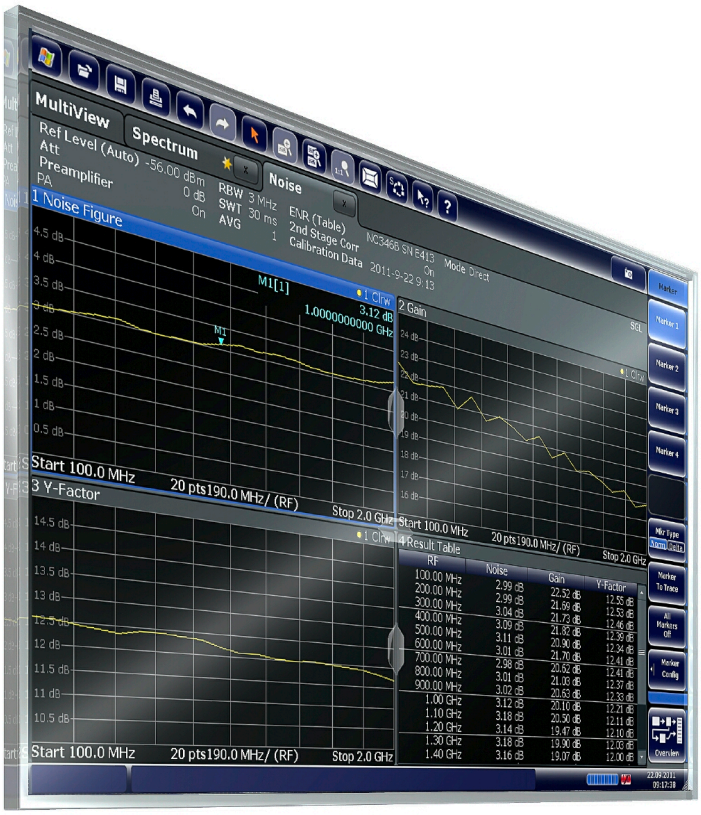
R&S®FSW-K30
Noise Figure Measurements
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 1.51 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)

The following firmware options are described:

- R&S FSW-K30 (1313.1380.02)

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Printed in Germany – Subject to change – Data without tolerance limits is not binding.

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

Contents

1 Preface

1.1 About this Manual

This User Manual provides all the information **specific to the application**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FSW User Manual.

The main focus in this manual is on the measurement results and the tasks required to obtain them. The following topics are included:

- **Welcome to the Noise Figure Application**
  Introduction to and getting familiar with the application
- **Typical applications**
  Example measurement scenarios in which the application is frequently used.
- **Measurements and Result Displays**
  Details on supported measurements and their result types
- **Noise Figure Measurement Basics**
  Background information on basic terms and principles in the context of the measurement
- **Noise Figure Measurement Configuration + Analysis**
  A concise description of all functions and settings available to configure measurements and analyze results with their corresponding remote control command
- **How to Perform Measurements with the Noise Figure Application**
  The basic procedure to perform each measurement and step-by-step instructions for more complex tasks or alternative methods
- **Measurement Examples**
  Detailed measurement examples to guide you through typical measurement scenarios and allow you to try out the application immediately
- **Optimizing and Troubleshooting the Measurement**
  Hints and tips on how to handle errors and optimize the test setup
- **Remote Commands for Noise Figure Measurements**
  Remote commands required to configure and perform noise figure measurements in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FSW User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Annex**
  Reference material
- **List of remote commands**
  Alpahabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

The user documentation for the R&S FSW consists of the following parts:

- "Getting Started" printed manual
- Online Help system on the instrument
- Documentation CD-ROM with:
  - Getting Started
  - User Manuals for base unit and options
  - Service Manual
  - Release Notes
  - Data sheet and product brochures

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. Online help is available using the icon on the toolbar of the R&S FSW.

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

The Getting Started manual in various languages is also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html.

User Manuals

User manuals are provided for the base unit and each additional (software) option.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FSW in general, and the Spectrum application in particular. Furthermore, the software functions that enhance the basic functionality for various applications are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual application manuals, the specific instrument functions of the application are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FSW is not included in the application manuals.

All user manuals are also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html.

Service Manual

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSW by replacing modules.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes.

The most recent release notes are also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html > Downloads > Firmware.

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.3.2 Conventions for Procedure Descriptions

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

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

2 Welcome to the Noise Figure Measurement Application

The R&S FSW-K30 is a firmware application that adds functionality to perform noise figure measurements to the R&S FSW.

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

All functions not discussed in this manual are the same as in the base unit and are described in the R&S FSW User Manual. The latest version is available for download at the product homepage (http://www2.rohde-schwarz.com/product/FSW.html).

Installation

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

2.1 Starting the Application

The noise figure measurement application adds a new type of measurement to the R&S FSW.

To activate the the Noise Figure application

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

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

2. Select the "Noise" item.

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

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 (including the "MultiView") as the measurements are performed. Sequential operation itself is independant of the currently *displayed* tab.

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

2.2 Understanding the Display Information

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

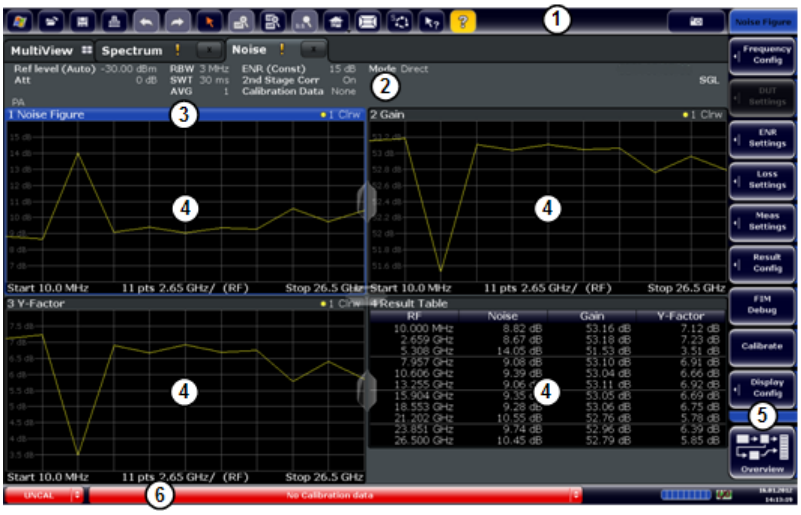


Fig. 2-1: Screen layout of the noise figure measurement application

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

Channel bar information

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

Fig. 2-2: Channel bar of the Noise Figure application

Ref Level	Reference level of the R&S FSW.
Att	Attenuation of the R&S FSW.
RBW	Resolution bandwidth
SWT	Sweep time
AVG	Number of averages
ENR	Excess noise ratio
2nd Stage Corr	State of the 2nd stage correction.
Calibration Data	Date and time of the current calibration data.
Mode	Currently selected measurement mode.

Window title bar information

For each diagram, the header provides the following information:

Fig. 2-3: Window title bar information for the Noise Figure application

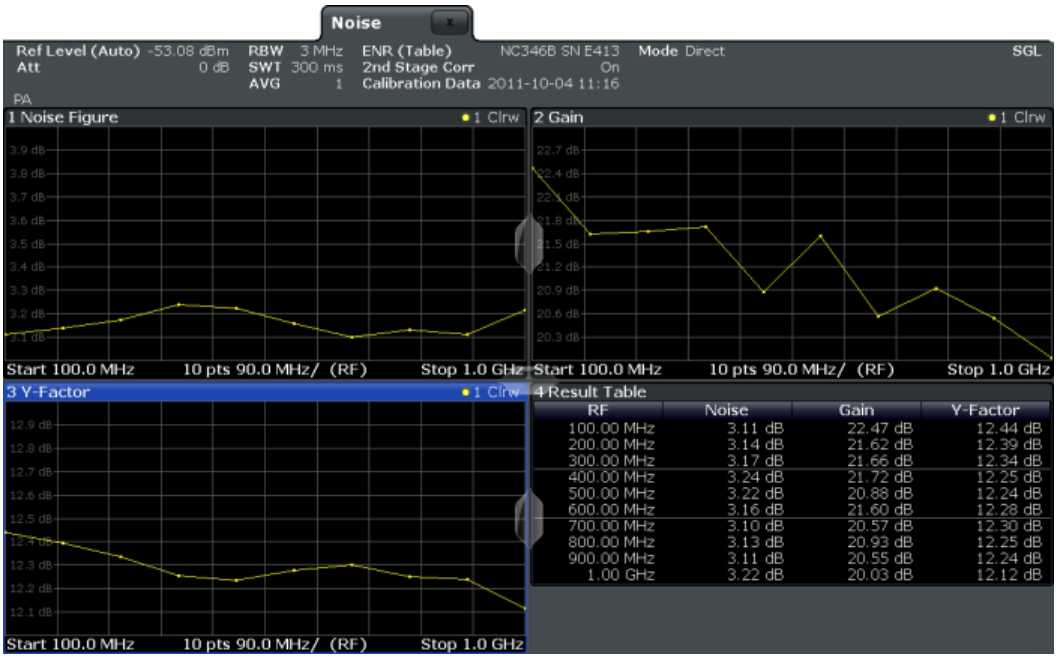
1 = Window number
2 = Window type
3 = Trace color and number
4 = Trace mode

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.

3 Measurements and Result Displays

The R&S FSW-K30 measures the noise figure of a DUT and displays the results graphically and numerically. Each graphical result display shows the noise figure from a different perspective that may be relevant. In the default configuration, the application shows the Noise Figure of the DUT, the Gain of the DUT and the corresponding Y-Factor. In addition it shows the numerical results of the measurement.



In all graphical result displays, the horizontal axis represents the frequency. The displayed frequency is either the RF (radio frequency) or the IF (intermediary frequency). The range depends on the frequency set you have currently defined. Because the application only measures selected frequencies, it connects the results to draw a trace.

Negative noise figure and noise temperature

From a physical point of view, the noise figure and the noise temperature have a positive range of level values (including zero).

However, the application may also show negative values in some cases that are based on the mathematical operations the application performs. The reasons may be, for example, measurement or calibration inaccuracies.

Selecting the result display

► Select the icon in the toolbar or press the MEAS key.

The application enters the SmartGrid configuration mode.

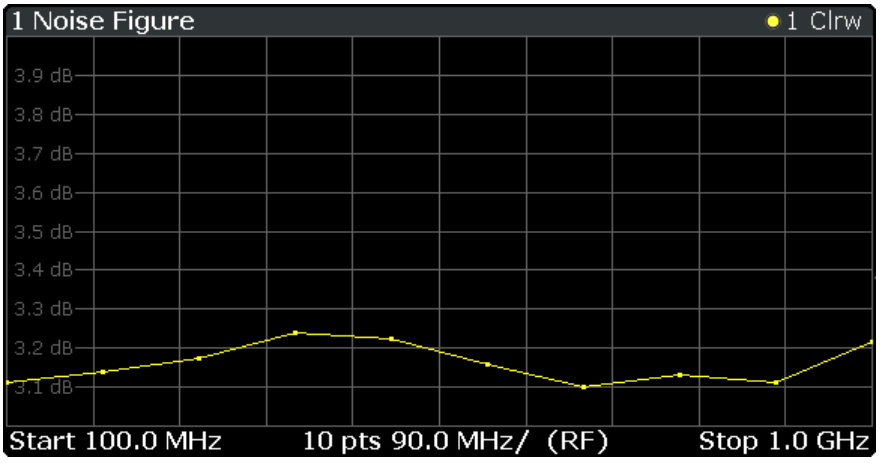
For more information on the SmartGrid functionality see the R&S FSW Getting Started.

Noise Figure
Shows the noise figure of the DUT.

The noise figure is the ratio of the signal-to-noise ratio at the DUT input to that at the DUT output.

$$\text{Noise Figure} = \frac{SNR_{in}}{SNR_{out}}$$

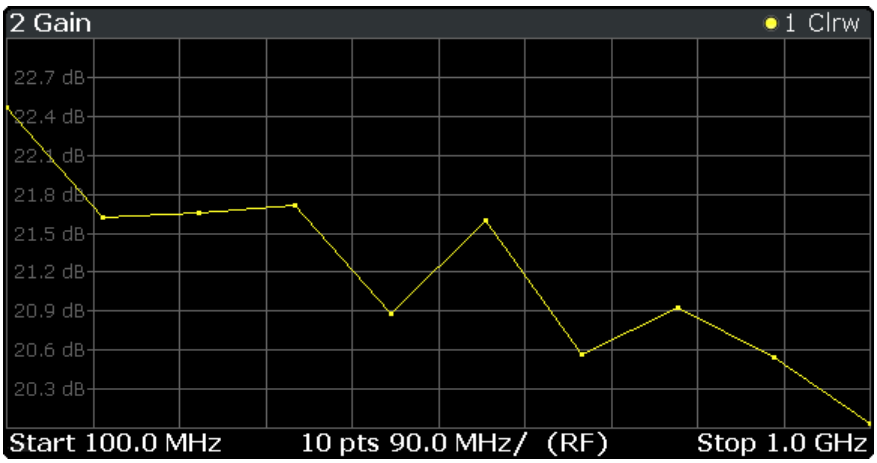
The vertical axis shows the level of the noise figure in dB. The scale depends on the settings in the "Display Configuration" dialog box.



SCPI command:
TRACe<t>[:DATA] NFIGure

Gain
Shows the gain characteristics of the DUT.

The vertical axis shows the level of the gain in dB. The scale depends on the settings in the "Display Configuration" dialog box.



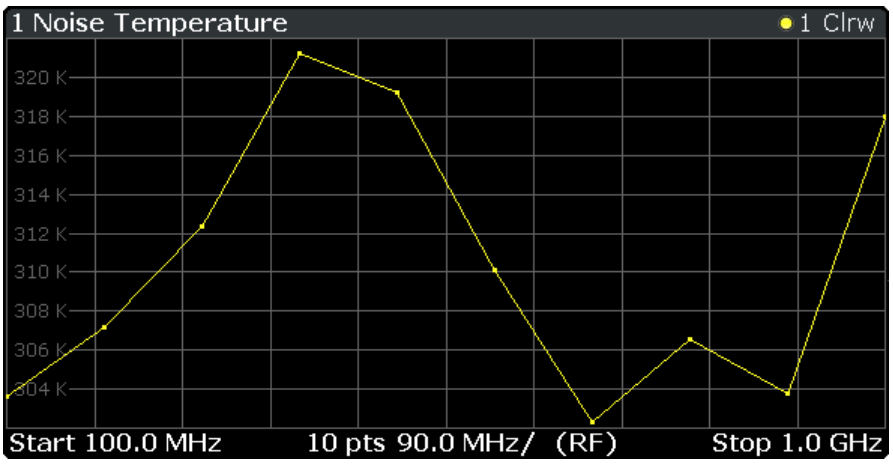
SCPI command:
TRACe<t>[:DATA] GAIN

Noise Temperature
Shows the noise temperature characteristics of the DUT.

$$\text{Noise Temperature} = \frac{P}{B \cdot k}$$

with
P = Power
B = Bandwidth
k = Boltzmann constant

The vertical axis shows the noise temperature in Kelvin. The scale depends on the settings in the "Display Configuration" dialog box.



SCPI command:
TRACe<t>[:DATA] TEMPerature

Y-Factor
Shows the ratio of the hot and the cold power of the DUT.

The Y-factor indicates the quality of measurement tolerances and uncertainties. To get the result, the application measures the DUT power with the noise source turned on (hot power) and the noise source turned off (cold power).

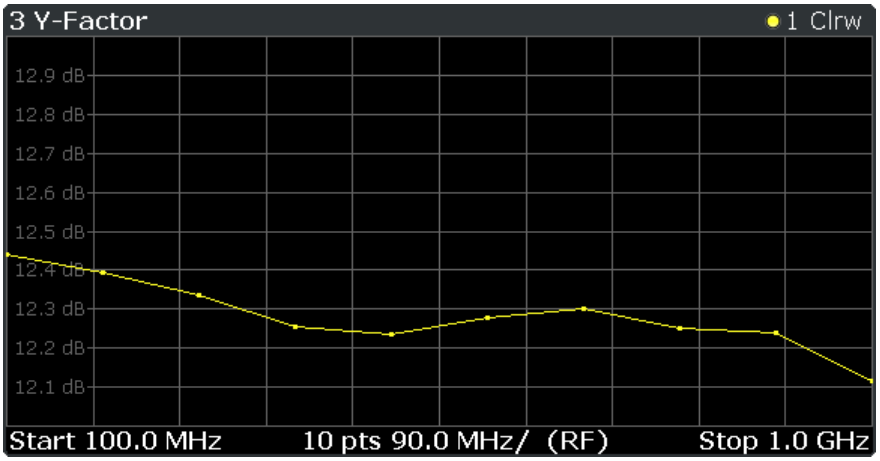
$$\text{Y}-\text{Factor} = \frac{N_{on}}{N_{off}}$$

with

N_{on} = Noise power [dB] with noise source on

N_{off} = Noise power [dB] with noise source off

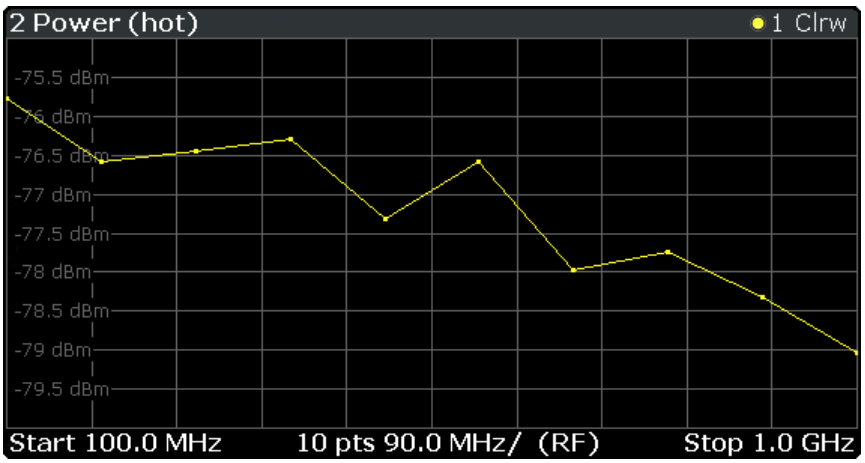
The vertical axis shows the linear relation. The scale depends on the settings in the "Display Configuration" dialog box.



SCPI command:
TRACe<t>[:DATA] YFACtor

Power (Hot)
Shows the absolute power characteristics at the instrument input. The noise source is turned on.

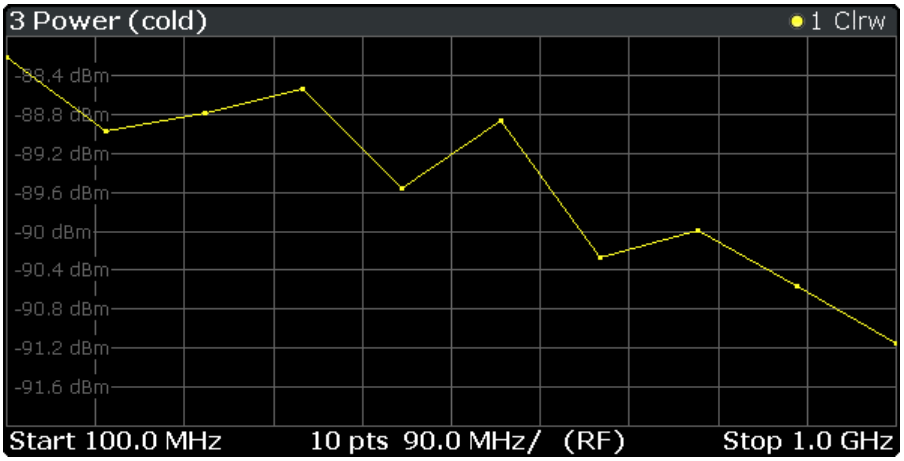
The vertical axis shows the power in dBm. The scale depends on the settings in the "Display Configuration" dialog box.



SCPI command:
TRACe<t>[:DATA] PHOT

Power (Cold)
Shows the absolute power characteristics at the instrument input. The noise source is turned off.

The vertical axis shows the power in dBm. The scale depends on the settings in the "Display Configuration" dialog box.



SCPI command:
TRACe<t>[:DATA] PCOLd

Result List
Shows the measurement results in numerical form in a table.

The contents of the table depend on the "Display Settings". By default it shows the results for the Noise Figure, Gain and Y-Factor result type. Each row represents one measurement point. Each column represents one result type. The first column shows the measurement frequency.

If you display the uncertainty result, it is displayed in the Noise column next to the Noise Figure result. Note that the uncertainty is displayed only after you have turned on the uncertainty calculation and also include the result in the display.

The result table shows either the RF or the IF, depending on you selection.

For more information see chapter 6.1.2, "Configuring Numerical Results", on page 56.

4 Result Table

RF	Noise	Gain	Y-Factor
100.00 MHz	3.11 dB	22.47 dB	12.44 dB
200.00 MHz	3.14 dB	21.62 dB	12.39 dB
300.00 MHz	3.17 dB	21.66 dB	12.34 dB
400.00 MHz	3.24 dB	21.72 dB	12.25 dB
500.00 MHz	3.22 dB	20.88 dB	12.24 dB
600.00 MHz	3.16 dB	21.60 dB	12.28 dB
700.00 MHz	3.10 dB	20.57 dB	12.30 dB
800.00 MHz	3.13 dB	20.93 dB	12.25 dB
900.00 MHz	3.11 dB	20.55 dB	12.24 dB
1.00 GHz	3.22 dB	20.03 dB	12.12 dB

SCPI command:

`TRACe<n>[:DATA]?` on page 78

Marker Table

Shows the marker characteristics in numerical form in a table.

The size of the table depends on the number of active markers and the way you have configured the table in the "Result Config" dialog box. For more information see chapter 6.3, "Using Markers", on page 58 and chapter 6.1.2, "Configuring Numerical Results", on page 56.

4 Marker Table

Type	Ref	Trc	Stimulus	Noise	Gain
N1		1	400.00 MHz	3.24 dB	21.72 dB
D2	N1	1	100.00 MHz	-0.01 dB	-0.84 dB
D3	N1	1	200.00 MHz	-0.08 dB	-0.12 dB

The first four columns of the table are fix.

- Type
  Shows the marker type. 'M' represents a normal marker, 'D' represents a delta marker.
- Ref
  Shows the reference marker for relative delta markers.
- Trc
  Shows the trace the marker is positioned on.
- Stimulus
  Shows the horizontal position (frequency) of the marker.
  In case of normal markers, the position is an absolute value. The position of delta markers are relative to another marker.
- <Result>
  Shows the measurement result at the marker position.
  In case of normal markers, the result is an absolute value. Results for delta markers are relative to another marker.

SCPI command:

`CALCulate<n>:MARKer<m>:Y?` on page 114

`CALCulate<n>:DELTamarker<m>:Y?` on page 117

Current
Shows the result at the current measurement point.

The contents of the "Current" result display are updated as soon as a new measurement point is analyzed.

The result types shown in the table depend on the "Display Settings". By default it shows the results for the Noise Figure, Gain and Y-Factor result type. Each row represents one result type. The first column shows the result type, the second column shows the result.

For more information see chapter 6.1.2, "Configuring Numerical Results", on page 56.

4 Measurement Basics

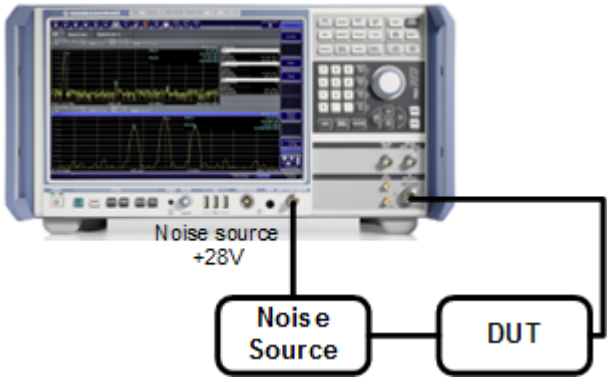
The measurement basics contain background information on the terminology and principles of noise measurements.

Noise figure measurements determine the noise that a device under test (DUT) adds to a signal as that signal passes through the DUT.

4.1 Tuning Modes

Basically, the application calculates the noise figure of a DUT based on the characteristics of the DUT that have been measured and a noise source whose properties are known.

In addition to the noise characteristics of a DUT, the application is also able to determine several more DUT characteristics like its gain or its noise temperature characteristics.



The application provides several measurement modes or **tuning modes**.

4.1.1 Swept Measurements

The **sweep** tuning mode performs measurements on a set of discrete frequencies based on the frequency parameters. Each measurement analyzes the noise characteristics of the corresponding frequency or measurement point.

For swept measurements, the application automatically determines the measurement frequencies and combines them in a frequency list.

Such a frequency set is the result of the frequency and span information that you have provided. The frequency and span information is made up out of the center frequency,

the span, the start and the stop frequency. In combination with the measurement points or the frequency table step size, the application calculates the contents of the frequency table.

The **center frequency** is the frequency in the center of the frequency band you are measuring. Thus, it is defined either by the span or the start and stop frequencies.

The **measurement points** is the number of entries in a frequency list and thus the number of measurements that the application performs during a noise figure measurement.

The **stepsize** defines the distance between two measurement points. It is constant for all measurement points.

If the stepsize is larger than the distance between start and stop frequency, the frequency table consists of the start and stop frequencies only.

4.1.2 Frequency List Measurements

The **frequency list** tuning mode also performs measurements on a set of frequencies based on the contents of a frequency list. Each measurement analyzes the noise characteristics of the corresponding frequency.

Compared to a swept measurement, you can customize the contents of the frequency list. Thus, you can add frequencies that are independent of the frequency stepsize and the number of measurement points.

4.2 DUT Types

Noise figure measurements are possible on DUTs with a wide variety of characteristics. The DUT characteristics are important to know because they not only have an effect on the test setup, but also determine the way the application populates the frequency list in case of swept measurements.

The R&S FSW-K30 supports measurements on DUTs that work on a fixed frequency as well as measurements on frequency-converting DUTs.

4.2.1 Measurements on Linear DUTs

In case of a linear DUT, the RF frequency remains the same between its input and output. For measurements on such DUTs, it is sufficient to measure the signal's RF frequency without any additional equipment (like a local oscillator). A typical linear DUT is, for example, an amplifier.

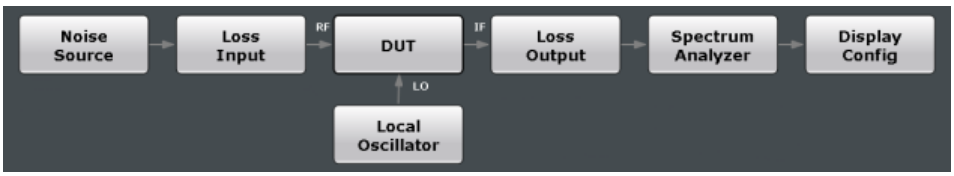
The test setup for measurements on such DUTs usually consists of the noise source, the DUT and an analyzer. If necessary, the measurement also considers loss that might occur somewhere in the measurement path.

If you are measuring linear DUTs, the contents and layout of the "Overview" dialog box represents the configuration of a typical test setup.

4.2.2 Measurements on Frequency Converting DUTs

A frequency converting DUT converts the RF frequency to an intermediate frequency (IF) using the local oscillator. A frequency-converting DUT either converts the RF frequency to a lower IF (down-conversion) or a higher IF (up-conversion).

If you have selected a frequency-converting DUT measurement mode, the layout of the "Overview" dialog box adds the local oscillator to the test setup.



Fixed LO frequency

If you select one of the fixed LO measurement modes, the LO frequency is the same for all entries in the frequency list. The IF frequency for each entry is variable and is the result of the equation the selected mode is based on.

- $f_{RF} + f_{LO}$ for up-converters
- $f_{RF} - f_{LO}$ for down-converters

The fixed LO measurement modes are, for example, required for measurements on satellite converters.

4.3 Image Frequency Rejection

Frequency converting DUTs convert a radio frequency (RF) to an intermediate frequency (IF). The IF is lower than the RF in case of down-converting DUTs and higher than the RF in case of up-converting DUTs.

In a basic test setup, the image frequency of the RF signal is also converted to the IF. Depending on the DUT, this effect may be wanted or even necessary, or not. To avoid measurement errors of the noise figure and gain of up to 3 dB, make sure to use the appropriate measurement configuration.

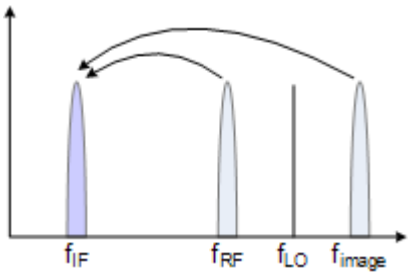
Basically, you can distinguish between single sideband (SSB) mixers and double sideband (DSB) mixers or those that partly suppress a sideband. If a sideband is not needed or only partly needed, you can reject the image frequency. If you do so, the application activates a filter that suppresses the image frequency to a certain extent.

The following illustrations help you to configure the measurement in order to measure correctly.

For more information on how to configure image rejection see "Image Rejection" on page 38.

Double sideband measurements

Double sideband mixers use both sidebands to the same extent. Both RF and image frequency should be converted. In that case, you have to turn image rejection off.

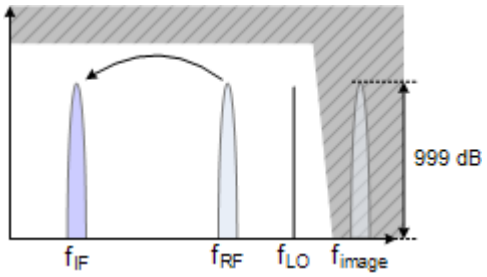


f_{LO} = frequency of the local oscillator
f_{IF} = intermediary frequency = $f_{RF} \pm f_{LO}$
f_{RF} = lower sideband = $f_{LO} - f_{IF}$
f_{image} = upper sideband = $f_{LO} + f_{IF}$

If image rejection is on, the results have a 3 dB error - noise figure results are 3 dB lower than they should be, gain results are 3 dB higher than in reality.

Single sideband measurements

Single sideband mixers use a single sideband only. In that case, you have to suppress the sideband that is not required. If you do so, the measurement is pretty straightforward and works like a measurement on an amplifier.

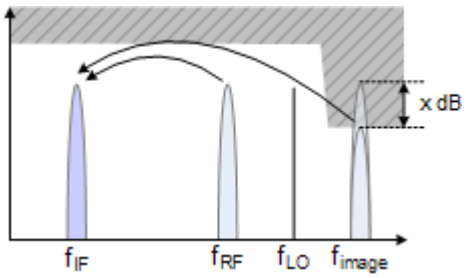


To suppress a sideband completely, it is best to set the image rejection to the maximum amount possible (999.99 dB).

Partial sideband suppression

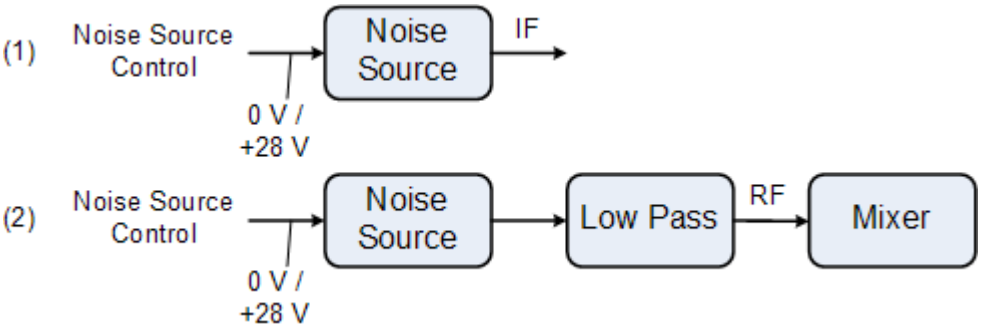
For measurements on mixers with a low image frequency rejection, there are two test scenarios.

- Mixers whose image rejection is known.
- Mixers whose image rejection is unknown.



In case of mixers whose image rejection is known, define the magnitude of image rejection in dB as accurate as possible. Else, measurement results (noise figure and gain) will deviate between 0 dB to 3 dB.

For accurate measurements on mixers whose image rejection characteristics are unkown a custom test setup including an additional filter is required. You also have to know the gain characteristics of the DUT.



(1) = Test setup for calibration
(2) = Test setup for noise measurement

In the test setup shown above, a lowpass filter prevents unwanted noise from being fed in at the image frequency.

Depending on the position of the frequency bands, a highpass or bandpass filter may also be necessary for the RF frequency instead of the lowpass filter. The important point is that unwanted noise is not converted by a further receive path of the mixer. The unwanted noise at the receive frequency must not be reduced. The insertion loss must be considered, if applicable.

With this test setup, the measurement on a mixer without sideband suppression is the same as SSB measurements.

To take the characteristics of the filter into account, include the insertion loss of the filter at the RF. To consider the actual filter suppression at the image frequency, include the actual attenuation for the image rejection.

Harmonics mixer measurement

For a harmonics mixer, the input signals are not only converted to the IF by the wanted harmonic, but also by the harmonic of the LO signal produced in the mixer. In many cases, the mixer even features a lower conversion loss in the case of unwanted harmonics. For measurements on this type of mixer, you have to use a bandpass filter to make sure that

that there is only noise at the desired input frequency at the input of the DUT. This measurement is similar to measurements on a mixer with an average sideband suppression.

4.4 Calibration (2nd Stage Correction)

The calibration procedure of the application measures the inherent noise of the R&S FSW you are using. Performing calibration therefore is recommended as it increases the accuracy of measurement results. The results get more accurate because the application takes the inherent noise of the analyzer into account while it calculates the results.

Calibration for noise figure measurements is also known as 2nd stage correction. This term is used because in a typical noise figure test setup, the DUT represents the first stage and the analyzer the second stage in the test setup.

The 2nd stage correction is a calibration that is specific to noise figure measurements. It is independent of the overall calibration state of the analyzer and does not calibrate the analyzer.

For successful calibration, you need additional equipment.

- Noise source
  The noise source is like a calibration standard. It provides a reference with known noise characteristics that allows the application to determine the inherent noise of the analyzer you are using.

During the calibration, the application measures the inherent noise characteristics of the analyzer at the set of measurement frequencies.

Thus, the 2nd stage correction is valid for a particular instrument configuration, the room temperature and the instrument temperature. As long as this configuration stays the same, calibration data remains valid.

- Interpolation
  If you change the frequency and the frequency span stays the same or gets smaller, the application interpolates the correction data for the new measurement points instead of requesting a new calibration.
  Measurements based on interpolated data might result in an increased measurement uncertainty. Highly accurate measurements that are conform to the values specified in the data sheet are only possible at calibrated measurement points.
  Note that useful interpolation is possible only if essential calibration parameters (e.g. impedance or attenuation) change only slightly. This is the case if the distance between the original calibration points has been sufficiently small.
  If the span increases compared to the span during calibration, a new calibration is necessary.
  If the application interpolates the caibration data, it shows a corresponding label in the channel bar and a warning message in the status bar.
- Invalid calibration
  If you change one of the amplitude parameters (e.g. the attenuation), calibration is labeled invalid. In that case, calibration is not accurate, because the settings are not in line with the settings at the time the R&S FSW has been calibrated. If calibration

is invalid, repeat the calibration or restore the settings as they were during the calibration.

Saving calibration data

If you save the current configuration or measurement results to a data set, calibration data is part of that data set.

For more information on saving and restoring data sets see chapter "Storing and Recalling Instrument Settings and Measurement Data" in the user manual of the R&S FSW.

The picture below shows a typical calibration setup that includes a noise source.

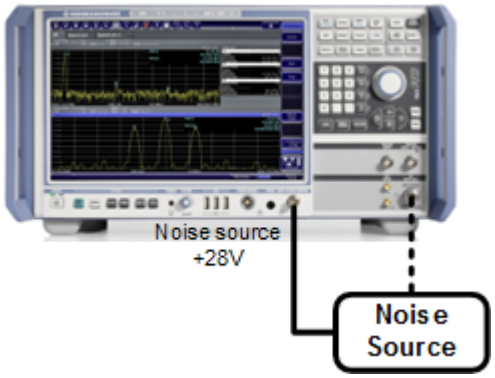


Fig. 4-1: Noise figure calibration setup

1. Connect the noise source directly and without a cable to the RF input of the analyzer.
2. Connect the noise source to the +28 V voltage supply (Noise Source interface) on the back of the R&S FSW.
   To connect the noise source to the voltage supply, you need a coaxial cable.

After you have set up calibration, there are several ways to start calibration.

- In the "Noise Overview" dialog box, press the "Calibrate" button.
- In the "Sweep" menu, press the "Calibrate" softkey.

4.5 Separating Signals by Selecting an Appropriate Resolution Bandwidth

The resolution bandwidth defines the 3 dB bandwidth of the resolution filter to be used. An RF sinusoidal signal is displayed according to the passband characteristic of the resolution filter (RBW), i.e. the signal display reflects the shape of the filter.

The highest sensitivity is obtained at the smallest bandwidth (1 Hz). If the bandwidth is increased, the reduction in sensitivity is proportional to the change in bandwidth. Increasing the bandwidth by a factor of 3 increases the displayed noise by approx. 5 dB (4.77

dB precisely). If the bandwidth is increased by a factor of 10, the displayed noise increases by a factor of 10, i.e. 10 dB.

The higher spectral resolution with smaller bandwidths is won by longer sweep times for the same span. The sweep time has to allow the resolution filters to settle during a sweep at all signal levels and frequencies to be displayed.

If the RBW is too large, signal parts that are very far away (e.g. from a different signal) are considered in the measurement and distort the results. The displayed noise increases.

If the RBW is too small, the measurement time increases.

4.6 Analyzing Several Traces - Trace Mode

The trace mode determines the way the data is processed and displayed. The application provides the following trace modes.

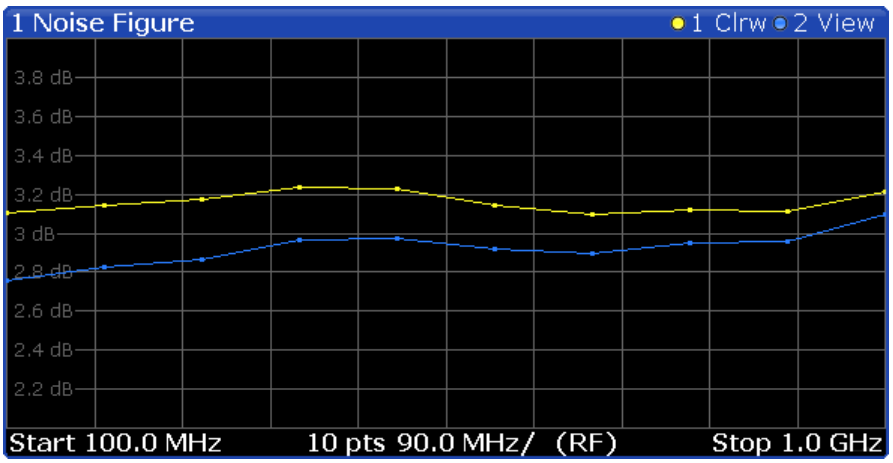
Table 4-1: Overview of available trace modes

Trace Mode	Description
Blank	Hides the selected trace.
Clear Write	Overwrite mode: the trace is overwritten by each sweep. This is the default setting.
View	The current contents of the trace memory are frozen and displayed.

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

The default trace mode for the first trace is Clear/Write. For trace 2-4, the deafult trace mode is Blank. If you require another mode, you have to set it manually.

As you can have up to four traces simultaneously, you can compare the results with different measurement configurations, e.g. if you freeze a trace and use it as a memory trace.



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

If you change the scaling of the y-axis, the R&S FSW automatically adapts the trace data to the changed display range. This allows an amplitude zoom to be made after the measurement in order to show details of the trace.

4.7 Using Markers

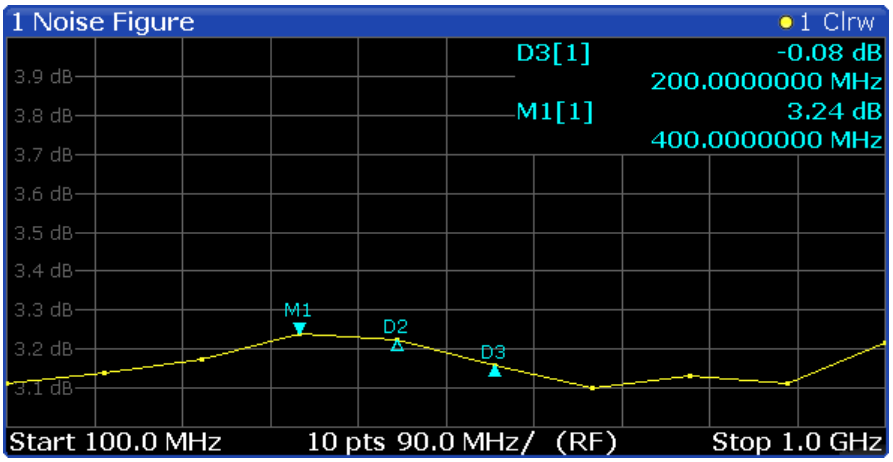
Markers are used to mark points on traces, to read out the results of a particular measurement point or compare results of different traces. The noise application provides four markers.

When you activate a marker, the application automatically positions it on the first measurement point (left border of the diagram) of trace 1, regardless of how many traces are active. A marker is always positioned on the same horizontal position in all active measurement windows. If you change the position of a marker in one window, the application adjusts the position of that marker in all other measurement windows. Thus, the marker results for a specific marker are always for the same frequency, which makes it easier to compare results.

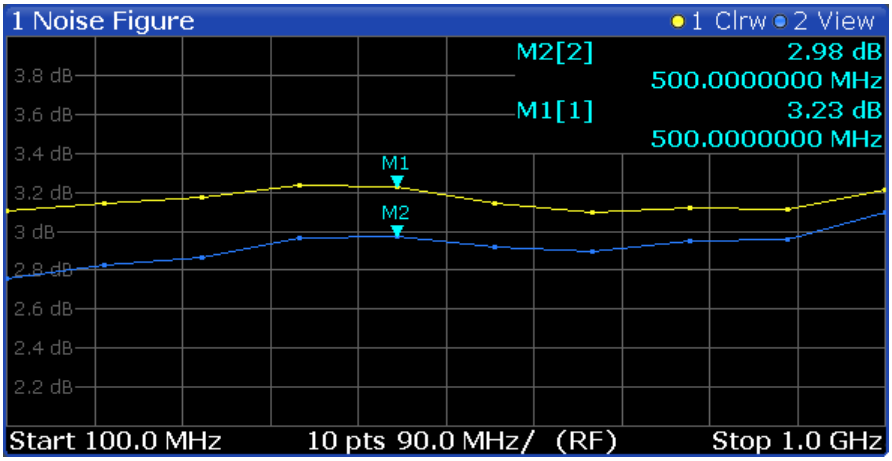
To move a marker, you can use several methods.

- Enter a particular measurement frequency in the input field that opens when you activate a marker.
- Move the marker around with the rotary knob or the cursor keys.
- Drag the marker around using the touchscreen.

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



The application always positions the marker on the trace with the lowest number that is in Clear/Write trace mode. To set the marker on another trace, use the Marker to Trace function. With this function, you can also position a marker on a trace that is in View trace mode, e.g. to compare measurement results. Note that at least one active marker has to be a normal marker.



The application shows the results at the marker position directly in the diagram area (up to two markers) or in the marker table (if you use more than two markers).

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 4)
- The assigned trace number in square brackets [ ]
- The marker value (response) on the y-axis
- The marker position (stimulus) 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 in a separate window. For more information on the contents of the marker table see "Marker Table" on page 19.

5 Configuration

Noise figure measurements require a special application on the R&S FSW, which you activate using the MODE key on the front panel.

When you activate a measurement channel in the Noise application, a measurement for the input signal is started automatically with the default configuration. The "Noise Figure" menu is displayed and provides access to the most important configuration functions.

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

The R&S FSW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before accepting the changes.

5.1 Configuration 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. Noise Source
   See chapter 5.5, "Configuring the Noise Source", on page 38.
2. Spectrum Analyzer
   See chapter 5.7, "Configuring the Analyzer", on page 46.
3. Input and Output Losses
   See chapter 5.6, "Configuring Additional Loss", on page 43.

To configure settings

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

Preset Channel

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

Note that the PRESET key on the front panel restores all measurements **in all measurement channels** on the R&S FSW to their default values!

For details see chapter 5.2, "Default Settings for Noise Measurements", on page 33.

SCPI command:

`SYSTem:PRESet:CHANnel[:EXECute]` on page 73

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

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

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

5.2 Default Settings for Noise Measurements

After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

Apart from these settings, the following default settings are activated directly after a measurement channel has been set to the Noise Figure application, or after a channel preset:

Table 5-1: Default settings for phase noise measurement channels

Parameter	Value
Center frequency	$f_{max}/2$
Span	f_{max}
RBW	1 MHz
Reference level	Auto
Attenuation	0 dB
Sweep time	30 ms
Averages	1
ENR	Constant (15 dB)
2nd stage correction	On
Mode	Direct
Temperature	20 °C
Loss (input & output)	Constant (0 dB)
Settling time	50 ms
Preamplifier	On (30 dB)

5.3 Defining the Measurement Frequency

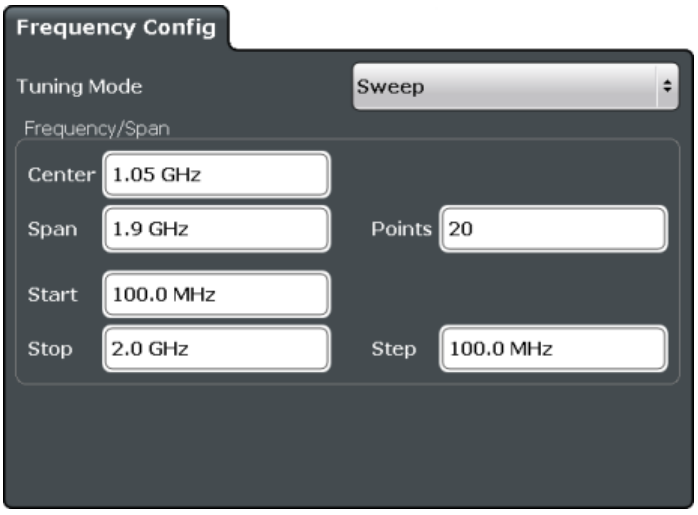
The "DUT" button or the "Frequency Settings" softkey open a dialog to configure the measurement frequencies.

5.3.1 Defining a Frequency Set

The "Frequency Config" tab in the "Frequency Settings" dialog box contains settings that define the frequency characteristics for the measurement.

The information in this tab is also the basis for an automatic population of the frequency table. All parameters of this dialog are interdependent. If you change one parameter, at least one other parameter will be changed by the application.

In order to get accurate results, changing a frequency set may require a new calibration.



Tuning Mode
Selects the tuning or measurement mode.

For more information see chapter 4.1, "Tuning Modes", on page 21.

"Sweep" The measurement is based on an automatically generated frequency set.

"Frequency Table" The measurement is based on a customized frequency table.

SCPI command:
Frequency list measurement (continuous sweep):
`CONFigure:LIST:CONTinuous` on page 79
Frequency list measurement (single sweep):
`CONFigure:LIST:SINGLe` on page 79

Center
Defines the center of the measurement frequency range.

If you change the center frequency, the application will change the start and stop frequency according to the span you have set.

The "Center" setting is also available via the FREQ key.

SCPI command:
`[SENSe:]FREQuency:CENter` on page 79

Span
Defines the measurement span.

If you change the span, the application will change the start frequency, the stop frequency and the stepsize according to the center frequency and the measurement points.

The "Span" setting is also available via the SPAN key.

SCPI command:
`[SENSe:]FREQuency:SPAN` on page 80

Start and Stop Frequency
Defines the start and stop frequencies.

If you change the start or stop frequency, the application will change the center frequency, the span and the measurement points according to the stop or start frequency and the stepsize.

The "Start" and "Stop" settings are also available via the FREQ key.

SCPI command:
Start frequency:
`[SENSe:]FREQuency:STARt` on page 80
Stopf frequency:
`[SENSe:]FREQuency:STOP` on page 81

(Measurement) Points
Defines the measurement points.

The number of measurement point corresponds to the number of entries in the frequency table.

If you change the measurement points, the application will change the stepsize according to the span.

The "Points" setting is also available via the SPAN key.

SCPI command:
`[SENSe:]SWEep:POINts` on page 80

Step
Defines the frequency step size in the frequency table.

The stepsize corresponds to the distance between two consecutive measurement points.

If you change the stepsize, the application will change the measurement point according to the span.

The "Stepsize" setting is also available via the FREQ key.

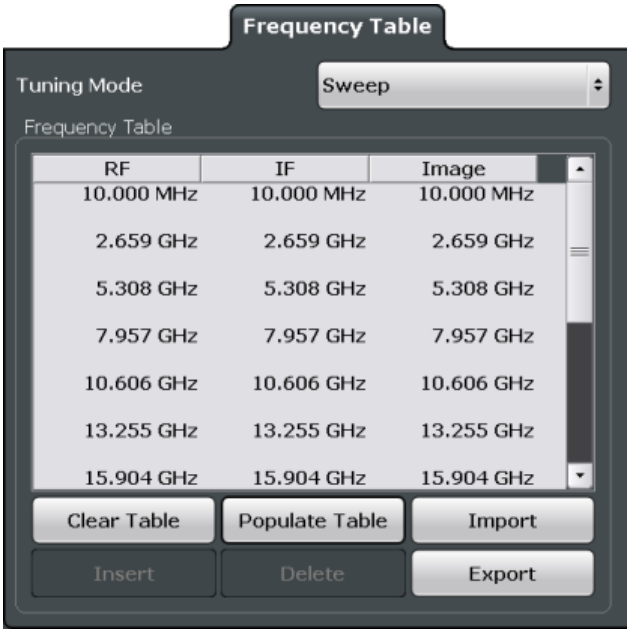
SCPI command:
`[SENSe:]FREQuency:STEP` on page 81

5.3.2 Using a Frequency Table

The "Frequency Table" tab in the "Frequency Settings" dialog box contains functionality to manage the measurement frequencies.

The application populates the table according to the information you have entered in the "Frequency Config" tab if you press the "Populate Table" button.

Note that changes to the frequency table take effect only if you have selected the "Frequency Table" tuning mode.



Frequency Table
Shows the current measurement points.

The table is made up of one column that represents the measurement frequency. Each frequency corresponds to one measurement point. The length of the table is variable.

When you perform measurements in "Sweep" or "Single Frequency" tuning mode, the contents of the table have no effect on the measurement.

When you select a table entry in "Frequency Table" tuning mode, you can edit it or add a new frequency below the selected frequency. A new frequency has to be greater than the last table entry and smaller than the next table entry.

Clear Table
Deletes the contents of the table.

Populate Table
Populates or restores the measurement frequencies based on the center frequency, the start and stop frequencies, the span, the stepsize and the number of measurement points.

SCPI command:
`[SENSe:]FREQuency:LIST:DATA` on page 80

Insert
Inserts a new measurement point above the one you have selected.

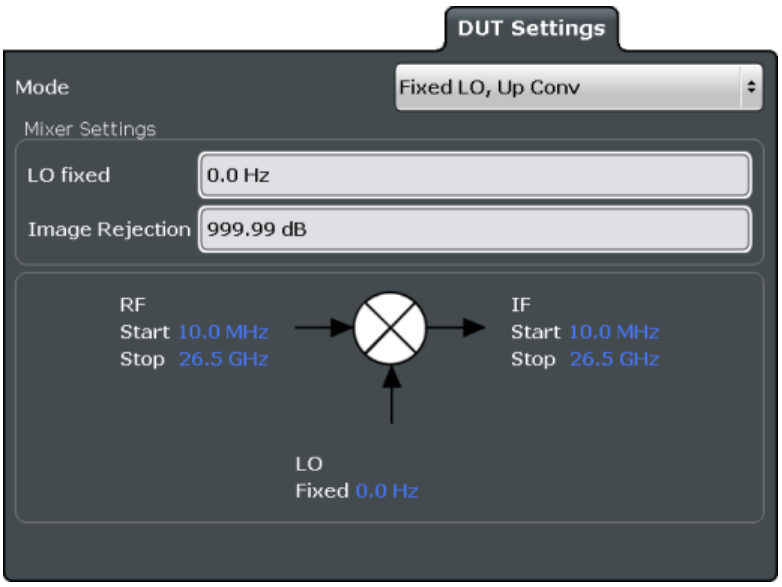
Delete
Deletes the currently selected measurement point.

Import / Export
Opens a dialog box to select an ENR table to import or export.

An import copies the ENR table into the default ENR table directory. An export copies the table to a location outside the default ENR table directory, e.g. a memory stick. The file extension has to be *.freq.

5.4 Selecting DUT Characteristics

The "DUT" button opens a dialog box to configure the characteristics of the DUT you are testing. The dialog box contains a schematic overview of the DUT input and output characteristics and the way it is integrated into the test setup.



Mode
Selects the measurement mode.

The measurement mode you should use depends on the type of DUT you are testing. For more information see chapter 4.2, "DUT Types", on page 22.

SCPI command:
`[SENSe:]CONFigure:MODE:DUT` on page 82

LO Fixed
Defines a fixed LO frequency for measurements on frequency-converting DUTs with a fixed LO.

After you have defined the LO, the application updates the frequency list accordingly.

SCPI command:
`[SENSe:]CONFigure:MODE:SYSTem:IF:FREQuency` on page 81

Image Rejection
Turns image rejection of the DUT on and off.

If you set an image rejection of 0 dB, the image frequency passes completely. If you set a high image rejection (up to 999.99 dB), the image frequency is suppressed completely. For DUTs that have a partial image rejection, define the amount of suppression.

For more information see chapter 4.3, "Image Frequency Rejection", on page 23.

SCPI command:
`[SENSe:]CORRection:IREJection` on page 82

5.5 Configuring the Noise Source

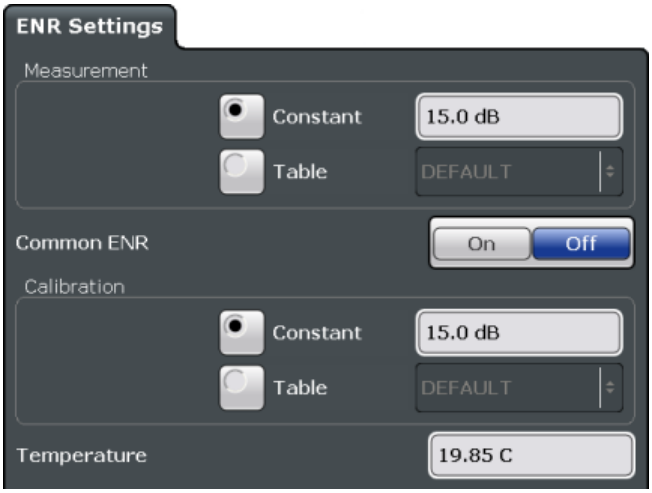
The "Noise Source" button or the "ENR Settings" softkey open a dialog to configure the characteristics of the noise source.

It is necessary to specify characteristics of the noise source you are using as close as possible in order to get accurate measurement results. The noise source characteristics are used to calculate the effective noise temperature of the noise source. The noise source characteristics should be supplied by its manufacturer.

5.5.1 Defining the Excess Noise Ratio (ENR)

The "ENR Settings" tab in the "ENR Settings" dialog box contains settings to characterize the noise source.

The noise source may have different ENR values during the calibration and the measurement stage.



Measurement
Selects the source of the ENR values.

The ENR may be approximated by a constant or be based on a ENR table.

If the ENR is a constant, the same ENR is used for all frequencies in the frequency table. If you have selected a constant ENR, you have to define its magnitude in the input field next to the radio button.

If the ENR is based on a table, the ENR level typically depends on the measurement frequency. You can select an existing table from the dropdown menu next to the radio button, if it is active. For more information on ENR tables see chapter 5.5.2, "Using an ENR Table", on page 41.

If the "Common ENR" is on, the ENR is used for both measurement and calibration.

SCPI command:
ENR mode:
[SENSe:]CORRection:ENR:MODE on page 84
Constant ENR:
[SENSe:]CORRection:ENR:SPOT on page 84
Select ENR table:
[SENSe:]CORRection:ENR:MEASurement:TABLe:SELect on page 83

Common ENR
Turns the use of a common ENR on and off.

Common ENRs have the same characteristics for the measurement and calibration. If you turn common ENR off, you can define an additional ENR to be used during calibration.

This is recommended in case of measurements on frequency converting DUTs, if one noise source does not cover the frequency range at the DUT input (RF) and the frequency range for calibration (IF).

Calibration
Selects the source of the ENR values used during calibration.

The ENR may be a constant or be based on a ENR table.

If the ENR is a constant, the same ENR value is used for all frequencies in the frequency table. If you have selected a constant ENR, you can also define its value in the input field next to the radio button.

If the ENR is based on a table, the ENR level depends on the measurement frequency. In that case, ENR values are interpolated to the measurement points. You can select a table from the dropdown menu next to the radio button, if it is active. For more information on ENR tables see chapter 5.5.2, "Using an ENR Table", on page 41.

The calibration settings are available if the "Common ENR" is off.

Temperature
Defines the absolute room temperature in degree Celsius or Fahrenheit.

The room temperature is required for the calculation of the real ENR of the noise source, because an ENR table is based on a temperature of 290K.

To change the unit of the temperature from Celsius to Fahrenheit, change the date format from "DE" to "US" in the "General" display settings.

- Press the SETUP key.
- Press the "Display" softkey.
- Select the "General" tab.
- Select "DE" for Celsius or "US" for Fahrenheit.

Note: If you define the temperature via remote control, the unit is degree Kelvin.

SCPI command:
[SENSe:]CORRection:TEMPerature on page 84

5.5.2 Using an ENR Table

The "Table Settings" tab in the "ENR Settings" dialog box contains the functionality to create and edit ENR tables.

ENR tables contain the noise source characteristics for particular frequencies. If the table does not contain an ENR for one of the measurement frequencies, the application will interpolate between ENR values.

The "Table Settings" tab contains a list of ENR tables currently available on the R&S FSW and shows the table currently in use if the "ENR Settings" are enabled.

In addition, the tab contains functionality to create new tables and modify existing ones.

New
Opens the Edit Table dialog box to create a new ENR table.

The contents of the dialog box are empty.

SCPI command:
`[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA` on page 83

Edit
Opens the Edit Table dialog box to modify the selected table.

SCPI command:
`[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA` on page 83

Copy To
Opens the Edit Table dialog box to modify the selected table and save it under a new name.

Delete
Deletes the selected table.

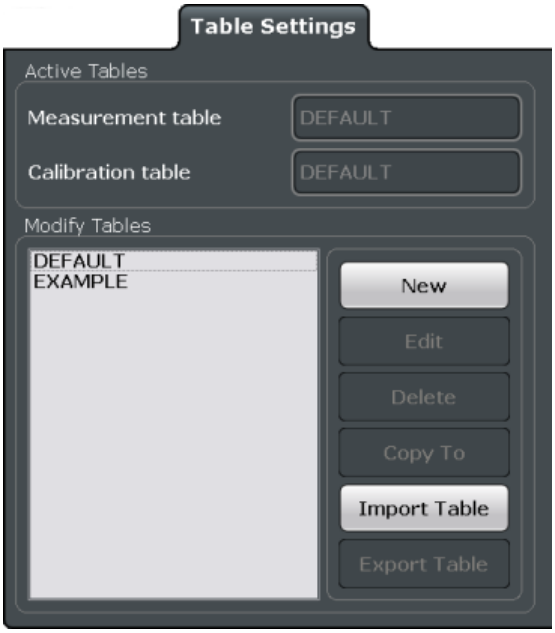
SCPI command:
`[SENSe:]CORRection:ENR:MEASurement:TABLe:DELete` on page 83

Import / Export Table
Opens a dialog box to select an ENR table to import or export.

An import copies the ENR table into the default ENR table directory. An export copies the table to a location outside the default ENR table directory, e.g. a memory stick. The file extension has to be *.enr.

Edit Table
Defines the ENR characteristics of a irregular noise source or the loss characteristics of additional measurement equipment.

The ENR and loss tables are made up of up to 500 data points. A data point consists of a frequency and its corresponding ENR or loss value. The ENR values should be supplied by the manufacturer of the noise source. The loss characterictics of measurement equipment should also be supplied by the manufacturer.



"Name" Name of the ENR or loss table.

"Comment" Comment for the ENR or loss table.

"Frequency" Frequency of a particular ENR or loss value.

"Value" ENR value or loss in dB.

"Clear Table" Deletes the contents of the ENR table (frequencies and ENR values) or the loss table.

"Insert" Inserts a new data point above the selected one.

"Delete" Deletes the selected data point.

"Save" Saves the ENR or loss table.

"Cancel" Exits the "Edit Table" dialog box and returns to the result diagram.

SCPI command:
Edit ENR table:
`[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA` on page 83
Edit input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe` on page 86
Edit output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe` on page 87

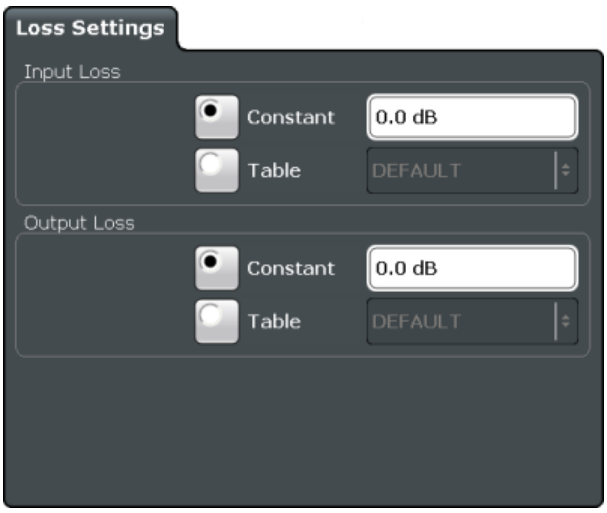
5.6 Configuring Additional Loss

The "Loss Input"/"Loss Output" buttons or the "Loss Settings" softkey open a dialog to configure the loss characteristics of additional equipment in the test setup like cables or attenuators at the DUT input or output. The characteristics of these should be supplied by the manufacturer.

Note that loss is only taken into account during the measurement and not during calibration because the noise source is connected directly to the analyzer input.

5.6.1 Defining Loss

The "Loss Settings" tab in the "Loss Settings" dialog box contains settings to define the loss characteristics of miscellaneous equipment in the test setup.



You can define the loss characteristics of the signal path to the DUT input and the signal path from the DUT output to the analyzer.

Input Loss
Selects the source of losses between the noise source and the DUT input.

The input loss is the sum of all losses caused by the measurement equipment. The loss may be constant or be based on a loss table.

If the loss is constant, the same loss is used for all frequencies in the frequency table. If you have selected a constant loss, you can also define its value in the input field next to the radio button.

If the loss is based on a table, the loss values are interpolated to the measurement frequencies. You can select a table from the dropdown menu next to the radio button, if it is active. For more information on loss tables see chapter 5.6.2, "Using a Loss Table", on page 44.

SCPI command:
Loss mode:
`[SENSe:]CORRection:LOSS:INPut:MODE` on page 85
Constant loss:
`[SENSe:]CORRection:LOSS:INPut:SPOT` on page 85
Select loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe:SELect` on page 86

Output Loss
Selects the source of loss between the DUT output and the RF input of the analyzer.

The output loss is the sum of all losses caused by the measurement equipment (e.g. connectors, cables or attenuators). The loss may be constant or be based on a loss table.

If the loss is constant, the same loss is used for all frequencies in the frequency table. If you have selected a constant loss, you can also define its value in the input field next to the radio button.

If the loss is based on a table, the loss values are interpolated to the measurement frequencies. You can select a table from the dropdown menu next to the radio button, if it is active. For more information on loss tables see chapter 5.6.2, "Using a Loss Table", on page 44.

SCPI command:
Loss mode:
`[SENSe:]CORRection:LOSS:OUTPut:MODE` on page 86
Constant loss:
`[SENSe:]CORRection:LOSS:OUTPut:SPOT` on page 87
Select loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe:SELect` on page 88

5.6.2 Using a Loss Table

The "Table Settings" tab in the "Loss Settings" dialog box contains the functionality to create and edit loss tables.

Loss table contain the loss characteristics of additional frequency dependent equipment in the test setup. If you are using a loss table, the loss values may be different on each frequency that is measured. If the table does not contain a loss for one of the measurement frequencies, the application will interpolate between values.

The "Table Settings" tab contains a list of loss tables currently available on the R&S FSW and shows the tables you are currently using if you have selected one in the "Loss Settings" tab.

In addition, the tab contains functionality to create new tables and modify existing ones.

New
Opens the Edit Table dialog box to create a new loss table.

The contents of the dialog box are empty.

SCPI command:
Create input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe` on page 86
Create output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe` on page 87

Edit
Opens the Edit Table dialog box to modify the selected table.

SCPI command:
Edit input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe` on page 86
Edit output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe` on page 87

Copy To
Opens the Edit Table dialog box to modify the selected table and save it under a new name.

Delete
Deletes the selected table.

SCPI command:
Delete input loss table:
`[SENSe:]CORRection:LOSS:INPut:TABLe:DELete` on page 86
Delete output loss table:
`[SENSe:]CORRection:LOSS:OUTPut:TABLe:DELete` on page 88

Import / Export Table
Opens a dialog box to select a loss table to import or export.

An import copies the loss table into the default loss table directory. An export copies the table to a location outside the default loss table directory, e.g. a memory stick. The file extension has to be *.loss.

5.7 Configuring the Analyzer

The "Spectrum Analyzer" button or the "Meas Settings" softkey open the "Measurement Settings" dialog box to set up general measurement characteristics.

5.7.1 Configuring the Measurement

The measurement settings include parameters directly related to the measurement itself.

2nd Stage Correction
Turns 2nd stage correction on and off.

If 2nd stage correction is on, the application excludes the inherent noise of the analyzer from the measurement results.

If 2nd stage correction is off, the application does not correct the measurement results, even if a valid calibration has been performed. Note that correction data does not get lost if you turn off the 2nd stage correction.

For more information see chapter 4.4, "Calibration (2nd Stage Correction)", on page 26.

SCPI command:
`CONFigure:CORRection` on page 88

Resolution Bandwidth (RBW)
Defines the resolution bandwidth for the measurement.

For more information on the resolution bandwidth see chapter 4.5, "Separating Signals by Selecting an Appropriate Resolution Bandwidth", on page 27.

SCPI command:
`[SENSe:]BANDwidth|BWIDth[:RESolution]` on page 90

Sweep Time
Defines the sweep time for the measurement.

The sweep time is the time it takes the analyzer to perform a measurement at one measurement frequency.

Note that noise measurements perform two measurements during one sweep. One with the noise source turned on, one with the noise source turned off.

SCPI command:
[SENSe:]SWEep:TIME on page 91

Settling Time
Defines the settling time of the DUT and the noise source.

Most noise sources need a certain amount of time to settle after you turn them on. Low-frequency DUTs may require a certain time until its coupling capacitators have been charged or discharged. Both are defined as the settling time. For details on the settling time refer to the datasheet of the noise source.

SCPI command:
SYSTem:CONFigure:DUT:STIMe on page 91

Average
Defines the number of measurements that are used to average the results.

The more measurements you include in the averaging, the more accurate and stable the results will be. However, accuracy and stability comes at the price of measurement speed.

SCPI command:
[SENSe:]SWEep:COUNt on page 91

5.7.2 Configuring Level Characteristics

The level and range settings configure all parameters related to the vertical diagram axis.

Ref Level
Turns automatic determination of the reference level on and off.

The reference level is the power level the R&S FSW expects at the RF input. Keep in mind that the noise signal has a high crest factor. Thus, the reference level has to be set at the peak envelope power of the noise signal, not the mean power in order to avoid an instrument overload.

The reference level should be about 5 to 15 dB above the noise display that occurs with the DUT connected and the noise source activated.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it may overload the RF and IF stages of the analyzer, regardless of the signal power. Measurement results may deteriorate.

Note that the signal level at the A/D converter may be stronger than the level the R&S FSW displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

If automatic detection of the reference level is on, the application performs a measurement to determine the ideal reference level. The time of this measurement depends on the state of the "2nd Stage Correction".

- 2nd Stage Correction is on
  The application determines the reference level before the calibration starts. The reference level is based on several test measurements on the start frequency.
  For more information see "Auto Level Range" on page 48.
- 2nd Stage Correction is off
  The application determines the reference level before the measurement begins. The reference level is based on the measurement of the first frequency that is measured. After this measurement is done, the application resumes the measurement.

If manual selection of the reference level is on, you can define the reference level in the corresponding input field.

Note: Reference level. Even for DUTs with a high-ripple frequency response it might be useful to enter the reference level manually, because determining the reference level automatically might not always result in optimal settings.

SCPI command:
Manual reference level:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel` on page 89
Automatic reference level:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:AUTO` on page 89

Auto Level Range
Defines the maximum expected gain of the DUT.

The application uses the auto level range to determine the reference level automatically if the 2nd stage correction is on.

Note that the range should not exceed the actual gain of the DUT by more than 10 dB.

SCPI command:
`SYSTem:CONFigure:DUT:GAIN` on page 91

RF Attenuation
Defines the RF attenuation of the analyzer.

The attenuation is applied to the signal at the RF input.

Attenuation affects the quality of the noise measurement results. For a low noise figure of the analyzer (and thus more accurate measurement results), you should keep the attenuation as low as possible. No attenuation is best. However, some high power DUTs require attenuation to avoid an overload of the analyzer. An attenuation of 10 dB will give better input VSWR of the analyzer, but will result in a deteriorating noise figure.

SCPI command:

`INPut:ATTenuation` on page 89

Preamplfier

Turns the preamplifier on and off.

The preamplifier should be turned on for a low inherent noise of the analyzer.

The preamplification level is 30 dB for R&S FSW model .26.

For R&S FSW models .08 or .13, preamplification levels of 15 dB or 30 dB are available.

SCPI command:

`INPut:GAIN:STATe` on page 90

5.8 Using the Uncertainty Calculator

Noise figure measurements are subject to uncertainty. This measurement uncertainty has to be considered when making a noise figure measurement. The noise figure measurement will be meaningless if the measurement uncertainty is too large. Knowing the uncertainty of the noise figure measurement adds value especially when comparing measurement results.

Uncertainty values and systematic error recognition

Note that the uncertainty calculation only takes systematic measurement inaccuracies into account.

The most significant inaccuracies are:

- uncertainties of the noise source and the analyzer
- input and output matching
- noise figure and gain of the DUT
- noise figure of the analyzer

The accuracy of the measurement may be additionally affected by insufficient repeatability during calibration or measurement.

The repeatability is mainly affected by:

- signal-to-noise ratio during calibration and measurement
- measurement time (if it is too short)
- environmental conditions (e.g. a change in the temperature between measurements)
- mechanical stability of the test setup

For more background information on noise figure measurement uncertainty refer to the application note "The Y-Factor Technique for Noise Figure Measurement" available for

download on the Rohde & Schwarz homepage (http://www2.rohde-schwarz.com/en/service_and_support/Downloads/Application_Notes?type=20&downid=7162).

In addition to the parameters described here, the application also considers several parameters from the general measurement configuration when calculating the uncertainty.

- Measurement mode
- 2nd Stage Correction
  If 2nd stage correction is on, but no calibration data is available, uncertainty is calculated without the 2nd stage correction data.
- Internal preamplification
- RF Attenuation
- Temperature
- ENR values

5.8.1 Configuring Noise Source Characteristics

Output Match
Defines the output match of the noise source you are using.

You can define the output match either as the VSWR or as the return loss (RL).

Refer to the datasheet of the noise source for these values.

SCPI command:
`CALCulate:UNCertainty:MATCh:SOURce[:VSWR]` on page 95
`CALCulate:UNCertainty:MATCh:SOURce:RL` on page 95

ENR Uncert(ainty)
Defines the uncertainty of the excess noise ratio of the noise source you are using.

Refer to the datasheet of the noise source for this value.

SCPI command:
`CALCulate:UNCertainty:ENR:UNCertainty` on page 93

5.8.2 Configuring DUT Characteristics

Input / Output Match
Defines the match at the DUT input and output.

You can define the match either as the VSWR or as the return loss (RL). If you define the VSWR or the return loss, the application automatically calculates the other.

If these values are not defined in the DUT datasheet, determine these values, for example, with a network analyzer.

SCPI command:
CALCulate:UNCertainty:MATCh:DUT:IN:[VSWR] on page 94
CALCulate:UNCertainty:MATCh:DUT:IN:RL on page 94
CALCulate:UNCertainty:MATCh:DUT:OUT:[VSWR] on page 94
CALCulate:UNCertainty:MATCh:DUT:OUT:RL on page 94

Use Measurement Values
Turns automatic determination of the DUT characteristics used for the uncertainty calculation on and off.

If on, the application calculates the uncertainty with the DUT characteristics (noise figure, gain and frequency) resulting from the noise figure measurement. In case of this method, the application calculates the uncertainty for each measurement point (or frequency) based on the noise figure and gain results of the last measurement. With this automatic determination of the DUT characteristics, you can display the uncertainty for each measurement point in the numerical result displays.

If you have selected automatic determination of the DUT characterictics, the application does not show a result in the "NF Uncertainty +/-" field in the dialog box. Instead, to view the uncertainty at all measurement points, use the "Result Table".

If off, define the gain, noise figure and frequency of the DUT manually for a single frequency. With this manual determination of the DUT characteristics, the application only calculates the uncertainty for that frequency and shows the result in the "NF Uncertainty +/-" field in the dialog box.

- Noise Figure of the DUT
- Gain of the DUT
- Frequency of the DUT

SCPI command:
Control automatic DUT characteristics determination:
CALCulate:UNCertainty:DATA:RESults on page 93
Manual definition of DUT characteristics:
CALCulate:UNCertainty:DATA:NOISe on page 93
CALCulate:UNCertainty:DATA:GAIN on page 92
CALCulate:UNCertainty:DATA:FREQuency on page 92

5.8.3 Configuring Analyzer Characteristics

For the analyzer characteristics, the application always uses the data specified in the datasheet of the R&S FSW model you are using. Thus, it is not possible to change or adjust the analyzer characteristics in any way. The uncertainty calculation takes several analyzer characteristics into account. Of those, it shows the following as read only fields in the user interface.

- Input match (VSWR and return loss)
- Gain uncertainty
- Noise figure uncertainty

- Noise figure of the analyzer

However, if you are using an external preamplifier in the test setup, you have to specify its characteristics in order to get a valid uncertainty result. If you specify an external preamplifier, the application automatically calculates and updates the analyzer characteristics based on the characteristics of the preamplifier.

SCPI command:

`CALCulate:UNCertainty:PREamp:STATe` on page 96

Refer to the datasheet of the preamplifier you are using for the values you have to enter.

If you are using a preamplifier, you have to define the following characteristics.

Preamplifier noise figure (PA NF)

Defines the noise figure of the preamplifier.

SCPI command:

`CALCulate:UNCertainty:PREamp:NOISe` on page 96

Preamplifier Gain (PA Gain)

Defines the gain of the preamplifier.

SCPI command:

`CALCulate:UNCertainty:PREamp:GAIN` on page 96

Net spectrum analyzer noise figure

Shows the noise figure of the analyzer.

If you are using an external preamplifier, the application calculates the noise figure of the analyzer including the noise figure of the preamplfier and shows the result here.

If you do not use an external preamplifier, this value is the same as the noise figure of the analyzer shown in the "SA NF" field.

5.8.4 Guidelines and Results

The lower part of the dialog box contains measurement guidelines that provide information on the quality of measurement and the actual noise figure uncertainty.

Guidelines

The guidelines are an indicator of the quality of the measurement and an indicator the repeatability of the measurement.

The three guidelines are:

- Make sure that the noise figure of the DUT and the gain of the DUT is greater than the noise figure of the analyzer plus 1 dB.

- Make sure that the ENR of the noise source is greater than the noise figure of the DUT plus 5 dB.
- Make sure that the ENR of the noise source is greater than the noise figure of the analyzer plus 3 dB.

A short form of these guidelines is indicated in the "Uncertainty Calculation" dialog box. The dialog box also indicates if the guidelines have been met or not by a colored dot.

- Green light : guideline condition met.
- Yellow light : guideline condition not met, but within 1 dB of being met.
- Red light : guideline condition not met.

Note that the guidelines have no effect on the actual uncertainty that has been calculated and that they are only considered for measurements with 2nd Stage Correction.

Uncertainty

The uncertainty result is shown only if you define the noise figure and gain characteristics of the DUT manually on a single frequency. In that case, the uncertainty shown in the "Uncertainty Calculation" dialog box is valid only for the DUT frequency you have defined.

If you are using the noise figure and gain that has been determined during a measurement, the uncertainty is displayed only in the result table.

For more information see "Use Measurement Values" on page 51.

SCPI command:

`CALCulate:UNCertainty[:RESult]?` on page 96

5.9 Performing Measurements

This chapter contains all functionality necessary to control and perform noise figure measurements.

The contents of this chapter correspond to the contents of the "Sweep" menu. You can access the "Sweep" menu with the SWEEP key.

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 has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, the RUN CONT key on the front panel controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

For details on the Sequencer, see the R&S FSW User Manual.

SCPI command:
`INITiate:CONTinuous` on page 98

Single Sweep/ RUN SINGLE
Inititates 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 has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.
Furthermore, the RUN SINGLE key on the front panel controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

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

SCPI command:
`INITiate[:IMMediate]` on page 98

Calibrate
Initiates a calibration measurement.

For more information see chapter 4.4, "Calibration (2nd Stage Correction)", on page 26.

SCPI command:
`INITiate[:IMMediate]` on page 98
when `CONFigure:CORRection` is on.

6 Analysis

This chapter contains all settings and parameters that the application provides to analyze and evaluate measurement results.

6.1 Configuring the Display

The "Display Configuration" button or the "Result Config" softkey open a dialog box to configure the way the results are displayed in the diagram.

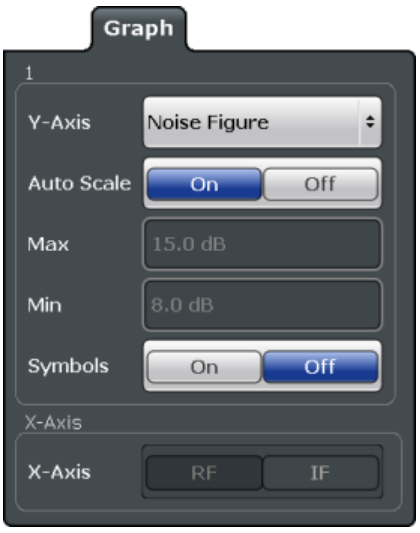
The contents depend on whether you want to configure a graphical result display or a numerical result display.

Specifics for

The settings you make apply to the results you have selected in the "Specifics for" drop-down menu. If more than one window is on, "Specifics for" also puts the focus on the corresponding window.

6.1.1 Configuring Graphical Results

When configuring graphical results, the dialog box contains functionality to scale and set up the diagram axes.



Y-Axis
Selects the result display and thus the scaling of the vertical axis.

For more information see chapter 3, "Measurements and Result Displays", on page 14.

Auto Scale / Min / Max
Turns automatic scaling of the vertical axis on and off.

If on, the application optimizes the scaling of the vertical axis after each measurement for ideal viewing of the results.

If off, you can define the scaling manually. The "Min" and "Max" input fields become available. These two input fields define the values at the top and bottom of the vertical axis.

SCPI command:
Automatic scaling:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO` on page 102
Manual minimum value:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:BOTTom` on page 102
Manual maximum value
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:TOP` on page 102

Symbols
Turns symbols that represent a measurement point on the trace on and off.

SCPI command:
`DISPlay[:WINDow<n>]:TRACe:SYMBols` on page 101

X-Axis
Selects the frequency data that is displayed on the x-axis.

For measurements on frequency converting DUTs with a variable intermediary frequency, you can display either the RF frequency or the IF frequency.

Note that a change of the x-axis scale applies to all result displays.

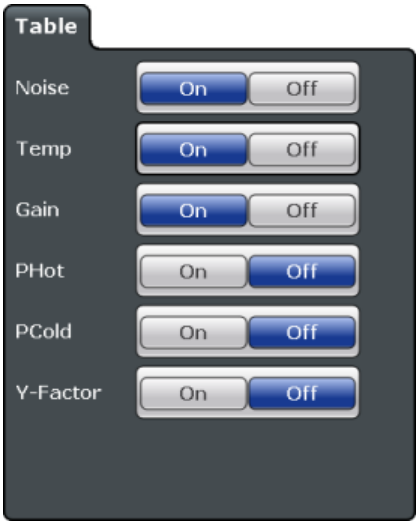
SCPI command:
`DISPlay[:WINDow<n>]:TRACe:X[:SCALe]` on page 101

6.1.2 Configuring Numerical Results

When configuring numerical results, the dialog box selects the type of results you want to display in the result table.

You can add an aspect of the measurement by turning the corresponding result on and remove it by turning it off.

For more information on each result see chapter 3, "Measurements and Result Displays", on page 14.



6.2 Working with Traces

A trace is the graphical representation of a set of measurement results in a diagram. Each measurement window that contains graphical results supports up to four individual traces. Each trace has a different color. Trace settings determine how the measured data is analyzed and displayed on the screen. The trace information, including a color map and trace mode is summarized in the diagram header.

The trace settings are combined in the "Trace Configuration" dialog box. You can access this dialog box with the "Trace Config" softkey or directly access one of the tabs via one of the softkeys in the "Trace" menu.

Traces

The "Trace 1 to 4" softkeys open the "Traces" tab of the "Trace Configuration" dialog box.

The "Traces" tab contains functionality to configure a trace.

"Trace Selection" The "Trace 1" to "Trace 4" buttons select a trace. If a trace is selected, it is highlighted orange.
Note that you cannot select a trace if its trace mode is "Blank".

"Trace Mode" Selects the trace mode for the corresponding trace.
For more information see chapter 4, "Measurement Basics", on page 21.

SCPI command:
Trace mode:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 103

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

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

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

SCPI command:
`TRACe<n>:COPY` on page 105

Preset Traces
Restores the default configuration for all traces in a window.

Trace Config
Opens a dialog box made up out of three tabs to configure traces.

The first tab contains functionality to configure a trace. For more information see "Traces" on page 57.

The second tab contains functionality to export trace data. For more information see "Trace Export" on page 58.

The third tab contains functionality to copy traces. For more information see "Copy Trace" on page 58.

Trace Export
The "Trace Export" tab contains functionality to export trace data.

"Trace to Export"	Selects the trace that will be exported to a file.
"Decimal Separator"	Selects the decimal separator for floating-point numerals for the ASCII Trace export. Evaluation programs require different separators in different languages.
"Export Trace to ASCII File"	Opens a file selection dialog box and saves the selected trace in ASCII format to the specified file and directory.

SCPI command:
Decimal separator:
`FORMat:DEXPort:DSEParator` on page 105
Export trace to ASCII file:
`MMEMory:STORe<n>:TRACe` on page 105

6.3 Using Markers

Markers help you to read out measurement results for particular frequencies or mark a particular point on a trace. The noise figure application features four markers. Markers in the noise figure application are linked. If you use more than one measurement window

and activate a marker in one window, it also appears in all other measurement windows on the same horizontal position.

6.3.1 Marker Configuration

Marker (1...4)
Selects or turns the corresponding marker on and off.

Turning on a marker also opens an input field to define the horizontal position of the marker.

By default, the first marker you turn on is a normal marker, all others are delta markers.

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).

SCPI command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 113
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 116

Marker to Trace
Opens an input field to assign the marker to a particular trace if you are using more than one trace.

All Markers Off
Deactivates all markers in one step.

SCPI command:
`CALCulate<n>:MARKer<m>:AOFF` on page 113

Marker Config
Opens the "Marker Configuration" dialog box.

The "Marker Configuration" dialog box contains all marker functions necessary to set up the four markers supported by the application.

- Selected
  Highlights the currently selected marker.
- State
  Turns a marker on and off.
- Stimulus
  Defines the marker position on the horizontal axis.
- Type
  Selects the marker type. For more information see "Marker Type" on page 59.
- Trace
  Selects the trace the marker is positioned on.

6.3.2 Marker Positioning

If you are using more thn one measurement window, the application performs the peak search in the currently selected measurement window. The currently selected measurement window has a blue border. Because the markers are linked in the noise figure application, the frequency position of the marker in the other window is updated accordingly, even if it means that the marker is on a peak in one window only.

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

The number in the softkey label (**<x>**) shows the number of the currently selected marker.

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

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

SCPI command:
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 118
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 119

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.

SCPI command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 119
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 118

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

SCPI command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 119
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 119

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.

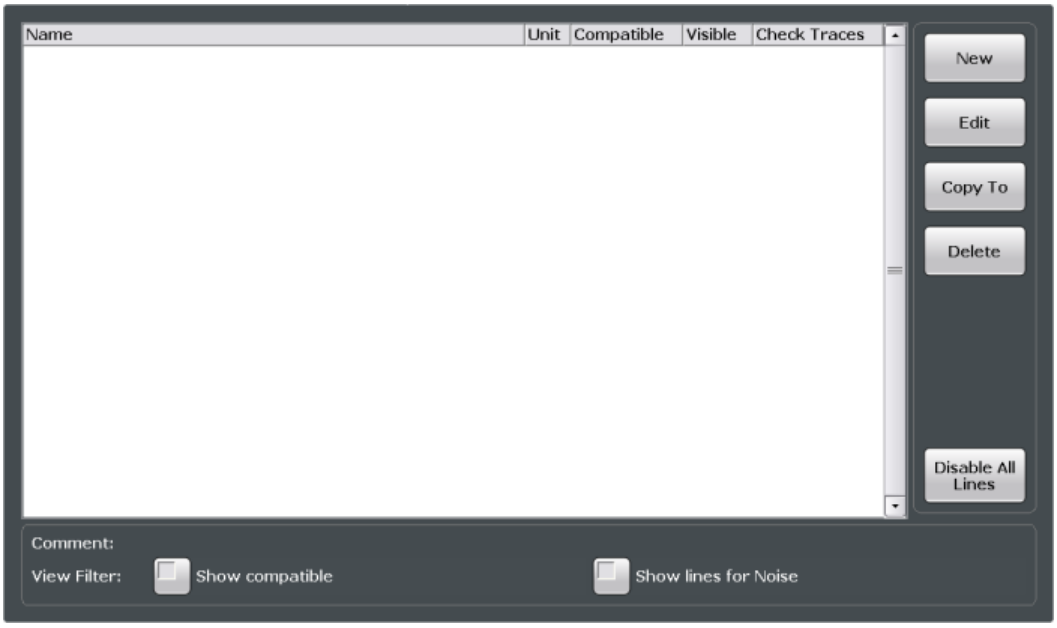
SCPI command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 118
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 119

6.4 Limit Line Settings and Functions

The noise figure measurement application supports up to eight active limit lines in each active measurement window.

6.4.1 Limit Line Management

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



For the limit line overview, the R&S FSW searches for all stored limit lines with the file extension `.LIM` 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 6.4.2, "Limit Line Details", on page 64.

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.

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.

SCPI command:
`CALCulate:LIMit<k>:LOWer:STATe` on page 109
`CALCulate:LIMit<k>:UPPer:STATe` on page 110
`CALCulate:LIMit:ACTive?` on page 111

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.

SCPI command:
`CALCulate:LIMit<k>:TRACe` on page 112

Comment
An optional description of the limit line.

Show compatible limit lines
Defines which of the stored limit lines are included in the overview.

If active, only limit lines that are compatible to the result display currently in focus are displayed.

Show lines for noise
If activated (default), only limit lines created for noise figure measurements are displayed. Otherwise, all limit lines are displayed.

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.

SCPI command:
`CALCulate:LIMit<k>:COPY` on page 111

Delete Line
Delete the selected limit line configuration.

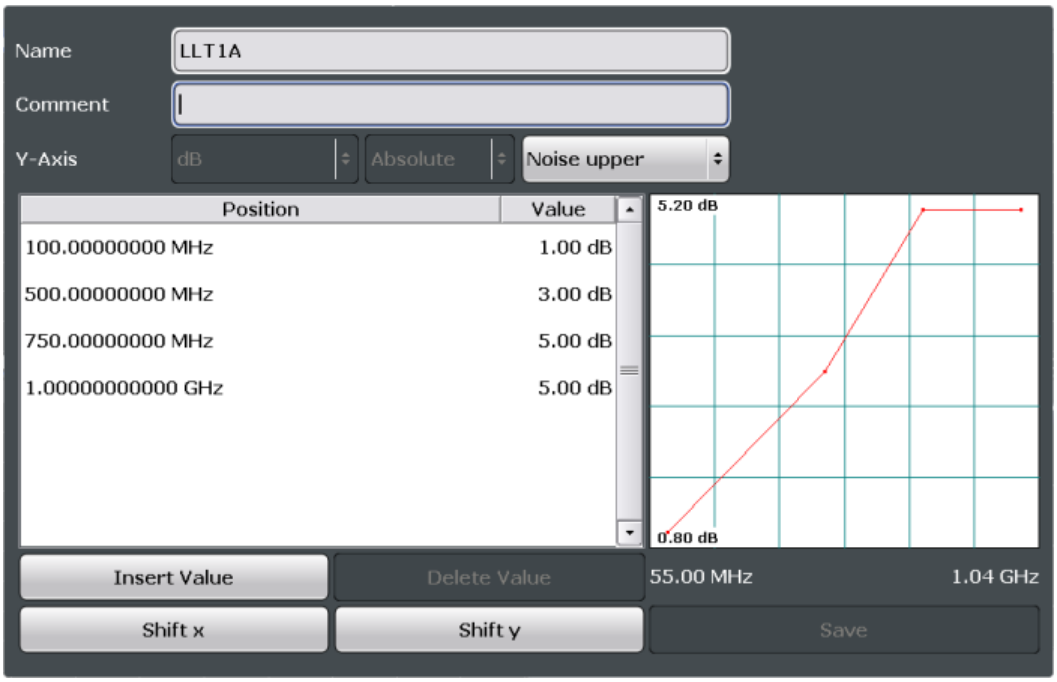
SCPI command:
`CALCulate:LIMit<k>:DELete` on page 111

Disable All Lines
Disable all limit lines in one step.

SCPI command:
`CALCulate:LIMit<k>:STATe` on page 112

6.4.2 Limit Line Details

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



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

SCPI command:
`CALCulate:LIMit<k>:NAME` on page 107

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

SCPI command:
CALCulate:LIMit:COMMent on page 107

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

You can select the type of limit line (upper or lower) for each type of result. From that information, the application sets the level unit and y-axis scaling. Both are then fix parameters because the unit depends on the result and the scaling is always absolute in case of noise figure measurements.

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.

SCPI command:
CALCulate:LIMit<k>:CONTrol[:DATA] on page 108
CALCulate:LIMit<k>:LOWer[:DATA] on page 109
CALCulate:LIMit<k>:UPPer[:DATA] on page 110

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.

SCPI command:
CALCulate:LIMit<k>:CONTrol:SHIFt on page 108

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

SCPI command:
CALCulate:LIMit<k>:LOWer:SHIFt on page 109
CALCulate:LIMit<k>:UPPer:SHIFt on page 110

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

7 Remote Control Commands for Noise Measurements

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

7.1 Introduction

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

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

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

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

Remote command examples

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

7.1.1 Long and Short Form

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

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

Example:

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

7.1.2 Numeric Suffixes

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

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

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

Example:

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

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

7.1.3 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

7.1.4 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`.

7.1.5 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters may have different forms of values.

7.1.5.1 Numeric Values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

7.1.5.2 Boolean

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

Querying boolean parameters

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

Example:

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

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

7.1.5.3 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 7.1.1, "Long and Short Form", on page 67.

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`

7.1.5.4 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'
```

7.1.5.5 Block Data

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

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a 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.

7.2 Controlling the Noise Figure Measurement Channel

The following commands are necessary to control the measurement channel.

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

This command adds an additional measurement channel. The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 7-1.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 7-1).

Example: `INST:CRE SAN, 'Spectrum 2'`
Adds an additional spectrum display named "Spectrum 2".

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

This command replaces a measurement channel with another one.

Parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 7-1.

<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 table 7-1).

Example: `INST:CRE:REPL 'Spectrum2',IQ,'IQAnalyzer'`
Replaces the channel named 'Spectrum2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

INSTrument:DELete <ChannelName>

This command deletes a measurement channel. If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

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

Example: `INST:DEL 'Spectrum4'`
Deletes the spectrum channel with the name 'Spectrum4'.

INSTrument:LIST?

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

Return values:

<ChannelType>, <ChannelName>
For each channel, the command returns the channel type and channel name (see table 7-1).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example:
```
INST:LIST?
```
Result for 3 measurement channels:
```
'ADEM','Analog Demod','IQ','IQ Analyzer','SANALYZER','Spectrum'
```

Usage: Query only

Table 7-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
VSA (R&S FSW-K70)	DDEM	VSA
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
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*)
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

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

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

Example: `INST:REN 'Spectrum2','Spectrum3'`
Renames the channel with the name 'Spectrum2' to 'Spectrum3'.

INSTrument[:SELect] <Application>

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

See also `INSTrument:CREate[:NEW]` on page 71.

For a list of available channel types see table 7-1.

Parameters:

<Application> **NOISe**
Noise figure measurements, R&S FSW–K30

SYSTem:PRESet:CHANnel[:EXECute]

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

Use `INST:SEL` to select the channel.

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

Usage: Event

Manual control: See "Preset Channel" on page 32

7.3 Working with Windows in the Display

The following commands are necessary to change the evaluation type and rearrange the screen layout as you do using the SmartGrid in manual operation.

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAY:ADD? '1',LEFT,MTAB
```

Result:

```
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Table 7-2: <WindowType> parameter values for noise figure application

Parameter value	Window type
GAIN	Gain result display
MTABle	Marker table
NOISe	Noise figure result display
PCOLd	Power cold result display
PHOT	Power hot result display
RESults	Result table
TEMPerature	Noise temperature result display
YFACtor	Y-Factor result display

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<Index_1>..<WindowName_n>,<Index_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<Index> **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.

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.

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, 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 74 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, as opposed to `LAYout:ADD[:WINDow]?`, the suffix <n> determines the existing window next to which the new window is added.

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.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 74 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).

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>).

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 74 for a list of available window types.

7.4 Measurement Results

The following commands are necessary to query measurement results.

TRACe<n>[:DATA]? <Trace>, <Result>

This command queries the noise measurement results.

Query parameters:

<Trace> Selects the trace to be read out.

TRACE1

TRACE2

TRACE3

TRACE4

<Result> Selects the result display to be read out.

GAIN
Queries gain reuslts.

NOISe
Queries noise figure results.

NUNCertainty
Queries noise figure uncertainty results.

PCOLd
Queries power (cold) results.

PHOT
Queries power (hot) results.

TEMPerature
Queries noise temperature results.

YFACtor
Queries y-factor results.

Return values:

<TraceData> For any graphical result display, the command returns one result for each measurement point.
The unit depends on the result you are querying.
If an invalid result for any measurement has been calculated, the command returns `-200` for that value.

Example:

```
TRAC? TRACE1,GAIN
```

Queries the gain results for the first trace.

Usage: Query only

Manual control:

See "Noise Figure" on page 15
See "Gain" on page 15
See "Noise Temperature" on page 16
See "Y-Factor" on page 16
See "Power (Hot)" on page 17
See "Power (Cold)" on page 18
See "Result List" on page 18

7.5 Defining the Measurement Frequency

The following commands are necessary to define the frequency characteristics of the noise figure measurement.

CONFigure:LIST:CONTinuous

This command configures the software to perform a frequency list measurement in continuous sweep mode.

Example:
```
CONF:LIST:CONT
INIT
```
Selects and initiates a frequency list measurement.

Usage: Event

Manual control: See "Tuning Mode" on page 34

CONFigure:LIST:SINGLe

This command configures the software to perform a frequency list measurement in single sweep mode.

Example:
```
CONF:LIST:SING
INIT
```
Selects and initiates a single frequency list measurement.

Usage: Event

Manual control: See "Tuning Mode" on page 34

[SENSe:]FREQuency:CENter <Frequency>

This command defines the center frequency.

Parameters:

<Frequency>
Range: see datasheet
*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 1GHZ
```
Defines a center frequency of 1 GHz.

Manual control: See "Center" on page 35

[SENSe:]FREQuency:LIST:DATA <Frequency>

This command defines the contents of a frequency list.

The command overwrites the current contents of the frequency list. The frequency list remains the same until you generate or create a new list.

Parameters:

<Frequency> Defines a frequency for each entry in the frequency list. A frequency list can contain up to 500 entries.

Range: 0 Hz to fmax

Example: `FREQ:LIST:DATA 100MHZ,200MHZ,300MHZ,400MHZ,500MHZ`

Creates a frequency list with five entries.

Manual control: See "Populate Table" on page 37

[SENSe:]SWEep:POINts <SweepPoints>

This command defines the number of measurement points analyzed during a sweep.

Parameters:

<SweepPoints> Range: 1 to 500
*RST: 20

Example: `SWE:POIN 100`

Defines 100 measurement points.

Manual control: See "(Measurement) Points" on page 35

[SENSe:]FREQuency:SPAN <Span>

This command defines the frequency span.

If you change the span, the application creates a new frequency list.

Parameters:

<Span> This parameter is ....

*RST: RST value

Example: `FREQ:SPAN 500MHZ`

Defines a span of 500 MHz.

Manual control: See "Span" on page 35

[SENSe:]FREQuency:STARt <Frequency>

This command defines the start frequency.

If you change the start frequency, the application creates a new frequency list.

Parameters:
<Frequency> *RST: RST value

Example: `FREQ:STAR 900MHZ`
Defines a start frequency of 900 MHz.

Manual control: See "Start and Stop Frequency" on page 35

[SENSe:]FREQuency:STEP <Stepsize>

This command defines the frequency stepsize in the frequency table.

The stepsize corresponds to the distance from one measurement point to another.

If you change the stepsize, the application creates a new frequency list.

Parameters:
<Stepsize> Range: 0 Hz to span
*RST: 100 MHz

Example: `FREQ:STEP 100MHZ`
Defines a stepsize of 100 MHz.

Manual control: See "Step" on page 36

[SENSe:]FREQuency:STOP <Frequency>

This command defines the stop frequency.

If you change the stop frequency, the application creates a new frequency list.

Parameters:
<Frequency> *RST: RST value

Example: `FREQ:STOP 900MHZ`
Defines a stop frequency of 900 MHz.

Manual control: See "Start and Stop Frequency" on page 35

7.6 Selecting DUT Characteristics

The following commands are necessary to define DUT characteristics.

[SENSe:]CONFigure:MODE:SYSTem:IF:FREQuency <IntermediateFrequency>

This command defines the intermediate frequency for DUTs with a fixed IF.

Parameters:

<IntermediateFrequency>
Range: 0 Hz to 100 GHz
*RST: 10 MHz, if frequency converting mode has been selected

Example: `CONF:MODE:SYST:IF:FREQ 1GHZ`
Defines an IF of 1 GHz.

Manual control: See "LO Fixed" on page 38

[SENSe:]CONFigure:MODE:DUT <DUTType>

This command selects the type of DUT you are testing.

Parameters:

<DUTType>
AMPLifier
Measurements on fixed frequency DUTs.
DOWNconv
Measurements on down-converting DUTs.
UPConv
Measurements on up-converting DUTs.
*RST: AMPLifier

Example: `CONF:MODE:DUT DOWN`
Selects the measurement mode for a down-converting DUT.

Manual control: See "Mode" on page 38

[SENSe:]CORRection:IREJection <ImageRejection>

This command defines the image frequency rejection for the DUT.

Parameters:

<ImageRejection>
Range: 0 to 999.99
*RST: 999.99
Default unit: dB

Example: `CORR:IREJ 0`
Turns image rejection off.

Manual control: See "Image Rejection" on page 38

7.7 Configuring the Noise Source

The following commands are necessary to define the noise source characteristics.

[SENSe:]CORRection:ENR[:MEASurement]:TABLe:DATA <Frequency>, <ENR>

This command defines the contents of the currently selected ENR table.

The ENR table should contain an ENR for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the frequency list.

Parameters:

<Frequency>, <ENR> Each entry of the ENR table consists of one measurement point and the corresponding ENR.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<ENR>
ENR of the measurement point.
The range is from -999.99 dB to 999.99 dB.

Example: `CORR:ENR:MEAS:TABL:DATA 1MHZ,10,2MHZ,12`
Defines a new ENR table with two measurement points.

Manual control: See "New" on page 41
See "Edit" on page 41
See "Edit Table" on page 41

[SENSe:]CORRection:ENR:MEASurement:TABLe:DELete <TableName>

This command deletes an ENR table.

Parameters:

<TableName> String containing the name of the table.

Example: `CORR:ENR:MEAS:TABL:DEL 'ENRTable'`
Deletes the table with the name 'ENRTable'.

Usage: Event

Manual control: See "Delete" on page 41

[SENSe:]CORRection:ENR:MEASurement:TABLe:SELect <TableName>

This command selects an ENR table.

Parameters:

<TableName> String containing the table name.

Example: `CORR:ENR:MEAS:TABL:SEL 'ENRTable'`
Selects a table called 'ENRTable'.

Manual control: See "Measurement" on page 39

[SENSe:]CORRection:ENR:MODE <Mode>

This command selects the ENR mode.

Parameters:

<Mode>

SPOT
Uses a constant ENR value for all measurement points (see `[SENSe:]CORRection:ENR:SPOT` on page 84).

TABLe
Uses the contents of the ENR table.

*RST: SPOT

Example:
```
CORR:ENR:MODE SPOT
```
Uses a constant ENR value for all measurement points.

Manual control: See "Measurement" on page 39

[SENSe:]CORRection:ENR:SPOT <ENR>

This command defines the constant ENR for all measurement points.

Parameters:

<ENR>

Range: -999.99 to 999.99
*RST: 15
Default unit: dB

Example:
```
CORR:ENR:MODE SPOT
CORR:ENR:SPOT 30
```
Selects constant ENR value mode and defines an ENR of 30 dB for all measurement points.

Manual control: See "Measurement" on page 39

[SENSe:]CORRection:TEMPerature <Temperature>

This command defines the room temperature of the measurement environment. The temperature is taken into account when calculating noise results.

Parameters:

<Temperature>

Range: 278.15 to 318.15
*RST: 293
Default unit: K

Example:
```
CORR:TEMP 291.50
```
Specifies a room temperature of 291.50 Kelvin (18.5 C).

Manual control: See "Temperature" on page 40

7.8 Configuring Additional Loss

The following commands are necessary to define loss resulting from equipment in the measurement setup.

[SENSe:]CORRection:LOSS:INPut:MODE <Mode>

This command selects the input loss mode.

Parameters:

<Mode>

SPOT
Uses a constant input loss value for all measurement points (see `[SENSe:]CORRection:LOSS:INPut:SPOT` on page 85).

TABLe
Uses the contents of the input loss table.

*RST: SPOT

Example:
```
CORR:LOSS:INP:MODE SPOT
```
Selects constant input loss.

Manual control: See "Input Loss" on page 43

[SENSe:]CORRection:LOSS:INPut:SPOT <Loss>

This command defines a constant input loss for all measurement points.

Parameters:

<Loss>

Range: -999.99 to 999.99
*RST: 0 dB
Default unit: dB

Example:
```
CORR:LOSS:INP:MODE SPOT
CORR:LOSS:INP:SPOT 10
```
Selects constant input loss mode and defines an input loss of 10 dB for all measurement points.

Manual control: See "Input Loss" on page 43

[SENSe:]CORRection:LOSS:INPut:TABLe <Frequency>, <Loss>

This command defines the contents of the currently selected input loss table.

The table should contain an input loss for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the loss table.

Parameters:

<Frequency>, <ENR> Each entry of the loss table consists of one measurement point and the corresponding loss.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<Loss>
Loss of the measurement point.
The range is from -999.99 dB to 999.99 dB.

Example: `CORR:LOSS:INP:TABL 1MHz,10,2MHz,12`
Defines a new input loss table with two measurement points.

Manual control: See "Edit Table" on page 41
See "New" on page 45
See "Edit" on page 45

[SENSe:]CORRection:LOSS:INPut:TABLe:DELete <TableName>

This command deletes an input loss table.

Parameters:

<TableName> String containing the name of the table.

Example: `CORR:LOSS:INP:TABL:DEL 'InputLoss'`
Deletes the table with the name 'InputLoss'.

Manual control: See "Delete" on page 45

[SENSe:]CORRection:LOSS:INPut:TABLe:SELect <TableName>

This command selects an input loss table.

Parameters:

<TableName> String containing the table name.

Example: `CORR:LOSS:INP:TABL:SEL 'InputLoss'`
Selects a table called 'InputLoss'.

Manual control: See "Input Loss" on page 43

[SENSe:]CORRection:LOSS:OUTPut:MODE <Mode>

This command selects the output loss mode.

Parameters:

<Mode>

SPOT
Uses a constant output loss value for all measurement points (see `[SENSe:]CORRection:LOSS:OUTPut:SPOT` on page 87).

TABLe
Uses the contents of the output loss table.

*RST: SPOT

Example:
```
CORR:LOSS:OUTP:MODE SPOT
```
Selects constant output loss.

Manual control: See "Output Loss" on page 44

[SENSe:]CORRection:LOSS:OUTPut:SPOT <Loss>

This command defines a constant output loss for all measurement points.

Parameters:

<Loss>

Range: -999.99 to 999.99
*RST: 0 dB
Default unit: dB

Example:
```
CORR:LOSS:OUTP:MODE SPOT
CORR:LOSS:OUTP:SPOT 10
```
Selects constant output loss mode and defines an output loss of 10 dB for all measurement points.

Manual control: See "Output Loss" on page 44

[SENSe:]CORRection:LOSS:OUTPut:TABLe <Frequency>, <Loss>

This command defines the contents of the currently selected output loss table.

The table should contain an output loss for all measurement points.

If you create a new table with this command, it will overwrite the current entries of the frequency list.

Parameters:

<Frequency>, <ENR>

Each entry of the loss table consists of one measurement point and the corresponding loss.
The table can contain up to 500 entries.

<Frequency>
Frequency of the measurement point.
The range is from 0 Hz to 999.99 GHz.

<Loss>
Loss of the measurement point.
The range is from -999.99 dB to 999.99 dB.

Example:
```
CORR:LOSS:OUTP:TABL 1MHz,10,2MHz,12
```
Defines a new output loss table with two measurement points.

Manual control: See "Edit Table" on page 41
See "New" on page 45
See "Edit" on page 45

[SENSe:]CORRection:LOSS:OUTPut:TABLe:DELete <TableName>

This command deletes an output loss table.

Parameters:
<TableName> String containing the name of the table.

Example: `CORR:LOSS:OUTP:TABL:DEL 'OutputLoss'`
Deletes the table with the name 'OutputLoss'.

Manual control: See "Delete" on page 45

[SENSe:]CORRection:LOSS:OUTPut:TABLe:SELect <TableName>

This command selects an output loss table.

Parameters:
<TableName> String containing the table name.

Example: `CORR:LOSS:OUTP:TABL:SEL 'OutputLoss'`
Selects a table called 'OutputLoss'.

Manual control: See "Output Loss" on page 44

7.9 Configuring the Analyzer

The following commands are necessary to configure the analyzer.

CONFigure:CORRection

This command configures the software to perform a calibration measurement.

If you initate a measurement with `INITiate[:IMMediate]`, the software initates a calibration instead of the actual measurement.

Example: `CONF:CORR`
Configures to run calibration.
`INIT`
Initiates the calibration.

Usage: Event

Manual control: See "2nd Stage Correction" on page 46
See "Calibrate" on page 54

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level.

Parameters:
<ReferenceLevel> Range: see datasheet
*RST: -30 dBm
Default unit: dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual control: See "Ref Level" on page 47

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:AUTO <State>

This command turns automatic determination of the reference level on and off.

Parameters:
<State> ON | OFF

Example: `DISP:TRAC:Y:RLEV:AUTO ON`
Turns on automatic level detection.

Usage: SCPI confirmed

Manual control: See "Ref Level" on page 47

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:
<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual control: See "RF Attenuation" on page 48

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

The command requires option R&S FSW-B24.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual control: See "Preamplfier" on page 49

[SENSe:]BANDwidth|BWIDth[:RESolution] <Bandwidth>

This command defines the resolution bandwidth.

The command also decouples the resolution bandwidth from the span.

For statistics measurements, this command defines the **demodulation** bandwidth.

Parameters:
<Bandwidth> refer to data sheet
*RST: RBW: AUTO is set to ON; DBW: 3MHz

Example: `BAND 1 MHz`
Sets the resolution bandwidth to 1 MHz

Usage: SCPI confirmed

Manual control: See "Resolution Bandwidth (RBW)" on page 46

[SENSe:]CORRection[:STATe] <State>

This command includes or excludes calibration data in the actual measurement.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CORR ON`
Includes calibration data in the measurement.

[SENSe:]SWEep:COUNt <Averages>

This command defines the number of measurements that are used to average the results.

Parameters:

<Averages> Number of measurements that are performed at a single frequency before average results are displayed.
If you set an average of 0 or 1, the application performs a single measurement at each frequency.

Range: 0 to 32767
*RST: 1

Example: `SWE:COUN 10`
The application averages 10 measurements before it displays the results.

Manual control: See "Average" on page 47

[SENSe:]SWEep:TIME <Time>

This command defines the sweep (or: data capture) time.

Parameters:

<Time> refer to data sheet
*RST: (AUTO is set to ON)

Example: `SWE:TIME 10s`

Usage: SCPI confirmed

Manual control: See "Sweep Time" on page 46

SYSTem:CONFigure:DUT:GAIN <Gain>

This command defines the expected gain of the DUT.

The application uses the gain for automatic reference level detection.

Parameters:

<Gain> Range: 10 to 1000
*RST: 30
Default unit: dB

Example: `SYST:CONF:DUT:GAIN 25`
Defines gain of 25 dB.

Manual control: See "Auto Level Range" on page 48

SYSTem:CONFigure:DUT:STIMe <SettlingTime>

This command defines the settling time of the noise source.

Parameters:

<SettlingTime> Range: 0 s to 20 s
*RST: 50 ms

Example: `SYST:CONF:DUT:STIM 1 s`
Defines a settling time of 1 second.

Manual control: See "Settling Time" on page 47

7.10 Using the Uncertainty Calculator

The following commands are necessary to work with the measurement uncertainty calculator.

CALCulate:UNCertainty:DATA:FREQuency <Frequency>

This command defines the frequency for which the uncertainty should be calculated.

This command is available if you have turned automatic determination of the DUT characteristics off with `CALCulate:UNCertainty:DATA:RESults`.

Parameters:

<Frequency> Frequency of the DUT.
*RST: 1 GHz

Example: `CALC:UNC:DATA:FREQ 100MHZ`
Defines a frequency of 100 MHz.

Manual control: See "Use Measurement Values" on page 51

CALCulate:UNCertainty:DATA:GAIN <Gain>

This command defines the gain of the DUT.

This command is available if you have turned automatic determination of the DUT characteristics off with `CALCulate:UNCertainty:DATA:RESults`.

Parameters:

<Gain> Gain of the DUT.

*RST: 0 dB

Example: `CALC:UNC:DATA:GAIN -5DB`
Defines a DUT gain of -5 dB.

Manual control: See "Use Measurement Values" on page 51

CALCulate:UNCertainty:DATA:NOISe <NoiseLevel>

This command defines the noise level of the DUT.

This command is available if you have turned automatic determination of the DUT characteristics off with `CALCulate:UNCertainty:DATA:RESults`.

Parameters:

<NoiseLevel> Noise level of the DUT.

*RST: 0 dB

Example: `CALC:UNC:DATA:NOIS 10DB`
Defines a DUT noise level of 10 dB.

Manual control: See "Use Measurement Values" on page 51

CALCulate:UNCertainty:DATA:RESults <State>

This command turns automatic determination of the DUT characteristics for the calculation of the uncertainty on and off.

Parameters:

<State>

ON
The application calculates the uncertainty with the DUT characteristics (noise figure, gain and frequency) resulting from the noise figure measurement.

OFF
The application calculates the uncertainty with the DUT characteristics (noise figure, gain and frequency) based on the values you have defined manually.

Example: `CALC:UNC:DATA:RES ON`
Includes the uncertainty in the results displays.

Manual control: See "Use Measurement Values" on page 51

CALCulate:UNCertainty:ENR:UNCertainty <Uncertainty>

This command defines the uncertainty of a noise source.

Parameters:

<Uncertainty> Uncertainty value of the noise source.
Refer to the data sheet of the noise source to determine its uncertainty.

*RST: 0.1 dB

Example: `CALC:UNC:ENR:UNC 0.05`
Defines an uncertainty of 0.05 dB.

Manual control: See "ENR Uncert(ainty)" on page 50

CALCulate:UNCertainty:MATCh:DUT:IN:RL <ReturnLoss>

This command defines the return loss at the DUT input.

Parameters:

<ReturnLoss> *RST: 50.0 dB

Example: `CALC:UNC:MATC:DUT:IN:RL 25DB`
Defines a return loss of 25 dB.

Manual control: See "Input / Output Match" on page 50

CALCulate:UNCertainty:MATCh:DUT:IN:[VSWR] <VSWR>

This command defines the VSWR at the DUT input.

Parameters:

<VSWR> *RST: 1.0

Example: `CALC:UNC:MATC:DUT:IN 1.1`
Defines a VSWR of 1.1 at the DUT input.

Manual control: See "Input / Output Match" on page 50

CALCulate:UNCertainty:MATCh:DUT:OUT:RL <ReturnLoss>

This command defines the returns loss at the DUT output.

Parameters:

<ReturnLoss> *RST: 50.0 dB

Example: `CALC:UNC:MATC:DUT:OUT:RL 40DB`
Defines a return loss of 40 dB at the DUT output.

Manual control: See "Input / Output Match" on page 50

CALCulate:UNCertainty:MATCh:DUT:OUT:[VSWR] <VSWR>

This command defines the VSWR at the DUT output.

Parameters:

<VSWR> *RST: 1.0

Example: `CALC:UNC:MATC:DUT:OUT 2.0`
Defines a VSWR of 2.0 at the DUT output.

Manual control: See "Input / Output Match" on page 50

CALCulate:UNCertainty:MATCh:PREamp:RL <ReturnLoss>

This command defines the return loss at the input of the preamplifier.

Parameters:
<ReturnLoss> *RST: 13.98 dB

Example: `CALC:UNC:MATC:PRE:RL 14.5DB`
Defines a return loss of 14.5 dB.

CALCulate:UNCertainty:MATCh:PREamp[:VSWR] <VSWR>

This command defines the VSWR at the input of the preamplifier.

The command is available if you have turned on the preamplifier with `CALCulate:UNCertainty:PREamp:STATe` on page 96.

Parameters:
<VSWR> *RST: 1.5

Example: `CALC:UNC:MATC:PRE 1.8`
Defines a VSWR of 1.8.

CALCulate:UNCertainty:MATCh:SOURce:RL <ReturnLoss>

This command defines the return loss at the noise source output.

Parameters:
<ReturnLoss> *RST: 23.13 dB

Example: `CALC:UNC:MATC:SOUR:RL 20DB`
Defines a return loss of 20 dB.

Manual control: See "Output Match" on page 50

CALCulate:UNCertainty:MATCh:SOURce[:VSWR] <VSWR>

This command defines the VSWR at the noise source output.

Parameters:
<VSWR> *RST: 1.15

Example: `CALC:UNC:MATC:SOUR 1.4`
Defines a VSWR of 1.4.

Manual control: See "Output Match" on page 50

CALCulate:UNCertainty:PREamp:GAIN <Gain>

This command define the gain of an external preamplifier that may be part of the test setup.

Parameters:

<Gain> **Gain of the preamplifier.**
Refer to the data sheet of the preamplifier to determine its gain.
*RST: 20 dB

Example: `CALC:UNC:PRE:GAIN 15DB`
Defines a gain of 15 dB.

CALCulate:UNCertainty:PREamp:NOISe <NoiseLevel>

This command defines the noise level of an external preamplifier that may be part of the test setup.

Parameters:

<NoiseLevel> Noise level of the preamplifier.
Refer to the data sheet of the preamplfier to determine its noise level.
*RST: 5 dB

Example: `CALC:UNC:PRE:NOIS 10DB`
Defines a noise level of 10 dB.

CALCulate:UNCertainty:PREamp:STATe <State>

This command includes or excludes an external preamplifier from the uncertainty calculation.

If the test setup uses an external preamplifier, you also have to define its noise figure and gain values.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:UNC:PRE:STAT ON`
Turns the preamplifier on.

CALCulate:UNCertainty[:RESult]?

This command queries the uncertainty of noise figure results.

Return values:

<Uncertainty> Measurement uncertainty in dB.

Example: `CALC:UNC?`
Queries the uncertainty.

Usage: Query only

7.11 Performing Measurements

The following commands are necessary to perform noise figure measurements.

Example: perform calibration and subsequent single sweep measurement

```
//Perform calibration:
CONF:CORR
INIT;*OPC?
//Perform single sweep measurement and use 2nd stage correction:
CORR:STAT ON
CONF:LIST:SING
INIT
```

You can also perform a sequence of measurements using the Sequencer (see "Multiple Measurement Channels and Sequencer Function" on page 11).

ABORt

This command aborts a current measurement 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 see the "Remote Basics" chapter in the R&S FSW User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate:SEQuencer:ABORt` on page 99 command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel (GPIB, LAN or other interface) to the R&S FSW 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 FSW 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: SCPI confirmed

INITiate:CONTinuous <State>

This command controls the sweep mode.

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 the "Remote Basics" chapter in the R&S FSW User Manual.

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 99) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: ON

Example: `INIT:CONT OFF`
Switches the sweep mode to single sweep.
`INIT:CONT ON`
Switches the sweep mode to continuous sweep.

Manual control: See "Continuous Sweep/RUN CONT" on page 53

INITiate[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Example: (For Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Sets the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.

Manual control: See "Single Sweep/ RUN SINGLE" on page 54
See "Calibrate" on page 54

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate:SEQuencer:IMMediate` on page 99.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 100.

Usage: Event

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer. Its effect is similar to the `INITiate[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 100).

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate:SEQuencer:MODE <Mode>

This command selects the way the R&S FSW application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 100).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequencer mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single Sequencer mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Parameters:

<State> ON | OFF

ON
The Sequencer is activated and a sequential measurement is started immediately.

OFF
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: OFF

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

7.12 Configuring the Display

The following commands are necessary to configure and scale the result displays.

DISPlay[:WINDow<n>]:TRACe:SYMBols <State>

This command turns symbols that represent the measurement points on a trace on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `DISP:WIND2:TRAC:SYMB ON`
Switches on the display of symbols in window 2..

Manual control: See "Symbols" on page 56

DISPlay[:WINDow<n>]:TRACe:X[:SCALe] <Frequency>

This command selects the type of frequency displayed on the x-axis.

Parameters:
<Frequency> **IF**
Intermediary frequency, e.g. for measurements on frequency converting DUTs.
RF
Radio frequency.
*RST: RF

Example: `CONF:MODE:DUT DOWN`
The DUT converts the input frequency to a lower output frequency.
`DISP:TRAC:X RF`
Shows the RF frequency on the x-axis.

Manual control: See "X-Axis" on page 56

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:BOTTom <Level>

This command defines the bottom value of the y-axis.

Parameters:

<Level> The value ranges depend on the result display.

Noise figure
-75 dB to 75 dB

Noise temperature
-999990000 K to 999990000 K

Y-factor
-200 dB to 200 dB

Gain
-75 dB to 75 dB

Power (hot)
-200 dBm to 200 dBm

Power (cold)
-200 dBm to 200 dBm

Example:
```
DISP:WIND2:TRAC:Y:SCAL:AUTO OFF
DISP:WIND2:TRAC:Y:BOTT
```

Usage: SCPI confirmed

Manual control: See "Auto Scale / Min / Max" on page 56

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO <State>

This command turns automatic scaling of the y-axis on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example:
```
DISP:WIND2:TRAC:Y:AUTO ON
```
Turns on automatic scaling for measurement window 2.

Usage: SCPI confirmed

Manual control: See "Auto Scale / Min / Max" on page 56

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:TOP <Level>

This command defines the top value of the y-axis.

Parameters:

<Level> The value ranges depend on the result display.

Noise figure
-75 dB to 75 dB

Noise temperature
-999990000 K to 999990000 K

Y-factor
-200 dB to 200 dB

Gain
-75 dB to 75 dB

Power (hot)
-200 dBm to 200 dBm

Power (cold)
-200 dBm to 200 dBm

Example:
```
DISP:WIND2:TRAC:Y:SCAL:AUTO OFF
DISP:WIND2:TRAC:Y:TOP
```

Usage: SCPI confirmed

Manual control: See "Auto Scale / Min / Max" on page 56

7.13 Working with Traces

The following commands are necessary to define trace characteristics.

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command selects the trace mode.

Parameters:

<Mode> BLANk | VIEW | WRITe

*RST: Trace 1: WRITe, Trace 2-4: BLANk

Example: `INIT:CONT OFF`
Switching to single sweep mode.
`SWE:COUN 16`
Sets the number of measurements to 16.
`DISP:TRAC3:MODE WRIT`
Selects clear/write mode for trace 3.
`INIT;*WAI`
Starts the measurement and waits for the end of the measurement.

Manual control: See "Traces" on page 57

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Parameters:
<State> ON | OFF
*RST: Trace 1: ON, Trace 2-4: OFF

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from the R&S FSW to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSW. The R&S FSW automatically recognizes the data it receives, regardless of the format.

Parameters:
<Format> **ASCii**
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>
COMMa
Uses a comma as decimal separator, e.g. *4,05*.
POINt
Uses a point as decimal separator, e.g. *4.05*.
*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual control: See "Trace Export" on page 58

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

Parameters:

<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3,'TEST.ASC'`
Stores trace 3 from window 1 in the file `TEST.ASC`.

Usage: SCPI confirmed

Manual control: See "Trace Export" on page 58

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Parameters:

<TraceNumber>, <TraceNumber>
TRACE1 | TRACE2 | TRACE3 | TRACE4
The first parameter is the destination trace, the second parameter is the source.

Example: `TRAC:COPY TRACe1,TRACe2`
Copies the data from trace 2 to trace 1.

Usage: SCPI confirmed

Manual control: See "Copy Trace" on page 58

7.14 Working with Limit Lines

The following commands are necessary to set up limit lines and checks.

When configuring limit lines for the noise figure application via remote control, you have to send some commands in a defined order.

1. Select the limit line you want to configure by name or create a new limit line name.
2. Select the result type you want to apply the limit line to.

   The application automatically selects the unit and scale to make the line compatible to the result type.
3. Define the horizontal data points of the limit line.
4. Define the vertical data points of the limit line. Depending on the command syntax you are using, the shape also defines if the limit line is an upper or lower limit line (`CALCulate:LIMit:UPPer:...` or `CALCulate:LIMit:LOWer:...`).

Example: Configure an upper limit line for the Noise Figure result type

```
//Select or create the limit line by name.
CALC:LIM:NAME 'NoiseFigure'
//Comment on the limit line.
CALC:LIM:COMM 'Limit line to test noise figure results'
//Select the result type (here: Noise Figure) to apply the limit line to.
CALC:LIM:TYPE NOIS
//Define the horizontal data points of the limit line.
CALC:LIM:CONT 100MHZ,850MHZ
//Shift the limit line 50 MHz to the left.
CALC:LIM:CONT:SHIF -50MHZ
//Define the vertical data points of an (upper) limit line.
//The unit is fix according to the result type you have selected.
CALC:LIM:UPP 10,10
//Shift the limit line 5 dB down.
CALC:LIM:UPP:SHIF -5
//Turn the limit line on.
CALC:LIM:UPP:STAT ON
//Select the trace to check.
CALC:LIM:TRAC 1
//Turn on the limit check.
CALC:LIM:STAT ON
//Query the limit check results.
CALC:LIM:FAIL?
```

7.14.1 Defining General Characteristics of a Limit Line

CALCulate:LIMit:COMMent <Comment>

This command defines a comment for a limit line.

Parameters:

<Comment> String containing the description of the limit line. The comment may have up to 40 characters.

Manual control: See "Comment" on page 65

CALCulate:LIMit<k>:NAME <Name>

This command selects a limit line that already exists or defines a name for a new limit line.

Parameters:

<Name> String containing the limit line name.

*RST: REM1 to REM8 for lines 1 to 8

Manual control: See "Name" on page 64

CALCulate:LIMit<k>:TYPE <Result>

This command configures a limit line for a particular result type.

Parameters:

<Result>

GAIN
Assigns the limit line to gain reuslts.

NOISe
Assigns the limit line to noise figure results.

PCOLd
Assigns the limit line to power (cold) results.

PHOT
Assigns the limit line to power (hot) results.

TEMPerature
Assigns the limit line to noise temperature results.

YFACtor
Assigns the limit line to y-factor results.

Example: `CALC:LIM2:TYPE GAIN`
Assigns limit line 2 to the gain result display.

7.14.2 Defining Horizontal Data Points

Note that the number of data points on the horizontal axis should be the same as the number of data points on the vertical axis. Otherwise the limit line may take on an unintended shape.

Example: Number of vertical data points < number of horizontal data points

```
CALC:LIM:CONT 100MHZ,200MHZ,300MHZ,400MHZ,500MHZ
CALC:LIM:UPP 0,5,0
```

⇒ the application dumps 400 and 500 MHz.

Example: Number of vertical data points > number of horizontal data points

```
CALC:LIM:CONT 100MHZ,200MHZ,300MHZ,400MHZ,500MHZ
CALC:LIM:UPP 0,5,0,5,0,5,0
```

⇒ the application adds new horizontal data points (500.00000100 MHz and 500.00000200 MHz).

CALCulate:LIMit<k>:CONTrol[:DATA] <LimitLinePoints>

This command defines the horizontal definition points of a lower 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:LIMit<k>:LOWer[:DATA]` or `CALCulate:LIMit<k>:UPPer[:DATA]`. If not, the R&S FSW either adds missing values or ignores surplus values.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual control: See "Data points" on page 65

CALCulate:LIMit<k>:CONTrol:SHIFt <Distance>

This command moves a complete limit line horizontally.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Numeric value.
The unit depends on the scale of the x-axis.

Manual control: See "Shift x" on page 65

7.14.3 Controlling Lower Limit Lines

CALCulate:LIMit<k>:LOWer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of a lower 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:LIMit<k>:CONTrol[:DATA]`. If not, the R&S FSW either adds missing values or ignores surplus values.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual control: See "Data points" on page 65

CALCulate:LIMit<k>:LOWer:SHIFt <Distance>

This command moves a complete lower limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Defines the distance that the limit line moves.

Manual control: See "Shift y" on page 65

CALCulate:LIMit<k>:LOWer:STATe <State>

This command turns a lower limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate:LIMit<k>:NAME` on page 107.

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual control: See "Visibility" on page 63

7.14.4 Controlling Upper Limit Lines

CALCulate:LIMit<k>:UPPer[:DATA] <LimitLinePoints>

This command defines the vertical definition points of an upper 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:LIMit<k>:CONTrol[:DATA]`. If not, the R&S FSW either adds missing values or ignores surplus values.

*RST: Limit line state is OFF

Usage: SCPI confirmed

Manual control: See "Data points" on page 65

CALCulate:LIMit<k>:UPPer:SHIFt <Distance>

This command moves a complete upper limit line vertically.

Compared to defining an offset, this command actually changes the limit line definition points by the value you define.

Parameters:

<Distance> Defines the distance that the limit line moves.

Usage: Event

Manual control: See "Shift y" on page 65

CALCulate:LIMit<k>:UPPer:STATe <State>

This command turns an upper limit line on and off.

Before you can use the command, you have to select a limit line with `CALCulate:LIMit<k>:NAME` on page 107.

Parameters:

<State> ON | OFF

*RST: OFF

Usage: SCPI confirmed

Manual control: See "Visibility" on page 63

7.14.5 Managing Limit Lines

CALCulate:LIMit:ACTive?

This command queries the names of all active limit lines.

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 control: See "Visibility" on page 63

CALCulate:LIMit<k>:COPY <Line>

This command copies a 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 control: See "Copy Line" on page 63

CALCulate:LIMit<k>:DELete

This command deletes a limit line.

Usage: Event

Manual control: See "Delete Line" on page 63

7.14.6 Controlling Limit Checks

CALCulate:LIMit: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.

Example: `CALC:LIM:CLE`
Deletes the result of the limit check.

Usage: SCPI confirmed

CALCulate<n>:LIMit<k>:FAIL

This command queries the result of a limit check.

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 sweeps. See also `INITiate:CONTinuous` on page 98.

Return values:
<Result> **0**
PASS
1
FAIL

Example: `INIT;*WAI`
Starts a new sweep and waits for its end.
`CALC:LIM3:FAIL?`
Queries the result of the check for limit line 3.

Usage: SCPI confirmed

CALCulate:LIMit<k>:STATe <State>

This command turns the limit check on and off.

To query the limit check result, use `CALCulate<n>:LIMit<k>:FAIL`.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:LIM:STAT ON`
Switches on the limit check for limit line 1.

Usage: SCPI confirmed

Manual control: See "Disable All Lines" on page 64

CALCulate:LIMit<k>:TRACe <TraceNumber>

This command links a limit line to one or more traces.

Parameters:
<TraceNumber> 1 to 4
*RST: 1

Example: `CALC:LIM2:TRAC 3`
Assigns limit line 2 to trace 3.

Manual control: See "Traces to be Checked" on page 63

7.15 Working with Markers

The following commands are necessary to work with markers.

7.15.1 Using Markers

Note that the suffix at `CALCulate` has an effect only if you query the characteristics of a marker. If you set a marker, you can ignore the suffix because the markers are linked to each other over all measurement windows and will always be on the same frequency.

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual control: See "All Markers Off" on page 59

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual control: See "Marker Type" on page 59

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.

Parameters:
<Trace> **1 to 4**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Note that markers have to be positioned on a discrete frequency that is part of the frequency list. If you set the marker on a frequency not included in the frequency list, the application positions the marker to the nearest frequency in the list (rounding up or down).

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
The unit is Hz.
Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

CALCulate<n>:MARKer<m>:Y? <Result>

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 98.

Parameters:

<Result> Selects the result.

GAIN
Queries gain reuslts.

NOISe
Queries noise figure results.

NUNCertainty
Queries the noise figure uncertainty results.

PCOLd
Queries power (cold) results.

PHOT
Queries power (hot) results.

TEMPerature
Queries noise temperature results.

YFACtor
Queries y-factor results.

Return values:

<Result> Result at the marker position.

Example:

```
INIT:CONT OFF
```
Switches to single measurement mode.
```
CALC:MARK2 ON
```
Switches marker 2.
```
INIT;*WAI
```
Starts a measurement and waits for the end.
```
CALC:MARK2:Y?
```
Outputs the measured value of marker 2.

Usage: Query only

Manual control: See "Marker Table" on page 19

7.15.2 Using Delta Markers

Note that the suffix at `CALCulate` has an effect only if you query the characteristics of a marker. If you set a marker, you can ignore the suffix because the markers are linked to each other over all measurement windows and will always be on the same frequency.

CALCulate<n>:DELTamarker:AOFF

This command turns all delta markers off.

Example: CALC:DELT:AOFF
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>:MREF <Reference>

This command selects a reference marker for a delta marker other than marker 1.

The reference may be another marker or the fixed reference.

Parameters:

<Reference> **1 to 16**
Selects markers 1 to 16 as the reference.

FIXed
Selects the fixed reference as the reference.

Example: CALC:DELT3:MREF 2
Specifies that the values of delta marker 3 are relative to marker 2.

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.

Parameters:

<State> ON | OFF

*RST: OFF

Example: CALC:DELT2 ON
Turns on delta marker 2.

Manual control: See "Marker Type" on page 59

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.

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.

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.

CALCulate<n>:DELTamarker<m>:Y? <Result>

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 98.

The unit depends on the application of the command.

Parameters:

<Result> Selects the result.

GAIN
Queries gain reuslts.

NOISe
Queries noise figure results.

PCOLd
Queries power (cold) results.

PHOT
Queries power (hot) results.

TEMPerature
Queries noise temperature results.

YFACtor
Queries y-factor results.

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

Manual control: See "Marker Table" on page 19

7.15.3 Positioning Markers

If you are using more than one window, the application performs the peak search in the window that you have selected with the suffix at `CALCulate` only. Because the markers are linked, the frequency position of the marker in the other windows is adjusted accordingly, even if it means that the marker is on a peak in the selected window only.

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

Usage: Event

Manual control: See "Search Next Peak" on page 61

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Peak Search" on page 61

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

Usage: Event

Manual control: See "Search Next Minimum" on page 61

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Search Minimum" on page 61

7.15.4 Positioning Delta Markers

If you are using more than one window, the application performs the peak search in the window that you have selected with the suffix at `CALCulate` only. Because the markers are linked, the frequency position of the marker in the other windows is adjusted accordingly, even if it means that the marker is on a peak in the selected window only.

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

Usage: Event

Manual control: See "Search Next Peak" on page 61

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Peak Search" on page 61

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

Usage: Event

Manual control: See "Search Next Minimum" on page 61

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker hasn't been active yet, the command first activates the marker.

Usage: Event

Manual control: See "Search Minimum" on page 61

7.16 Using the Status Register

The status reporting system stores information about the current state of the R&S FSW. This includes, for example, information about errors during operation or information about limit checks. The R&S FSW 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 FSW-K30 features several status registers that are specific to noise figure measurements. Here is a description of those, including the corresponding remote commands.

7.16.1 Status Registers for Noise Figure Measurements

The figure below shows the status registers of the noise figure application.

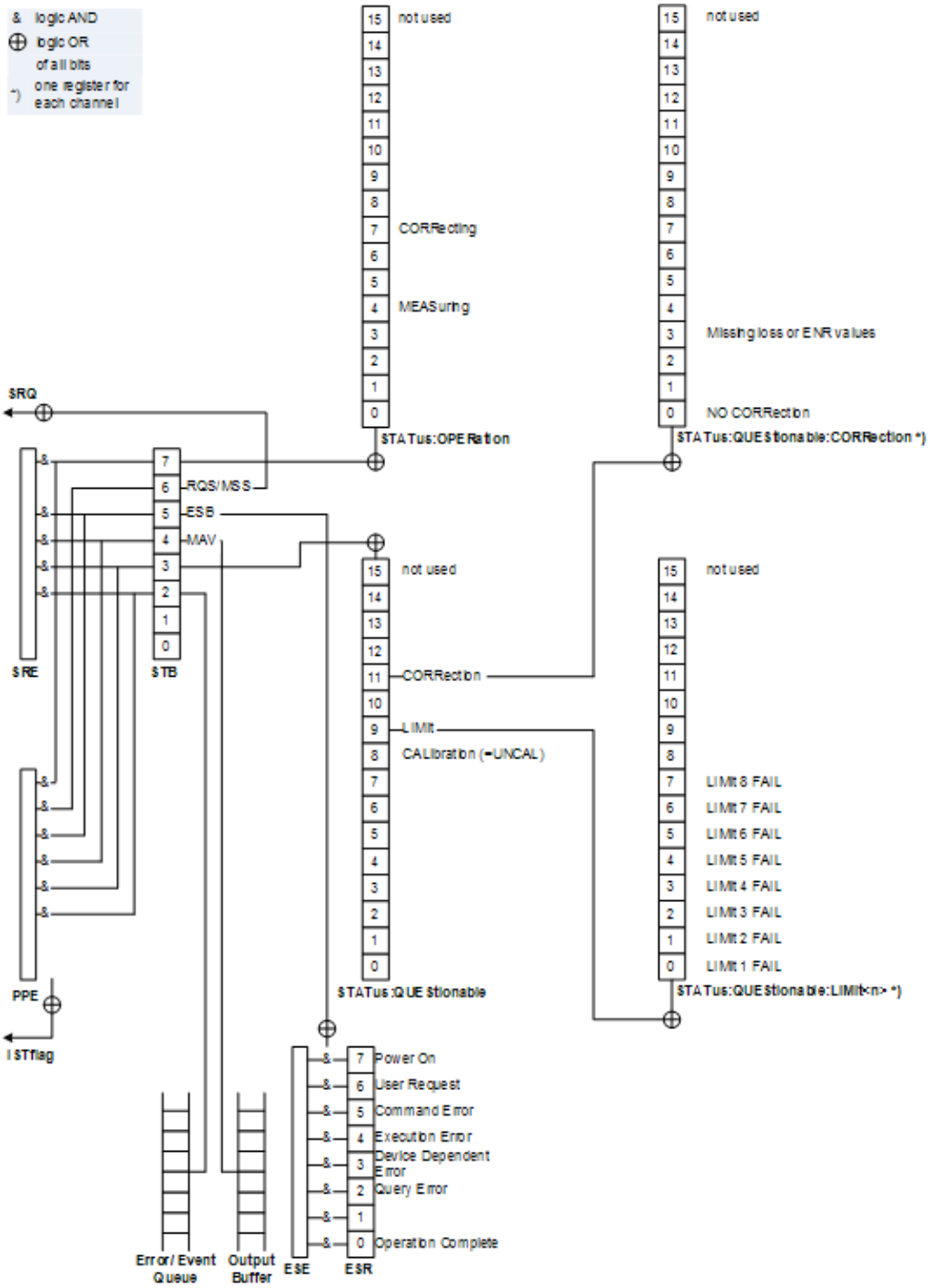


Fig. 7-1: Status registers for noise figure measurements

The R&S FSW 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.

7.16.1.1 STATus:OPERation Register

The `STATus:OPERation` register contains information on current activities of the R&S FSW. It also contains information on activities that have been executed since the last read out.

Bit no	Meaning
0 to 3	Unavailable for noise figure measurements.
4	MEASuring This bit is set if a measurement is in progress.
5 to 6	Unavailable for noise figure measurements.
7	CORRecting This bit is set if a 2nd stage correction is in progress.
8	HCOPy This bit is set if a hardcopy is created.
9 - 14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.16.1.2 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 7	Unavailable for noise figure measurements.
8	CALibration This bit is set if the R&S FSW is not calibrated.
9	LIMit This bit is set if a limit line is violated.
10	Unavailable for noise figure measurements.
11	CORRection This bit is set if the noise figure calibration is questionable.
14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.16.1.3 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 to 14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.16.1.4 STATus:QUEStionable:CORRection Register

The `STATus:QUEStionable:CORRection` register contains information about the calibration status of noise figure measurements.

Bit no	Meaning
0	NO CORRection This bit is set if calibration is required.
1 to 2	Unavailable for noise figure measurements.
3	Missing Loss or ENR values This bit is set if loss or ENR values are missing for one or more measurement frequencies.

Bit no	Meaning
4 to 14	Unavailable for noise figure measurements.
15	This bit is always 0.

7.16.1.5 Status Register Remote Commands

STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:CORRection[:EVENt]? <ChannelName>
STATus:QUEStionable:LIMit[: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:CORRection:CONDition? <ChannelName>
STATus:QUEStionable:LIMit: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:CORRection:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit: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:CORRection:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit: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:CORRection:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit: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.

7.17 Deprecated Remote Commands for Noise Figure Measurements

Following is a list of deprecated remote commands. The remote commands are still supported to maintain compatibility to previous versions of noise figure measurements (like the R&S FSV-K30), but it is strongly recommended to use the command system in the way it is meant to be used in the R&S FSW-K30.

Legacy command	Replaced by	Comment
`CALCulate:LIMit:TRACe`	`CALCulate:LIMit:TYPE`	Parameters `NFIGure`, `TEFFective` and `GAIN` were supported to assign a limit line to a result and thus the trace because trace and result type were fix. `CALCulate:LIMit:TRACe` now assigns the limit line to a trace (1 to 4).
`CALCulate:MARKer:TRACe` `CALCulate:DELTamarker:TRACe`		The parameters `NOISe`, `GAIN`, `NMEM1-3` and `GMEM1-3` have been replaced by `1 | 2 | 3 | 4` because no distinction is made between memory and live trace.
`CONFigure:ARRay:MEMory`	`TRACe:COPY`	No more distinction between memory and live traces.
`DISPlay:ARRay:MEMory:STATe` `DISPlay:CURRent:DATA:STATe`	`DISPlay:WINDow:TRACe:STATe`	No more distinction between memory and live traces.
`DISPlay:DATA:TRACe`	`LAYout` system	
`DISPlay:FORMat`	---	Functionality not supported any more.
`DISPlay:WINDow:TABLe`	`LAYout:WINDow:REPLace` / `LAYout:REPLace:WINDow`	
`FETCh:` command system	`TRACE:DATA`	
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List of Remote Commands (Noise Figure)

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