on page 96

CALCulate<n>:LIMit<li>:LOWer:OFFSet <Offset>

This command defines an offset for a complete lower limit line.

Compared to shifting the limit line, an offset does not actually change the limit line definition points.

Suffix:
<n> Window

 Limit line

Parameters:
<Offset> Numeric value.

*RST: 0
Default unit: dB

CALCulate<n>:LIMit<li>:LOWer:STATe <State>

This command turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate<n>:LIMit<li>:NAME` on page 209.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See "Visibility" on page 95

CALCulate<n>:LIMit<li>:STATe <State>

This command turns the limit check for a specific limit line on and off.

To query the limit check result, use `CALCulate<n>:LIMit<li>:FAIL?`.

Note that a new command exists to activate the limit check and define the trace to be checked in one step (see `CALCulate<n>:LIMit<li>:TRACe<t>:CHECk` on page 204).

Suffix:
<n> irrelevant

 Limit line

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:LIM:STAT ON`
Switches on the limit check for limit line 1.

Manual operation: See "Disable All Lines" on page 96

CALCulate<n>:LIMit<li>:TRACe<t> <TraceNumber>

This command links a limit line to one or more traces.

Note that this command is maintained for compatibility reasons only. Limit lines no longer need to be assigned to a trace explicitly. The trace to be checked can be defined directly (as a suffix) in the new command to activate the limit check (see `CALCulate<n>:LIMit<li>:TRACe<t>:CHECk` on page 204).

Suffix:
<n> Window

 Limit line

<t> irrelevant

Example: `CALC:LIM2:TRAC 3`
Assigns limit line 2 to trace 3.

CALCulate<n>:LIMit<li>:TRACe<t>:CHECk <State>

This command turns the limit check for a specific trace on and off.

To query the limit check result, use `CALCulate<n>:LIMit<li>:FAIL?`.

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported, however):

- `CALCulate<n>:LIMit<li>:TRACe<t>` on page 204
- `CALCulate<n>:LIMit<li>:STATe` on page 203

Suffix:
<n> Window

 Limit line

<t> Trace

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:LIM3:TRAC2:CHEC ON
Switches on the limit check for limit line 3 on trace 2.

Manual operation: See "Traces to be Checked" on page 95

CALCulate<n>:LIMit<li>:UPPer:STATe <State>

This command turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with CALCulate<n>:LIMit<li>:NAME on page 209.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See "Visibility" on page 95

6.6.5.2 Designing limit lines

CALCulate<n>:LIMit<li>:COMMent 205
CALCulate<n>:LIMit<li>:CONTrol[:DATA] 206
CALCulate<n>:LIMit<li>:CONTrol:DOMain 206
CALCulate<n>:LIMit<li>:CONTrol:MODE 207
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CALCulate<n>:LIMit<li>:LOWer:MODE 208
CALCulate<n>:LIMit<li>:LOWer:SHIFt 208
CALCulate<n>:LIMit<li>:LOWer:SPACing 209
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CALCulate<n>:LIMit<li>:UNIT 209
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CALCulate<n>:LIMit<li>:COMMent <Comment>

This command defines a comment for a limit line.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<Comment> String containing the description of the limit line.

Manual operation: See "Comment" on page 96

CALCulate<n>:LIMit<li>:CONTrol[:DATA] <LimitLinePoints>

This command defines the horizontal definition points of a limit line.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<LimitLinePoints> Variable number of x-axis values.
Note that the number of horizontal values has to be the same as the number of vertical values set with `CALCulate<n>:LIMit<li>:LOWer[:DATA]` or `CALCulate<n>:LIMit<li>:UPPer[:DATA]`. If not, the R&S FSMR3 either adds missing values or ignores surplus values.

*RST: -
Default unit: HZ

Manual operation: See "Data Points" on page 97

CALCulate<n>:LIMit<li>:CONTrol:DOMain <SpanSetting>

This command selects the domain of the limit line.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<SpanSetting> FREQuency | TIME

FREQuency
For limit lines that apply to a range of frequencies.

TIME
For limit lines that apply to a period of time.

CURRent
For limit lines that apply to a range of currents.

VOLTage
For limit lines that apply to a range of voltages.

*RST: FREQuency

Example: `CALC:LIM:CONT:DOM FREQ`
Select a limit line in the frequency domain.

Manual operation: See "X-Axis" on page 96

CALCulate<n>:LIMit<li>:CONTrol:MODE <Mode>

This command selects the horizontal limit line scaling.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<Mode> **ABSolute**
Limit line is defined by absolute physical values (Hz or s).

RELative
Limit line is defined by relative values related to the center frequency (frequency domain) or the left diagram border (time domain).

*RST: ABSolute

Manual operation: See "X-Axis" on page 96

CALCulate<n>:LIMit<li>:CONTrol:SHIFt <Distance>

This command moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<Distance> Numeric value.
The unit depends on the scale of the x-axis.

Default unit: HZ

Manual operation: See "Shift x" on page 97

CALCulate<n>:LIMit<li>:CONTrol:SPACing <InterpolMode>

This command selects linear or logarithmic interpolation for the calculation of limit lines from one horizontal point to the next.

Suffix:
<n> Window

 Limit line

Parameters:
<InterpolMode> LINear | LOGarithmic

*RST: LIN

Example:
```
CALC:LIM:CONT:SPAC LIN
```

Manual operation: See "X-Axis" on page 96

CALCulate<n>:LIMit<li>:LOWer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of a lower limit line.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<li>:CONTrol[:DATA]`. If not, the R&S FSMR3 either adds missing values or ignores surplus values.

*RST: Limit line state is OFF
Default unit: DBM

Manual operation: See "Data Points" on page 97

CALCulate<n>:LIMit<li>:LOWer:MODE <Mode>

This command selects the vertical limit line scaling.

Suffix:
<n> Window

 Limit line

Parameters:
<Mode> **ABSolute**
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual operation: See "Y-Axis" on page 97

CALCulate<n>:LIMit<li>:LOWer:SHIFt <Distance>

This command moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:
<n> Window

 Limit line

Parameters:
<Distance> Defines the distance that the limit line moves.
Default unit: DB

Manual operation: See "Shift y" on page 97

CALCulate<n>:LIMit<li>:LOWer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of a lower limit line from one horizontal point to the next.

Suffix:
<n> Window
 Limit line

Parameters:
<InterpolType> LINear | LOGarithmic
*RST: LIN

CALCulate<n>:LIMit<li>:NAME <Name>

This command selects a limit line that already exists or defines a name for a new limit line.

Suffix:
<n> Window
 Limit line

Parameters:
<Name> String containing the limit line name.
*RST: REM1 to REM8 for lines 1 to 8

Manual operation: See "Name" on page 96

CALCulate<n>:LIMit<li>:UNIT <Unit>

This command defines the unit of a limit line.

Suffix:
<n> irrelevant
 Limit line

Parameters:
<Unit> If you select a dB-based unit for the limit line, the command automatically turns the limit line into a relative limit line.
*RST: DBM

Manual operation: See "Y-Axis" on page 97

CALCulate<n>:LIMit<li>:UPPer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of an upper limit line.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<LimitLinePoints> Variable number of level values.
Note that the number of vertical values has to be the same as the number of horizontal values set with `CALCulate<n>:LIMit<li>:CONTrol[:DATA]`. If not, the R&S FSMR3 either adds missing values or ignores surplus values.

*RST: Limit line state is OFF
Default unit: DBM

Manual operation: See "Data Points" on page 97

CALCulate<n>:LIMit<li>:UPPer:MODE <Mode>

This command selects the vertical limit line scaling.

Suffix:
<n> Window

 Limit line

Parameters:
<Mode> **ABSolute**
Limit line is defined by absolute physical values.
The unit is variable.

RELative
Limit line is defined by relative values related to the reference level (dB).

*RST: ABSolute

Manual operation: See "Y-Axis" on page 97

CALCulate<n>:LIMit<li>:UPPer:SHIFt <Distance>

This command moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Suffix:
<n> irrelevant

 Limit line

Parameters:
<Distance> Defines the distance that the limit line moves.

Manual operation: See "Shift y" on page 97

CALCulate<n>:LIMit<li>:UPPer:SPACing <InterpolType>

This command selects linear or logarithmic interpolation for the calculation of an upper limit line from one horizontal point to the next.

Suffix:
<n> Window

 Limit line

Parameters:
<InterpolType> LINear | LOGarithmic
*RST: LIN

6.6.5.3 Reading out the results of a limit check

CALCulate<n>:LIMit<li>:CLEar[:IMMediate] 211
CALCulate<n>:LIMit<li>:FAIL? 211

CALCulate<n>:LIMit<li>:CLEar[:IMMediate]

This command deletes the result of the current limit check.

The command works on *all* limit lines in *all* measurement windows at the same time.

Suffix:
<n> Window

 irrelevant

Example: `CALC:LIM:CLE`
Deletes the result of the limit check.

CALCulate<n>:LIMit<li>:FAIL?

This command queries the result of a limit check in the specified window.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweep mode.

See also `INITiate<n>:CONTinuous` on page 118.

Suffix:
<n> Window

 Limit line

Return values:
<Result> **0**
PASS

1
FAIL

Example: `INIT;*WAI`
Starts a new sweep and waits for its end.
`CALC2:LIM3:FAIL?`
Queries the result of the check for limit line 3 in window 2.

Usage: Query only

6.6.5.4 Programming Example: Using Limit Lines

```
//-------------- Creating and editing limit lines -----------------------
//Select or create a limit line with index '1'
CALC:LIM1:NAME 'FM1'

//Define 5 horizontal definition points for limit line 1
calc:lim:cont 100hz,1khz,10khz,100khz,1000khz
//Select an absolute vertical scale for limit line 1
CALC:LIM1:UPP:MODE ABS
//Select the unit dBc_Hz for limit line 1
CALC:LIM1:UNIT DBC_HZ
//Define 5 vertical definition points for limit line 1
CALC:LIM1:UPP -60,-80,-90,-100,-110

//Shift the limit line 1 by -10 dB
CALC:LIM1:UPP:SHIF -10DB

//------------- Configuring a limit check -------------------
//Activate upper limit FM1 as line 1
CALC:LIM1:UPP:STAT ON

//Activate the limit to be checked against trace 1 and 2
CALC:LIM1:TRAC1:CHEC ON
CALC:LIM1:TRAC2:CHEC ON
//Query the names of all active limit lines
CALC:LIM:ACT?
//Result: 'FM1'
//Clear the previous limit check results
CALC:LIM:CLE

//------------- Performing the measurement----------------------
//Initiate a new measurement and wait until the last sweep has finished
INIT;*WAI

//-------------- Retrieving limit check results----------------------------
//Query the result of the limit line check
CALC:LIM1:FAIL?
```

6.7 Using the status register

The status reporting system stores information about the current state of the R&S FSMR3. This includes, for example, information about errors during operation or information about limit checks. The R&S FSMR3 stores this information in the status registers and in the error queue. You can query the status register and error queue via IEC bus.

The R&S FSMR3-B60 features several status registers that are specific to phase noise measurements. Here is a description of those, including the corresponding remote commands.

- Status registers for phase noise measurements.....213

6.7.1 Status registers for phase noise measurements

The figure below shows the status registers of the phase noise application.

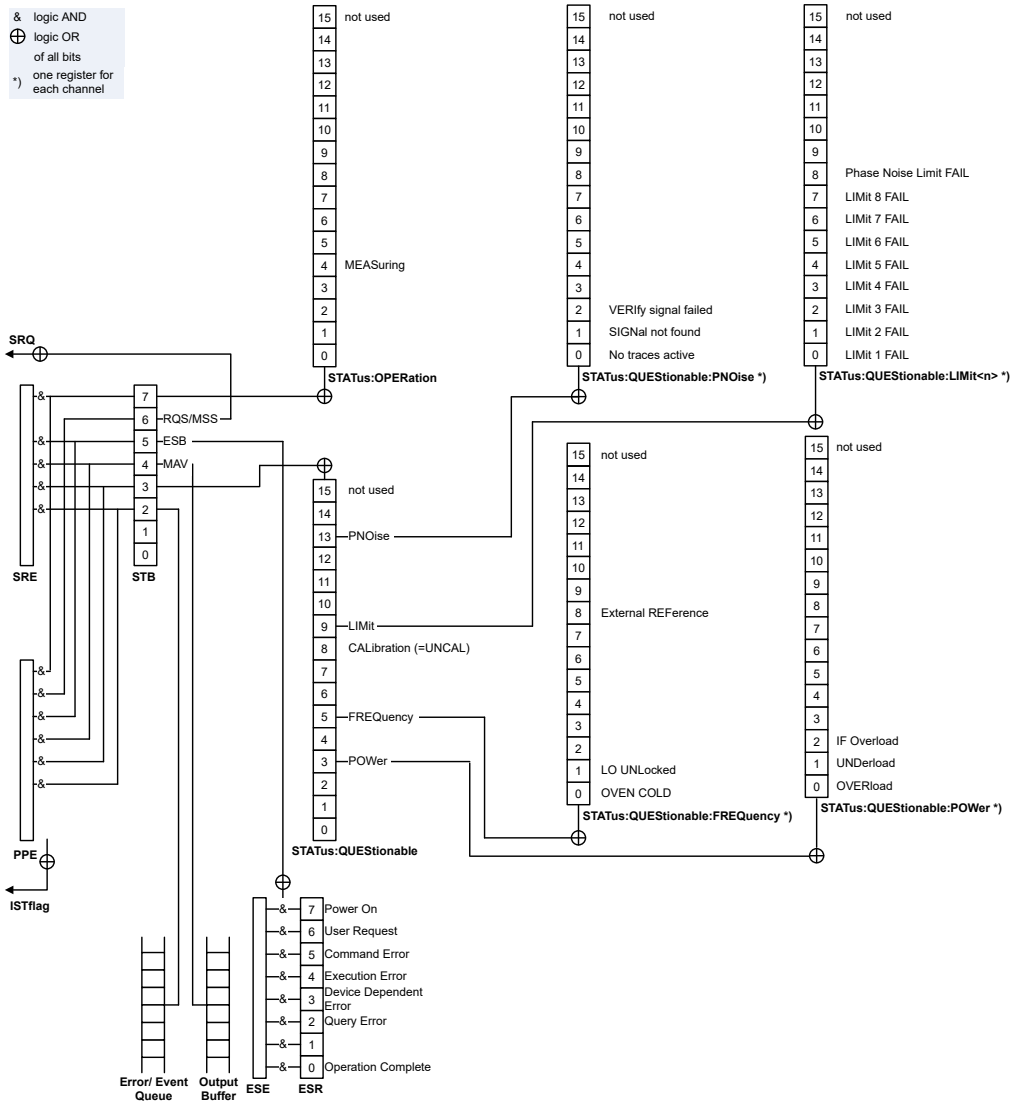

Figure 6-2: Status registers for phase noise measurements

The R&S FSMR3 structures the information hierarchically, with the Status Byte register (STB) and the Service Request Enable mask register (SRE) being on the highest level. The STB gets its information from the standard Event Status Register (ESR) and the Event Status Enable mask register (ESE). The STB and ESR are both defined by IEEE 488.2. In addition to the ESR, the STB also gets information from the STATus:OPERation and STATus:QUEStionable registers. These are the link to the lower levels of the status register and are defined by SCPI. They contain information about the state of the instrument.

For a more comprehensive description of the status registers not mentioned here and status register functionality in general see the manual of the base unit.

- STATus:QUEStionable register 215
- STATus:QUEStionable:POWer register 215
- STATus:QUEStionable:LIMit register 216
- STATus:QUEStionable:PNOise register 216
- Status register remote commands 217

6.7.1.1 STATus:QUEStionable register

The `STATus:QUEStionable` register contains information about indefinite states which may occur if the unit is operated without meeting the specifications.

Bit no	Meaning
0 to 2	Unavailable for phase noise measurements.
3	POWer This bit is set if a questionable power occurs.
5 to 7	Unavailable for phase noise measurements.
8	CALibration This bit is set if the R&S FSMR3 is not calibrated.
9	LIMit This bit is set if a limit line is violated.
10-12	Unavailable for phase noise measurements.
13	PNOise This bit is set if the phase noise measurement is questionable.
14	Unavailable for phase noise measurements.
15	This bit is always 0.

6.7.1.2 STATus:QUEStionable:POWer register

The `STATus:QUEStionable:POWer` register contains information about possible overload situations that may occur during operation of the R&S FSMR3.

Bit no	Meaning
0	OVERload This bit is set if an overload occurs at the RF input.
1	UNDerload This bit is set if an underload occurs at the RF input.
2	IF OVerload This bit is set if an overload occurs in the IF path.
3 to 14	Unavailable for phase noise measurements.
15	This bit is always 0.

6.7.1.3 STATus:QUEStionable:LIMit register

The `STATus:QUEStionable:LIMit` register contains information about limit lines and the results of a limit checks.

The number of LIMit registers depends on the number of measurement windows available in any application.

Bit no	Meaning
0	LIMit 1 FAIL This bit is set if limit line 1 is violated.
1	LIMit 2 FAIL This bit is set if limit line 2 is violated.
2	LIMit 3 FAIL This bit is set if limit line 3 is violated.
3	LIMit 4 FAIL This bit is set if limit line 4 is violated.
4	LIMit 5 FAIL This bit is set if limit line 5 is violated.
5	LIMit 6 FAIL This bit is set if limit line 6 is violated.
6	LIMit 7 FAIL This bit is set if limit line 7 is violated.
7	LIMit 8 FAIL This bit is set if limit line 8 is violated.
8	Phase Noise LIMit FAIL This bit is set if a limit of the phase noise limit line is violated.
9 to 14	Unavailable for phase noise measurements.
15	This bit is always 0.

6.7.1.4 STATus:QUEStionable:PNOise register

The `STATus:QUEStionable:PNOise` register contains information about the status of phase noise measurements.

Bit no	Meaning
0	No trace are active This bit is set if no trace is on.
1	SIGNal not found This bit is set if no valid signal could be found.
2	VERify This bit is set if signal verification has failed.

Bit no	Meaning
3 to 14	Unavailable for phase noise measurements.
15	This bit is always 0.

6.7.1.5 Status register remote commands

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STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:LIMit[:EVENt]? <ChannelName>
STATus:QUEStionable:PNOise[:EVENt]? <ChannelName>
STATus:QUEStionable:POWer[:EVENt]? <ChannelName>

These commands read out the EVENt section of the status register.

The commands at the same time delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:LIMit:CONDition? <ChannelName>
STATus:QUEStionable:PNOise:CONDition? <ChannelName>
STATus:QUEStionable:POWer:CONDition? <ChannelName>

These commands read out the CONDition section of the status register.

The commands do not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:OPERation:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:PNOise:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:POWer:ENABle <SumBit>,<ChannelName>

These commands control the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:OPERation:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:PNOise:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:POWer:NTRansition <SumBit>,<ChannelName>

These commands control the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:OPERation:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:PNOise:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:POWer:PTRansition <SumBit>,<ChannelName>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:
<SumBit> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

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