R&S®ZNL
I/Q Analyzer (Option R&S®ZNL3|4|6-B1)
User Manual

1178598902

User Manual

Version 09

ROHDE&SCHWARZ

This manual applies to the following R&S®ZNL models with firmware version 1.35 and higher:

- R&S®ZNL3, 5 kHz to 3 GHz, 2 ports, N(f) connectors, order no. 1323.0012.03
- R&S®ZNL4, 5 kHz to 4.5 GHz, 2 ports, N(f) connectors, order no. 1323.0012.04
- R&S®ZNL6, 5 kHz to 6 GHz, 2 ports, N(f) connectors, order no. 1323.0012.06

The following firmware options are described:

- R&S®ZNL3-B1 Spectrum Analysis (1323.1802.02)
- R&S®ZNL4-B1 Spectrum Analysis (1303.8099.02)
- R&S®ZNL6-B1 Spectrum Analysis (1323.2067.02)

In addition to the I/Q Analyzer application, the following options are described:

- R&S®FPL1-B5, Additional Interfaces (1323.1883.02)
- R&S®FPL1-K9 Power Sensor Support (1323.1754.02)
- R&S®FPL1-B40, Bandwidth extension 40 MHz (1323.1931.02)

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1178.5989.02 | Version 09 | R&S®ZNL

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

Contents

1 Preface

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

1.1 Documentation-Overview

This section provides an overview of the R&S ZNL user documentation. Unless specified otherwise, you find the documents on the R&S ZNL product page at:

www.rohde-schwarz.com/manual/ZNL or www.rohde-schwarz.com/manual/ZNLE.

1.1.1 Getting Started Manual

Introduces the R&S ZNL and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc.

A printed version is delivered with the instrument. A PDF version is available for download on the Internet.

1.1.2 User Manuals and Help

Separate user manuals are provided for the base unit and the firmware applications:

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- Firmware application manual
  Contains the description of the specific functions of a firmware application, including remote control commands. Basic information on operating the R&S ZNL is not included.

The contents of the user manuals are available as help in the R&S ZNL. The help offers quick, context-sensitive access to the complete information for the base unit and the firmware applications.

All user manuals are also available for download or for immediate display on the Internet.

1.1.3 Service Manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS):

https://gloris.rohde-schwarz.com

1.1.4 Instrument Security Procedures

Deals with security issues when working with the R&S ZNL in secure areas. It is available for download on the Internet.

1.1.5 Basic Safety Instructions

Contains safety instructions, operating conditions and further important information. The printed document is delivered with the instrument.

1.1.6 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S ZNL. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/ZNL or www.rohde-schwarz.com/brochure-datasheet/ZNLE.

1.1.7 Release Notes and Open Source Acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation.

The open-source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/ZNL or www.rohde-schwarz.com/firmware/ZNLE.

1.1.8 Application Notes, Application Cards, White Papers, etc.

These documents deal with special applications or background information on particular topics.

See www.rohde-schwarz.com/application/ZNL or www.rohde-schwarz.com/application/ZNLE.

1.1.9 Calibration Certificate

The document is available on https://gloris.rohde-schwarz.com/calcert. You need the device ID of your instrument, which you can find on a label on the rear panel.

1.2 Conventions Used in the Documentation

1.2.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
[Keys]	Key and knob names are enclosed by square brackets.
`Filenames, commands, program code`	Filenames, commands, coding samples and screen output are distinguished by their font.
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.

1.2.2 Conventions for Procedure Descriptions

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

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

1.2.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as many as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

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

2 Welcome to the I/Q Analyzer Application

The R&S FPL1 I/Q Analyzer is a firmware application that adds functionality to perform I/Q data acquisition and analysis to the R&S ZNL.

The R&S FPL1 I/Q Analyzer features:

- Acquisition of analog I/Q data
- Import of stored I/Q data from other applications
- Spectrum, magnitude, I/Q vector and separate I and Q component analysis of any I/Q data on the instrument
- Export of I/Q data to other applications

Availability of the I/Q Analyzer

The I/Q Analyzer becomes available when you equip the R&S ZNL3, R&S ZNL4 or R&S ZNL6 with the optional Spectrum Analyzer hardware (R&S ZNL3|4|6-B1).

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 ZNL User Manual. The latest version is available for download at the product homepage http://www.rohde-schwarz.com/product/ZNL.

Additional information

Several application notes discussing I/Q analysis are available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

1EF92: Wideband Signal Analysis

1MA257: Wideband mm-Wave Signal Generation and Analysis

1EF84: Differential measurements with Spectrum Analyzers and Probes

Installation

The R&S FPL1 I/Q Analyzer application is part of the optional Spectrum application and requires no further installation.

2.1 Starting the I/Q Analyzer Application

The I/Q Analyzer is an application on the R&S ZNL.

To activate the I/Q Analyzer application

1. Select the [MODE] key.

A dialog box opens that contains all applications currently available on your R&S ZNL.

2. Select the "I/Q Analyzer" item.

The R&S ZNL opens a new channel setup for the I/Q Analyzer application.

The measurement is started immediately with the default settings.

It can be configured in the I/Q Analyzer "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see Chapter 5.1, "Configuration Overview", on page 28).

Multiple Channel Setups and Sequencer Function

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

The number of channel setups 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 setup. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

If activated, the measurements configured in the currently defined channel setups 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 channel setups are updated in the tabs (as well as the "MultiView") as the measurements are performed. Sequential operation itself is independent of the currently *displayed* tab.

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

2.2 Understanding the Display Information

The following figure shows a measurement diagram during I/Q Analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.

Figure 2-1: Screen elements in the I/Q Analyzer application

1 = Channel Setup bar for firmware and measurement settings
2+3 = Window title bar with diagram-specific (trace) information
4 = Diagram area with marker information
5 = Diagram footer with diagram-specific information, depending on result display
6 = Instrument status bar with error messages and date/time display

Channel Setup bar information

In the I/Q Analyzer application, the R&S ZNL shows the following settings:

Table 2-1: Information displayed in the channel setup bar for the I/Q Analyzer application

Ref Level	Reference level
(m.+el.)**Att**	(Mechanical and electronic) RF attenuation
Ref Offset	Reference level offset
Freq	Center frequency
Meas Time	Measurement time
Rec Length	Defined record length (number of samples to capture)
SRate	Defined sample rate for data acquisition
RBW	(Spectrum evaluation only) Resolution bandwidth calculated from the sample rate and record length

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

Window title bar information

For each diagram, the header provides the following information:

Figure 2-2: Window title bar information in the I/Q Analyzer application

1 = Window number
2 = Window type
3 = Trace color
4 = Trace number
5 = Detector
6 = Trace mode

Diagram footer information

The information in the diagram footer (beneath the diagram) depends on the evaluation:

- Center frequency
- Number of sweep points
- Range per division (x-axis)
- Span (Spectrum)

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram.

3 Measurement and Result Displays

Access: "Overview" > "Display Config"

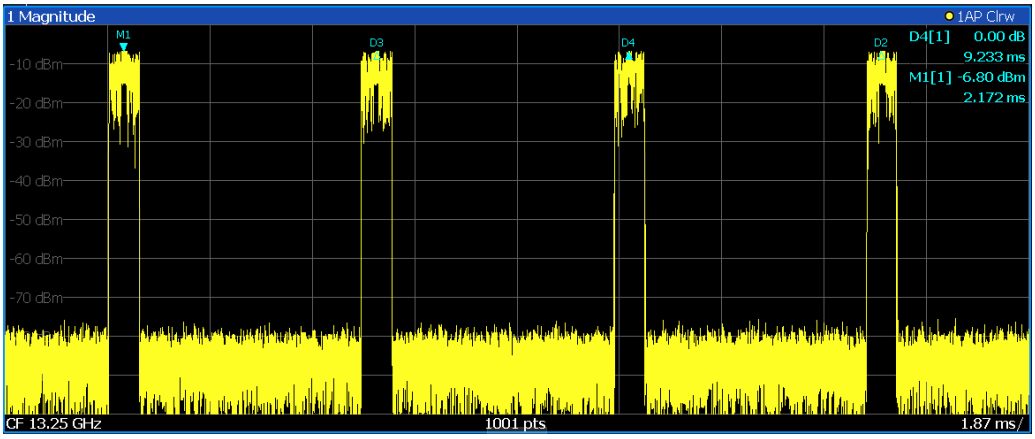
Or: [MEAS] > "Display Config"

The I/Q Analyzer can capture I/Q data. The I/Q data that was captured by or imported to the R&S ZNL can then be evaluated in various different result displays. Select the result displays using the SmartGrid functions.

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

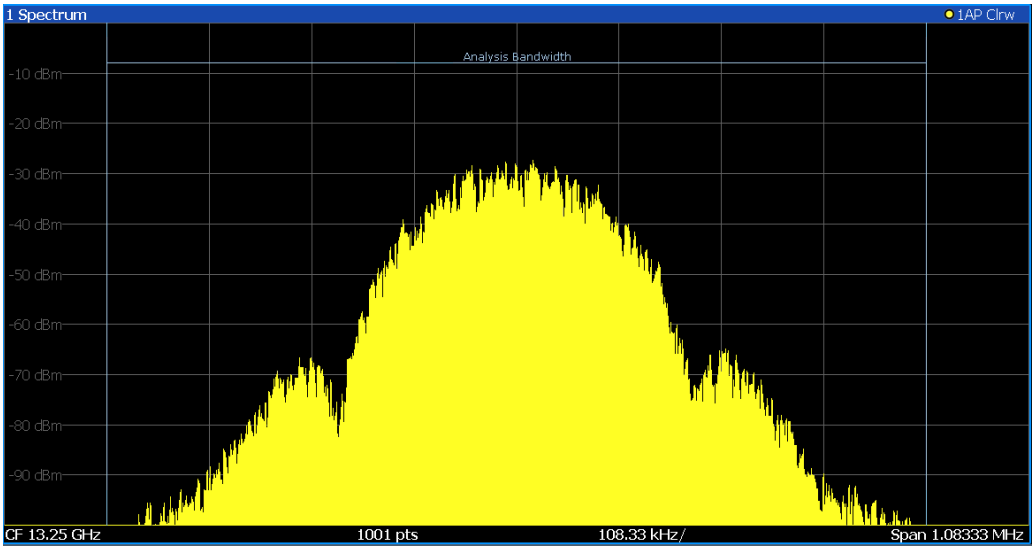
Result displays for I/Q data:

Magnitude
Shows the level values in time domain.



Remote command:
`LAY:ADD:WIND? '1',RIGH,MAGN`, see `LAYout:ADD[:WINDow]?` on page 146
Results:
`TRACe<n>[:DATA]?` on page 211

Spectrum
Displays the frequency spectrum of the captured I/Q samples.

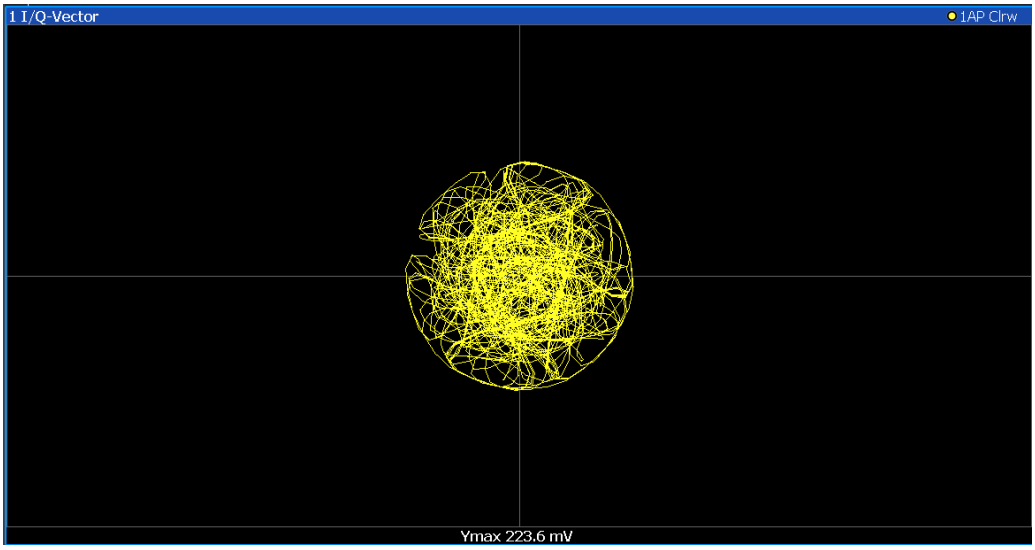


The specified Analysis Bandwidth is indicated by vertical blue lines.

Note that a peak search is performed only within the indicated Analysis Bandwidth, unless you specify Search Limits (Left / Right) in the marker settings.

Remote command:
`LAY:ADD:WIND? '1',RIGH,FREQ`, see `LAYout:ADD[:WINDow]?` on page 146
Results:
`TRACe<n>[:DATA]?` on page 211

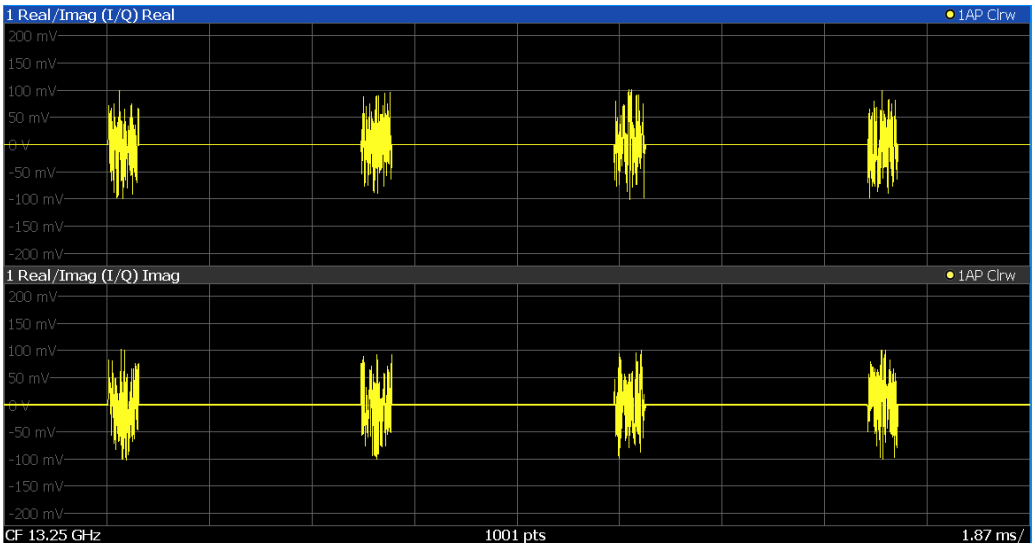
I/Q-Vector
Displays the captured samples in an I/Q-plot. The samples are connected by a line.



Note: For the I/Q vector result display, the number of I/Q samples to record ("Record Length") must be identical to the number of trace points to be displayed ("Sweep Points"; for I/Q Analyzer: 10001). For record lengths outside the valid range of sweep points the diagram does not show valid results.

Remote command:
LAY:ADD:WIND? '1',RIGH,VECT, see LAYout:ADD[:WINDow]? on page 146
Results:
TRACe<n>[:DATA]? on page 211

Real/Imag (I/Q)
Displays the I and Q values in separate diagrams.

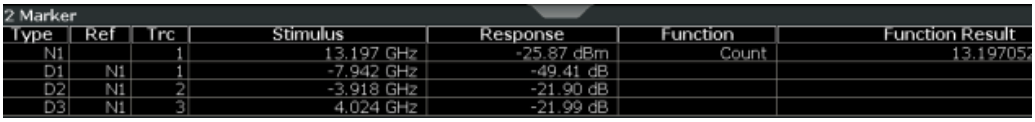


Remote command:
LAY:ADD:WIND? '1',RIGH,RIM, see LAYout:ADD[:WINDow]? on page 146
Results:
TRACe<n>[:DATA]? on page 211

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

This table is displayed automatically if configured accordingly.

(See "Marker Table Display" on page 77).

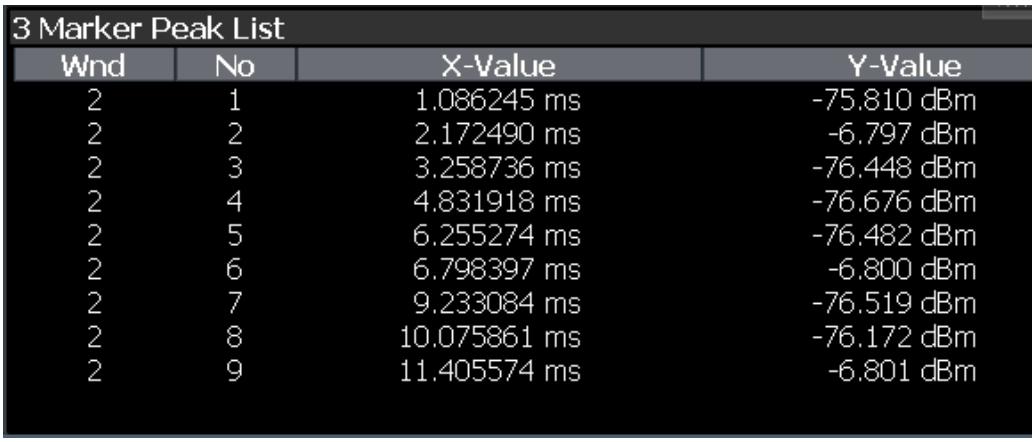


Tip: To navigate within long marker tables, simply scroll through the entries with your finger on the touchscreen.

Remote command:
LAY:ADD? '1',RIGH, MTAB, see LAYout:ADD[:WINDow]? on page 146
Results:
CALCulate<n>:MARKer<m>:X on page 177
CALCulate<n>:MARKer<m>:Y on page 216

Marker Peak List

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



3 Marker Peak List

Wnd	No	X-Value	Y-Value
2	1	1.086245 ms	-75.810 dBm
2	2	2.172490 ms	-6.797 dBm
2	3	3.258736 ms	-76.448 dBm
2	4	4.831918 ms	-76.676 dBm
2	5	6.255274 ms	-76.482 dBm
2	6	6.798397 ms	-6.800 dBm
2	7	9.233084 ms	-76.519 dBm
2	8	10.075861 ms	-76.172 dBm
2	9	11.405574 ms	-6.801 dBm

Remote command:

`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 146

Results:

`CALCulate<n>:MARKer<m>:X` on page 177

`CALCulate<n>:MARKer<m>:Y` on page 216

4 Basics on I/Q Data Acquisition and Processing

Some background knowledge on basic terms and principles used when describing I/Q data acquisition on the R&S ZNL in general, and in the I/Q Analyzer application in particular, is provided here for a better understanding of the required configuration settings.

The I/Q Analyzer provides various possibilities to acquire the I/Q data to be analyzed:

- Capturing analog I/Q data from the [RF Input] connector
- Importing I/Q data from a file

Background information for all these scenarios and more is provided in the following sections.

4.1 Processing Analog I/Q Data from RF Input

Complex baseband data

In the telephone systems of the past, baseband data was transmitted unchanged as an analog signal. In modern phone systems and in radio communication, however, the baseband data is modulated on a carrier frequency, which is then transmitted. The receiver must demodulate the data based on the carrier frequency. When using modern modulation methods (e.g. QPSK, QAM etc.), the baseband signal becomes complex. Complex data (or: *I/Q* data) consists of an imaginary (I) and a real (Q) component.

Sweep vs sampling

The standard Spectrum application on the R&S ZNL performs frequency sweeps on the input signal and measurements in the frequency and time domain. Other applications on the R&S ZNL, such as the I/Q Analyzer, sample and process the individual I and Q components of the complex signal.

I/Q Analyzer - processing complex data from RF input

The I/Q Analyzer is a standard application used to capture and analyze I/Q data on the R&S ZNL. By default, it assumes the I/Q data is modulated on a carrier frequency and input via the "RF Input" connector on the R&S ZNL.

The A/D converter samples the IF signal at a rate of 100 MHz. The digital signal is down-converted to the complex baseband, lowpass-filtered, and the sample rate is

reduced. The analog filter stages in the analyzer cause a frequency response which adds to the modulation errors. An **equalizer filter** before the **resampler** compensates for this frequency response. The continuously adjustable sample rates are realized using an optimal decimation filter and subsequent resampling on the set sample rate.

A dedicated memory (**capture buffer**) is available in the R&S ZNL for a maximum of 25 Msamples (25*1000*1000) of complex samples (pairs of I and Q data). The number of complex samples to be captured can be defined (for restrictions refer to Chapter 4.1.1, "Sample Rate and Maximum Usable I/Q Bandwidth for RF Input", on page 18).

The block diagram in Figure 4-1 shows the analyzer hardware from the IF section to the processor.

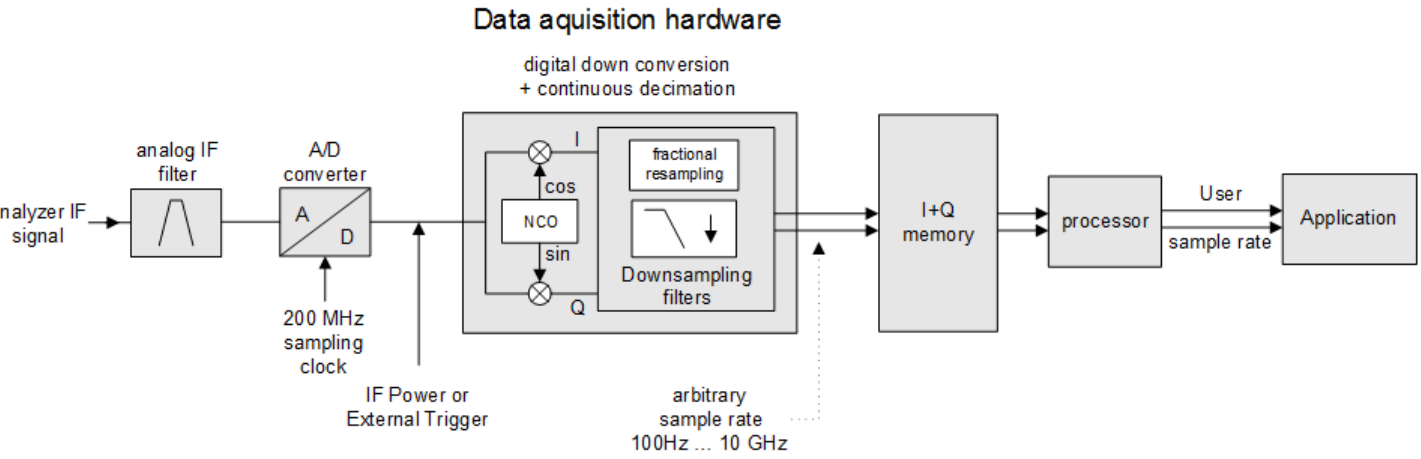


Figure 4-1: Block diagram illustrating the R&S ZNL signal processing for analog I/Q data (without bandwidth extension options)

4.1.1 Sample Rate and Maximum Usable I/Q Bandwidth for RF Input

Definitions

- **Input sample rate (ISR)**: the sample rate of the useful data provided by the device connected to the input of the R&S ZNL
- (User, Output) **Sample rate (SR)**: the user-defined sample rate (e.g. in the "Data Acquisition" dialog box in the "I/Q Analyzer" application) which is used as the basis for analysis or output
- **Usable I/Q (Analysis) bandwidth**: the bandwidth range in which the signal remains undistorted in regard to amplitude characteristic and group delay; this range can be used for accurate analysis by the R&S ZNL
- **Record length**: Number of I/Q samples to capture during the specified measurement time; calculated as the measurement time multiplied by the sample rate

For the I/Q data acquisition, digital decimation filters are used internally in the R&S ZNL. The passband of these digital filters determines the *maximum usable I/Q bandwidth*. In consequence, signals within the usable I/Q bandwidth (passband)

remain unchanged, while signals outside the usable I/Q bandwidth (passband) are suppressed. Usually, the suppressed signals are noise, artifacts, and the second IF side band. If frequencies of interest to you are also suppressed, try to increase the output sample rate, which increases the maximum usable I/Q bandwidth.

Bandwidth extension options

You can extend the maximum usable I/Q bandwidth provided by the R&S ZNL in the basic installation by adding options. These options can either be included in the initial installation (B-options) or updated later (U-options). The maximum bandwidth provided by the individual option is indicated by its number, for example, B40 extends the bandwidth to 40 MHz.

As a rule, the usable I/Q bandwidth is proportional to the output sample rate. Yet, when the I/Q bandwidth reaches the bandwidth of the analog IF filter (at very high output sample rates), the curve breaks.

- Relationship Between Sample Rate, Record Length and Usable I/Q Bandwidth... 19

4.1.1.1 Relationship Between Sample Rate, Record Length and Usable I/Q Bandwidth

Up to the maximum bandwidth, the following rule applies:

*Usable I/Q bandwidth = 0.8 * Output sample rate*

Regarding the record length, the following rule applies:

*Record length = Measurement time * sample rate*

Maximum record length for RF input

The maximum record length is the maximum number of samples that can be captured.

Table 4-1: Maximum record length

Sample rate	Maximum record length
100 Hz to 100 MHz	25 Msamples

The Figure 4-2 shows the maximum usable I/Q bandwidths depending on the output sample rates.

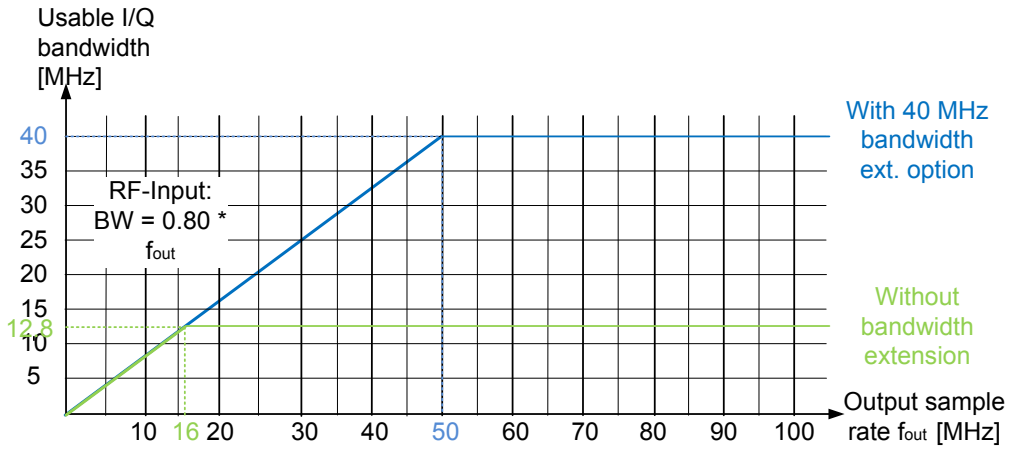
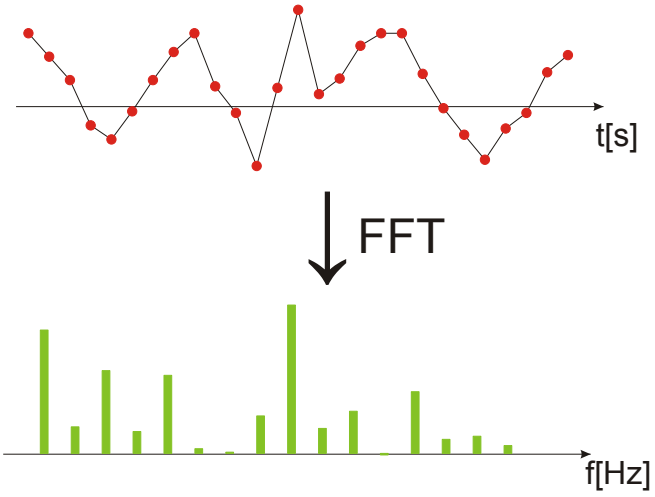


Figure 4-2: Relationship between maximum usable I/Q bandwidth and output sample rate

4.2 Basics on FFT

The I/Q Analyzer measures the power of the signal input over time. To convert the time domain signal to a frequency spectrum, an FFT (Fast Fourier Transformation) is performed which converts a vector of input values into a discrete spectrum of frequencies.



4.2.1 Window Functions

The Fourier transformation is not performed on the entire captured data in one step. Only a limited number of samples is used to calculate an individual result. This process is called windowing.

After sampling in the time domain, each window is multiplied with a specific window function. Windowing helps minimize the discontinuities at the end of the measured signal interval and thus reduces the effect of spectral leakage, increasing the frequency resolution.

Various different window functions are provided in the R&S ZNL to suit different input signals. Each of the window functions has specific characteristics, including some advantages and some trade-offs. Consider these characteristics to find the optimum solution for the measurement task.

Ignoring the window function - rectangular window

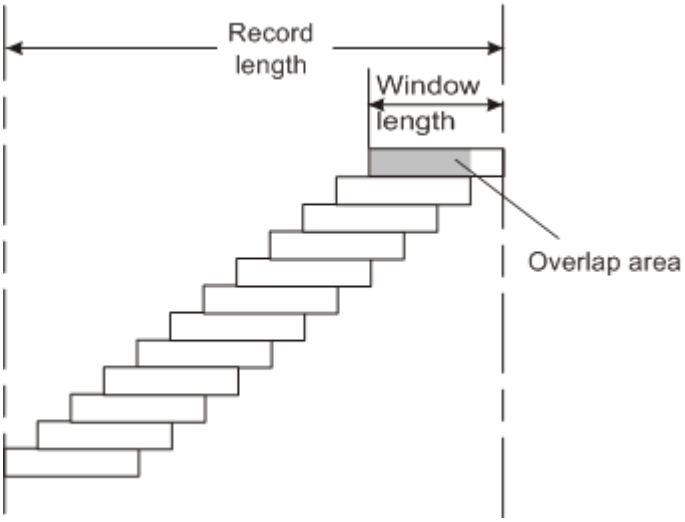
The rectangular window function is in effect not a function at all, it maintains the original sampled data. This may be useful to minimize the required bandwidth. However, be aware that if the window does not contain exactly one period of your signal, heavy sidelobes may occur, which do not exist in the original signal.

Table 4-2: Characteristics of typical FFT window functions

Window type	Frequency resolution	Magnitude resolution	Sidelobe suppression	Measurement recommendation
Rectangular	Best	Worst	Worst	No function applied. Separation of two tones with almost equal amplitudes and a small frequency distance
Blackman-Harris (default)	Good	Good	Good	Harmonic detection and spurious emission detection
Gauss (Alpha = 0.4)	Good	Good	Good	Weak signals and short duration
Flattop	Worst	Best	Good	Accurate single tone measurements
5-Term	Good	Good	Best	Measurements with very high dynamic range

4.2.2 Overlapping

The I/Q Analyzer calculates multiple FFTs per measurement by dividing one captured record into several windows. Furthermore, the I/Q Analyzer allows consecutive windows to overlap. Overlapping "reuses" samples that were already used to calculate the preceding FFT result.



In advanced FFT mode with averaging, the overlapping factor can be set freely. The higher the overlap factor, the more windows are used. This leads to more individual results and improves detection of transient signal effects. However, it also extends the duration of the calculation. The size of the window can be defined manually according to the record length, the overlap factor, and the FFT length.

An FFT overlap of 67%, for example, means the second FFT calculation uses the last 67% of the data of the first FFT. It uses only 33% new data. The third FFT still covers 33% of the first FFT and 67% of the second FFT, and so on.

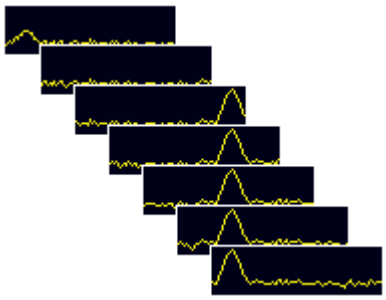


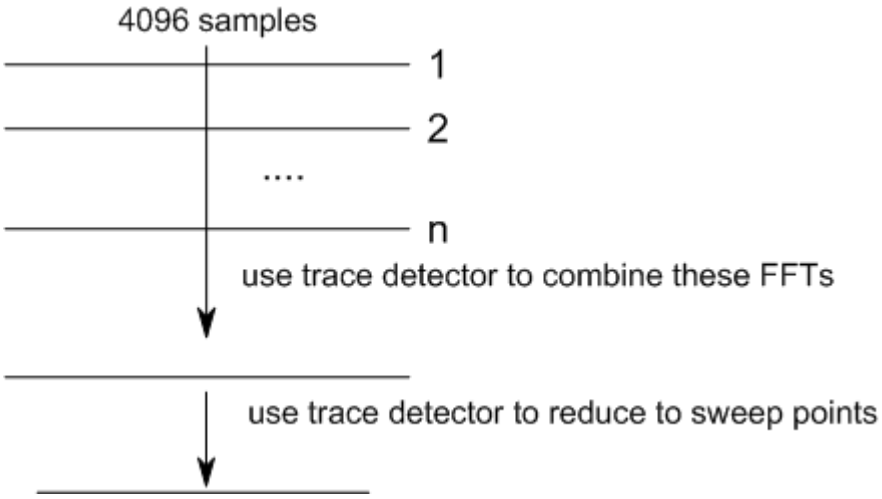
Figure 4-3: Overlapping FFTs

In "Manual" or "Auto" FFT mode, an FFT length of 4096 and a window length of 4096 (or the record length, if shorter) is used to calculate the spectrum.

Combining results - trace detector

If the record length permits, multiple overlapping windows are calculated and combined to create the final spectrum using the selected trace detector. If necessary, the trace detector is also used to reduce the number of calculated frequency points (defined by the FFT length) to the defined number of sweep points. By default, the Autopeak trace detector is used.

Since the frequency points are reduced to the number of sweep points, using a detector other than "Auto Peak" and fewer than 4096 sweep points can lead to false level results.



4.2.3 Dependencies Between FFT Parameters

FFT analysis in the R&S ZNL is highly configurable. Several parameters, including the resolution bandwidth, record length, and FFT length, are user-definable. Note, however, that several parameters are correlated and not all can be configured independently of the others.

Record Length

Defines the number of I/Q samples to capture. By default, the number of sweep points is used. The record length is calculated as the measurement time multiplied by the sample rate.

If you change the record length, the Meas Time is automatically changed, as well.

For FFTs using only a single window ("Single" mode), the record length (which is then identical to the FFT length) must not exceed 512k.

FFT Length

Defines the number of frequency points determined by each FFT calculation. The more points are used, the higher the resolution in the spectrum becomes, but the longer the calculation takes.

In "Auto" or "Manual" mode, an FFT length of 4096 is used.

If the FFT length is longer than the Window Length the sample data is filled up with zeros up to the FFT length. The FFT is then performed using interpolated frequency points.

For an FFT length that is not a power of 2, a DFT (discrete Fourier transform) is performed, which requires more time for calculation, but avoids the effects of interpolation.

To display all calculated frequency points (defined by the FFT length), the number of sweep points is set to the FFT length automatically in advanced FFT mode.

Window Length

Defines the number of samples to be included in a single window in averaging mode. (In single mode, the window length corresponds to the "Record Length" on page 53.)

Values from 3 to 4096 are available in "Manual" mode; in "Advanced" FFT mode, values from 3 to 524288 are available. However, the window length must not be longer than the FFT Length.

If the window length is shorter than the FFT Length, the sample data is filled up with zeros up to the FFT length.

If the window length is longer than the Record Length (that is, not enough samples are available), a window length the size of the Record Length is used for calculation.

The window length and the Window Overlap determine how many FFT calculations must be performed for each record in averaging mode (see "TransformationAlgorithm" on page 54).

4.2.4 Frequency Resolution of FFT Results - RBW

The **resolution bandwidth** defines the minimum frequency separation at which the individual components of a spectrum can be distinguished. Small values result in high precision, as the distance between two distinguishable frequencies is small. Higher values decrease the precision, but increase measurement speed.

The RBW is determined by the following equation:

$$RBW = Normalized\,Bandwidth * \frac{Sample\ Rate}{Window\ Length}$$

Equation 4-1: Definition of RBW

(Note: The normalized bandwidth is a fixed value that takes the noise bandwidth of the window function into consideration.)

The maximum RBW is restricted by the Analysis Bandwidth, or by the following equation, whichever is higher:

$$RBW_{max} = \frac{Normalized\,Bandwidth * Sample\ Rate}{3}$$

If a higher spectral resolution is required, the number of samples must be increased by using a higher sample rate or longer record length.

The minimum achievable RBW depends on the sample rate and record length, according to the following equation:

$$RBW_{min} = \frac{NormalizedBandwidth * Sample\ Rate}{min(4096, Record\ Length)}$$

To simplify operation, some parameters are coupled and automatically calculated, such as record length and RBW.

RBW mode

Depending on the selected RBW mode, the resolution bandwidth is either determined automatically or can be defined manually.

Auto mode:

This is the default mode in the I/Q Analyzer. The RBW is determined automatically depending on the Sample Rate and Window Length, where the window length corresponds to the Record Length, or a maximum of 4096.

If the record length is larger than the window length, multiple windows are combined; the FFT length is 4096.

A Flatop window function is used.

Manual mode:

The RBW is user-definable.

The Window Length is adapted to comply with Equation 4-1. Since only window lengths with integer values can be employed, the Sample Rate is adapted, if necessary, to obtain an integer window length value.

If the record length is larger than the window length, multiple windows are combined; the FFT length is 4096.

A Flatop window function is used.

Advanced FFT mode

The RBW is determined by the advanced FFT parameters, depending on the selected FFT Calculation Methods method.

4.2.5 FFT Calculation Methods

FFT calculation can be performed using different methods.

Single

In single mode, one FFT is calculated for the entire record length, that means the window length is identical to the record length.

If the defined FFT Length is larger than the record length, zeros are appended to the captured data to reach the FFT length.

Figure 4-4: FFT parameters for single FFT calculation

Averaging

In averaging mode, several overlapping FFTs are calculated for each record; the results are combined to determine the final FFT result for the record.

The number of FFTs to be combined is determined by the Window Overlap and the Window Length.

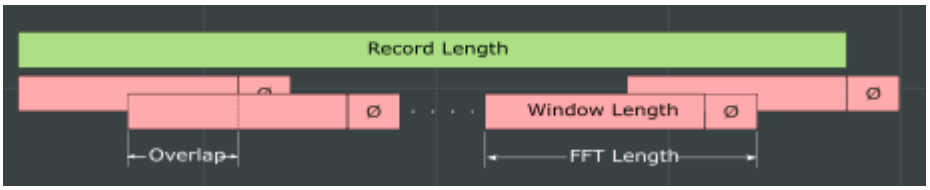


Figure 4-5: FFT parameters for averaged FFT calculation

4.3 Basics on Input from I/Q Data Files

The I/Q data to be evaluated in a particular R&S ZNL application can not only be captured by the application itself, it can also be loaded from a file, provided it has the correct format. The file is then used as the input source for the application.

The I/Q data must be stored in a format with the file extension `.iq.tar`. For a detailed description see Chapter C, "I/Q Data File Format (iq-tar)", on page 225.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

When using input from an I/Q data file, the [RUN SINGLE] function starts a single measurement (i.e. analysis) of the stored I/Q data, while the [RUN CONT] function repeatedly analyzes the same data from the file.

4.4 I/Q Data Import and Export

Baseband signals mostly occur as so-called complex baseband signals, i.e. a signal representation that consists of two channels; the in phase (I) and the quadrature (Q)

channel. Such signals are referred to as I/Q signals. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband.

Importing and exporting I/Q signals is useful for various applications:

- Generating and saving I/Q signals in an RF or baseband signal generator or in external software tools to analyze them with the R&S ZNL later
- Capturing and saving I/Q signals with an RF or baseband signal analyzer to analyze them with the R&S ZNL or an external software tool later

As opposed to storing trace data, which may be averaged or restricted to peak values, I/Q data is stored as it was captured, without further processing. The data is stored as complex values in 32-bit floating-point format. Multi-channel data is not supported. The I/Q data is stored in a format with the file extension `.iq.tar`.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

The import and export functions are available in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar (see Chapter 5.2, "Import/Export Functions", on page 30).

5 Configuration

Access: [MODE] > "I/Q Analyzer"

The I/Q Analyzer is a special application on the R&S ZNL.

For details see the "Operating Modes, Applications, Channel Setups, and Result Displays" chapter in the R&S ZNL User Manual.

When you switch to an I/Q Analyzer channel setup the first time, a set of parameters is passed on from the currently active application. After initial setup, the parameters for the channel setup are stored upon exiting and restored upon re-entering the channel setup. Thus, you can switch between applications quickly and easily.

When you activate a channel setup for the I/Q Analyzer application, data acquisition from the input signal is started automatically with the default configuration. The "I/Q Analyzer" menu is displayed and provides access to the most important configuration functions.

The remote commands required to perform these tasks are described in Chapter 9, "Remote Commands to Perform Measurements with I/Q Data", on page 100.

Importing and Exporting I/Q Data

The I/Q data to be evaluated in the I/Q Analyzer application can not only be captured by the I/Q Analyzer itself, it can also be imported to the R&S ZNL, provided it has the correct format. Furthermore, the captured I/Q data from the I/Q Analyzer can be exported for further analysis in external applications.

For details see Chapter 4.4, "I/Q Data Import and Export", on page 26.

5.1 Configuration Overview

Access: all menus

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

Multiple access paths to functionality

The easiest way to configure a channel setup is via the "Overview" dialog box, which is available from all menus.

Alternatively, you can access the individual dialog boxes from the corresponding menu items, or via tools in the toolbars, if available.

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

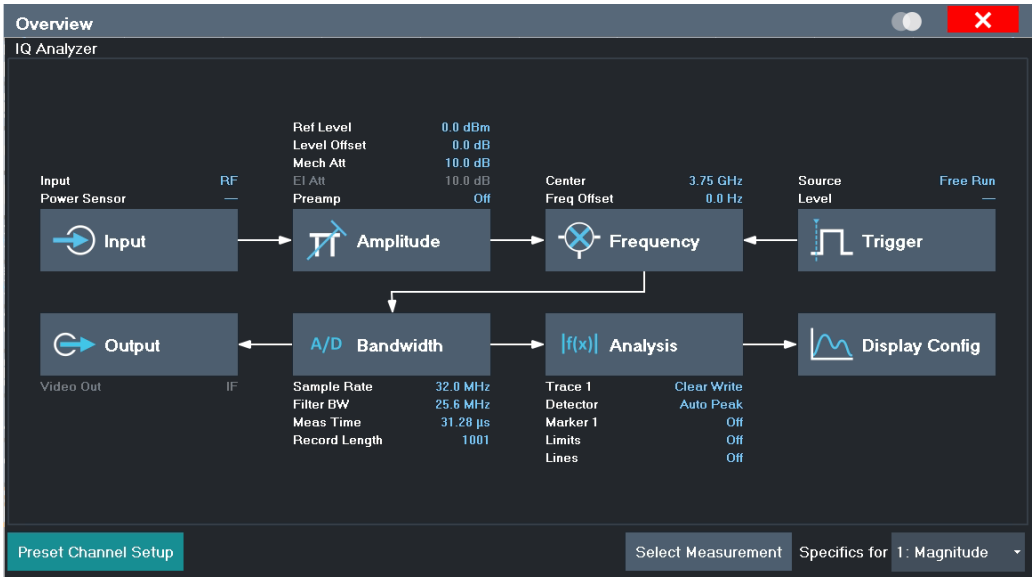


Figure 5-1: Configuration Overview for I/Q Analyzer Master

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 channel setup from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

The "Overview" for the I/Q Analyzer provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Input settings
   See Chapter 5.3.1, "Radio Frequency Input", on page 33
2. Amplitude settings
   See Chapter 5.4, "Amplitude", on page 42
3. Frequency settings
   See Chapter 5.5, "Frequency Settings", on page 46
4. Optionally, Trigger/Gate settings
   See Chapter 5.6, "Trigger Settings", on page 48
5. Bandwidth settings

See Chapter 5.7, "Data Acquisition and Bandwidth Settings", on page 51

6. Analysis settings and functions
   See Chapter 6, "Analysis", on page 61
7. Display configuration
   See Chapter 5.8, "Display Configuration", on page 57

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 channel setup tab) to change a specific setting.

For step-by-step instructions on configuring I/Q Analyzer measurements, see Chapter 7, "How to Perform Measurements in the I/Q Analyzer Application", on page 96.

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 109

Specifics for
The channel setup 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 Import/Export Functions

Access: "Save"/ "Open" icon in the toolbar > "Import" / "Export"

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

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

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

- I/Q data

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

- I/Q data

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

See the corresponding user manuals for those applications for details.

These functions are only available if no measurement is running.

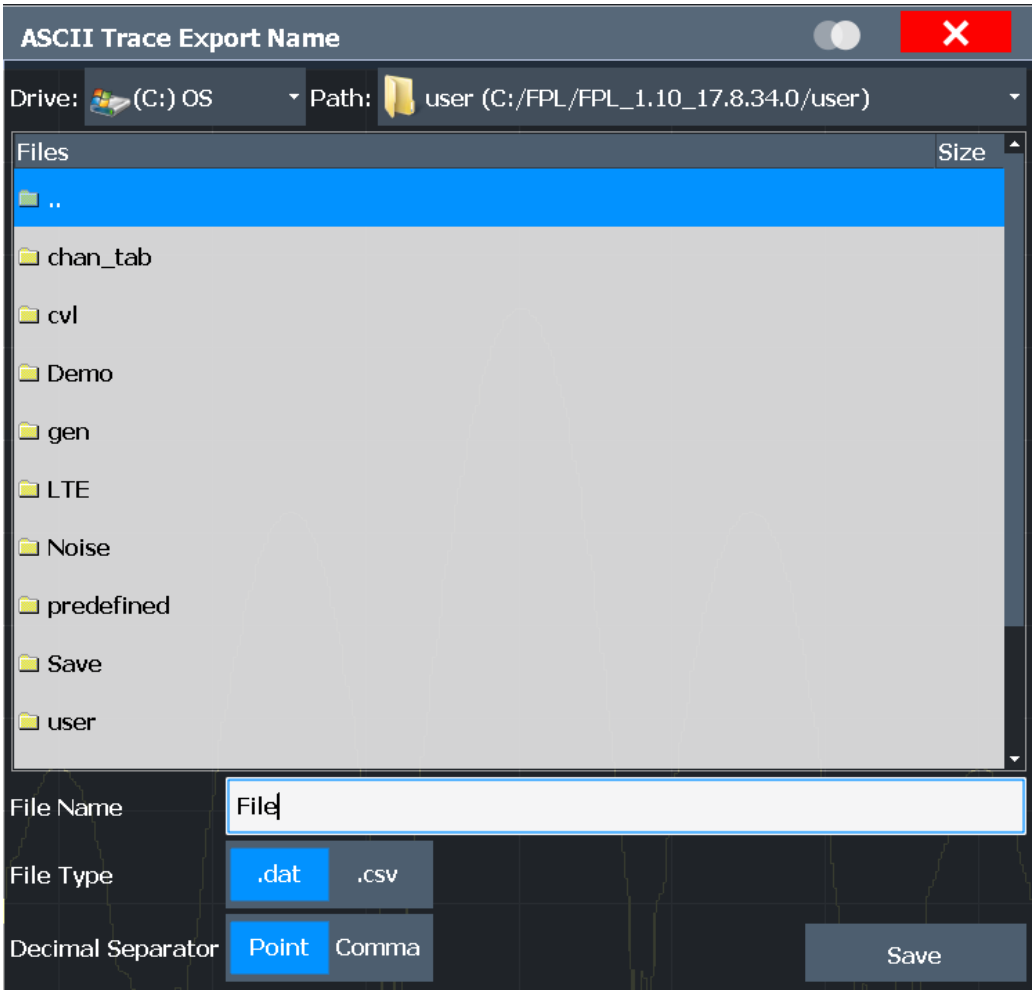
Import
Access: "Save/Recall" > Import

Provides functions to import data.

Export
Access: "Save/Recall" > Export

Opens a submenu to configure data export.

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



Remote command:
MMEMory:STORe<n>:TRACe on page 215

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

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

Remote command:
FORMat:DEXPort:FORMat on page 214

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

Remote command:
FORMat:DEXPort:DSEParator on page 214

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

Remote command:
not supported

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

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

It is not available in the Spectrum application, only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

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

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

Remote command:
`MMEMory:STORe<n>:IQ:STATe` on page 218
`MMEMory:STORe<n>:IQ:COMMent` on page 217

File Explorer ← I/Q Export ← Export
Opens the Microsoft Windows File Explorer.

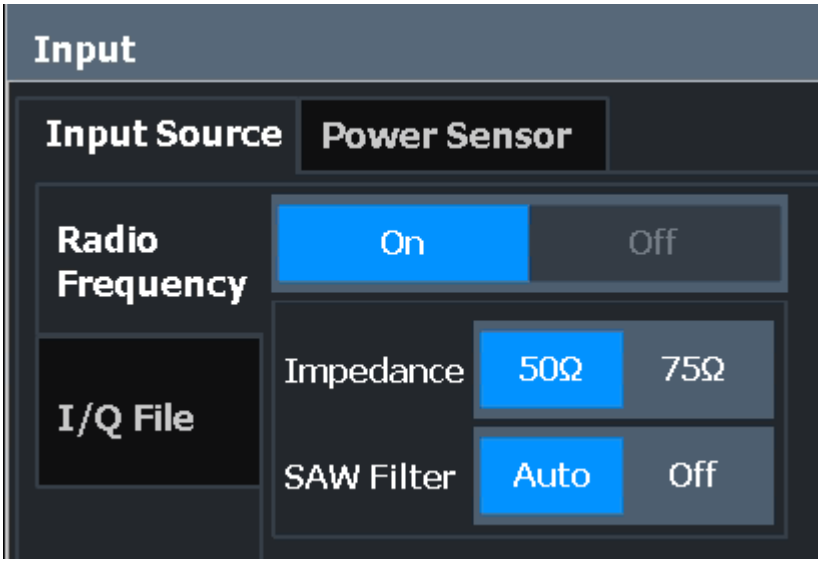
Remote command:
not supported

5.3 Receiving Data Input and Providing Data Output

The R&S ZNL can analyze signals from different input sources and provide various types of output (such as noise source control signals).

5.3.1 Radio Frequency Input

Access: "Overview" > "Input" > "Input Source" > "RadioFrequency"



RF Input Protection

The RF input connector of the R&S ZNL must be protected against signal levels that exceed the ranges specified in the data sheet. Therefore, the R&S ZNL is equipped with an overload protection mechanism. This mechanism becomes active as soon as the power at the input mixer exceeds the specified limit. It ensures that the connection between RF input and input mixer is cut off.

When the overload protection is activated, an error message is displayed in the status bar ("INPUT OVLD"), and a message box informs you that the RF Input was disconnected. Furthermore, a status bit (bit 3) in the `STAT:QUES:POW` status register is set. In this case you must decrease the level at the RF input connector and then close the message box. Then measurement is possible again. Reactivating the RF input is also possible via the remote command `INPut<ip>:ATTenuation:PROTection:RESet`.

The power sensor functions are described in the R&S ZNL User Manual.

Radio Frequency State

Activates input from the "RF Input" connector.

Remote command:

`INPut<ip>:SELect` on page 111

Impedance

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

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

This value also affects the unit conversion (see "Reference Level" on page 43).

Remote command:
`INPut<ip>:IMPedance` on page 111

5.3.2 Power Sensors

The R&S ZNL can also analyze data from a connected power sensor.

The "Sensor" connector is provided by the "Additional Interfaces" option R&S FPL1-B5. Additionally, the power sensor measurement requires the option R&S FPL1-K9.

5.3.2.1 Basics on Power Sensors

For precise power measurement, up to 4 power sensors can be connected to the instrument via the optional power sensor interface (on the rear panel) or the USB connectors. Both manual operation and remote control are supported.

For a detailed list of supported sensors, see the data sheet.

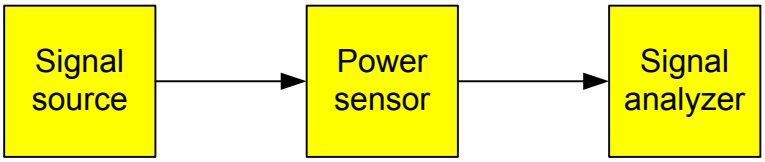


Figure 5-2: Power sensor support – standard test setup

Using the power sensor with several applications

The power sensor cannot be used from the R&S ZNL firmware and the R&S Power Viewer Plus (virtual power meter for displaying results of the R&S NRP power sensors) simultaneously.

Result display

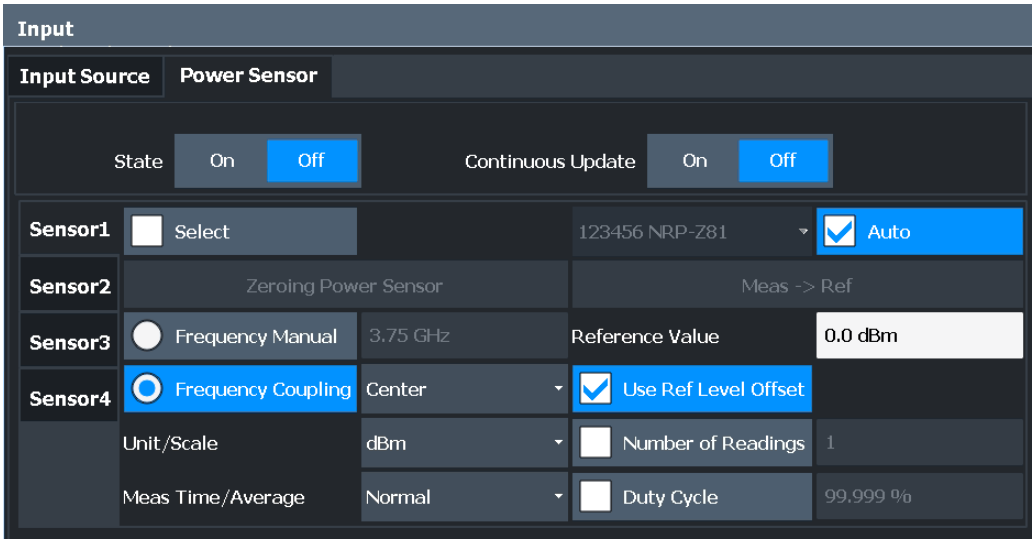
The results of the power sensor measurements are displayed in the marker table. For each power sensor, a row is inserted. The sensor index is indicated in the "Type" column.

5.3.2.2 Power Sensor Settings

Access: "Overview" > "Input" > "Power Sensor" tab

The power sensor measurement requires the option R&S FPL1-K9.

Each sensor is configured on a separate tab.



State
Switches the power measurement for all power sensors on or off. Note that in addition to this general setting, each power sensor can be activated or deactivated individually by the Select setting on each tab. However, the general setting overrides the individual settings.

Remote command:
`[SENSe:]PMETer<p>[:STATe]` on page 120

Continuous Value Update
If activated, the power sensor data is updated continuously during a sweep with a long sweep time, and even after a single sweep has completed.

This function cannot be activated for individual sensors.

Remote command:
`[SENSe:]PMETer<p>:UPDate[:STATe]` on page 120

Select
Selects the individual power sensor for usage if power measurement is generally activated (State function).

The detected **serial numbers** of the power sensors connected to the instrument are provided in a selection list. For each of the four available power sensor indexes ("Power Sensor 1"..."Power Sensor 4"), which correspond to the tabs in the configuration dialog, one of the detected serial numbers can be assigned. The physical sensor is thus assigned to the configuration setting for the selected power sensor index.

By default, serial numbers not yet assigned are automatically assigned to the next free power sensor index for which "Auto Assignment" is selected.

Alternatively, you can assign the sensors manually by deactivating the "Auto" option and selecting a serial number from the list.

Remote command:
`[SENSe:]PMETer<p>[:STATe]` on page 120
`SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine` on page 113
`SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe]` on page 113
`SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt?` on page 113

Zeroing Power Sensor
Starts zeroing of the power sensor.

For details on the zeroing process refer to the R&S ZNL User Manual.

Remote command:
`CALibration:PMETer<p>:ZERO:AUTO ONCE` on page 115

Frequency Manual
Defines the frequency of the signal to be measured. The power sensor has a memory with frequency-dependent correction factors. This allows extreme accuracy for signals of a known frequency.

Remote command:
`[SENSe:]PMETer<p>:FREQuency` on page 117

Frequency Coupling
Selects the coupling option. The frequency can be coupled automatically to the center frequency of the instrument or to the frequency of marker 1.

Remote command:
`[SENSe:]PMETer<p>:FREQuency:LINK` on page 117

Unit/Scale
Selects the unit with which the measured power is to be displayed. Available units are dBm, dB, W and %.

If dB or % is selected, the display is relative to the reference value that is defined with either the "Meas -> Ref" setting or the "Reference Value" setting.

Remote command:
`UNIT<n>:PMETer<p>:POWer` on page 120
`UNIT<n>:PMETer<p>:POWer:RATio` on page 121

Meas Time/Average
Selects the measurement time or switches to manual averaging mode. In general, results are more precise with longer measurement times. The following settings are recommended for different signal types to obtain stable and precise results:

"Short"	Stationary signals with high power (> -40dBm), because they require only a short measurement time and short measurement time provides the highest repetition rates.
"Normal"	Signals with lower power or modulated signals
"Long"	Signals at the lower end of the measurement range (<-50 dBm) or Signals with lower power to minimize the influence of noise
"Manual"	Manual averaging mode. The average count is set with the Average Count (Number of Readings) setting.

Remote command:
`[SENSe:]PMETer<p>:MTIMe` on page 118
`[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe]` on page 119

Setting the Reference Level from the Measurement Meas -> Ref
Sets the currently measured power as a reference value for the relative display. The reference value can also be set manually via the Reference Value setting.

Remote command:
`CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE` on page 115

Reference Value
Defines the reference value in dBm used for relative power meter measurements.

Remote command:
`CALCulate<n>:PMETer<p>:RELative[:MAGNitude]` on page 115

Use Ref Level Offset
If activated, takes the reference level offset defined for the analyzer into account for the measured power (see "Shifting the Display (Offset)" on page 43).

If deactivated, takes the Sensor Level Offset into account.

Remote command:
[SENSe:]PMETer<p>:ROFFset[:STATe] on page 119

Sensor Level Offset
Takes the specified offset into account for the measured power. Only available if Use Ref Level Offset is disabled.

Remote command:
[SENSe:]PMETer<p>:SOFFset on page 119

Average Count (Number of Readings)
Defines the number of readings (averages) to be performed after a single sweep has been started. This setting is only available if manual averaging is selected (Meas Time/ Average setting).

The values for the average count range from 0 to 256 in binary steps (1, 2, 4, 8, …). For average count = 0 or 1, one reading is performed. The general averaging and sweep count for the trace are independent from this setting.

Results become more stable with extended average, particularly if signals with low power are measured. This setting can be used to minimize the influence of noise in the power sensor measurement.

Remote command:
[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt on page 118

Duty Cycle
Sets the duty cycle to a percent value for the correction of pulse-modulated signals and activates the duty cycle correction. With the correction activated, the sensor calculates the signal pulse power from this value and the mean power.

Remote command:
[SENSe:]PMETer<p>:DCYCle[:STATe] on page 116
[SENSe:]PMETer<p>:DCYCle:VALue on page 117

5.3.2.3 How to Work With a Power Sensor

The following step-by-step instructions demonstrate how to set up a power sensor. For details on individual functions and settings see Chapter 5.3.2.2, "Power Sensor Settings", on page 36.

The remote commands required to perform these tasks are described in Chapter 9.4.1.3, "Working with Power Sensors", on page 112.

How to Set Up a Power Sensor

Up to 4 external power sensors can be configured separately and used for precise power measurement. All power sensors can be activated and deactivated individually.

The following procedure describes in detail how to configure and activate power sensors.

1. To display the "Power Sensor" tab of the "Input" dialog box, do one of the following:
   - Select "Input" from the "Overview".

- Select the [INPUT/OUTPUT] key and then the "PowerSensorConfig" softkey.

2. Select the tab for the power sensor index you want to configure, e.g. "Power Sensor 1".
3. Press "Select" to analyze the power sensor data according to the current configuration when power measurement is activated.
4. From the selection list with serial numbers of connected power sensors, select the sensor you want to configure.
   To have newly connected power sensors assigned to a tab automatically (default), select "Auto".
5. Define the frequency of the signal whose power you want to measure.
   a) To define the frequency manually, select "Frequency Manual" and enter a frequency.
   b) To determine the frequency automatically, select "Frequency Coupling" and then either "Center", to use the center frequency, or "Marker", to use the frequency defined by marker 1.
6. Select the unit for the power result display.
7. Select the measurement time for which the average is calculated, or define the number of readings to average. To define the number of readings to be taken into account manually, select "Manual" and enter the number in the "Number of Readings" field.
8. To activate the duty cycle correction, select "DutyCycle" and enter a percentage as the correction value.
9. If you selected "dB" or "%" as units (relative display), define a reference value:
   a) To set the currently measured power as a reference value, press the "Meas -> Ref" button.
   b) Alternatively, enter a value manually in the "Reference Value" field.
   c) Optionally, select the "Use Ref Level Offset" option to take the reference level offset set for the analyzer into account for the measured power.
10. If necessary, repeat steps 3-10 for another power sensor.
11. Set the "Power Sensor State" at the top of the "Power Sensor" tab to "On" to activate power measurement for the selected power sensors.

    The results of the power measurement are displayed in the marker table (Function: "Sensor <1...4>").

How to Zero the Power Sensor

1. To display the "Power Sensor" tab of the "Input" dialog box, do one of the following:
   - Select "Input" from the "Overview".
   - Select the [INPUT/OUTPUT] key and then the "PowerSensorConfig" softkey.
2. Select the tab that is assigned to the power sensor you want to zero.

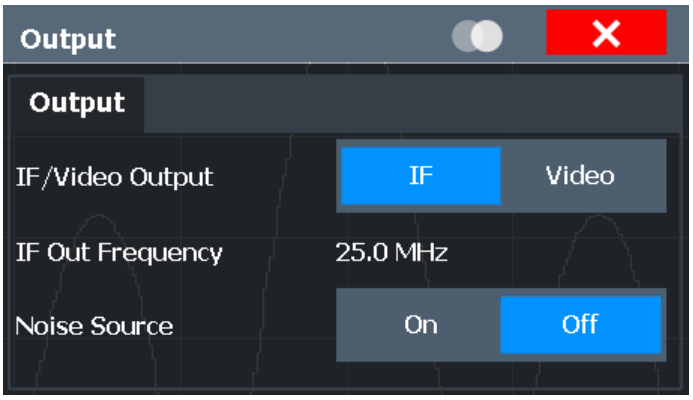
3. Press the "Zeroing Power Sensor" button.
   A dialog box is displayed that prompts you to disconnect all signals from the input of the power sensor.
4. Disconnect all signals sending input to the power sensor and press [ENTER] to continue.
5. Wait until zeroing is complete.
   A corresponding message is displayed.

5.3.3 Output Settings

Access: "Overview" > "Output"

The R&S ZNL can provide signals to different output connectors.

For details on connectors, refer to the R&S ZNL Getting Started manual, "Front / Rear Panel View" chapters.



Noise Source Control 41

Noise Source Control
The R&S ZNL provides a connector ("NOISE SOURCE CONTROL") with a 28 V voltage supply for an external noise source. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

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

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

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 121

5.4 Amplitude

Access: "Overview" > "Amplitude"

Amplitude settings are identical to the Spectrum application, except for a new scaling function for I/Q Vector and Real/Imag results (see "Y-Axis Max" on page 46).

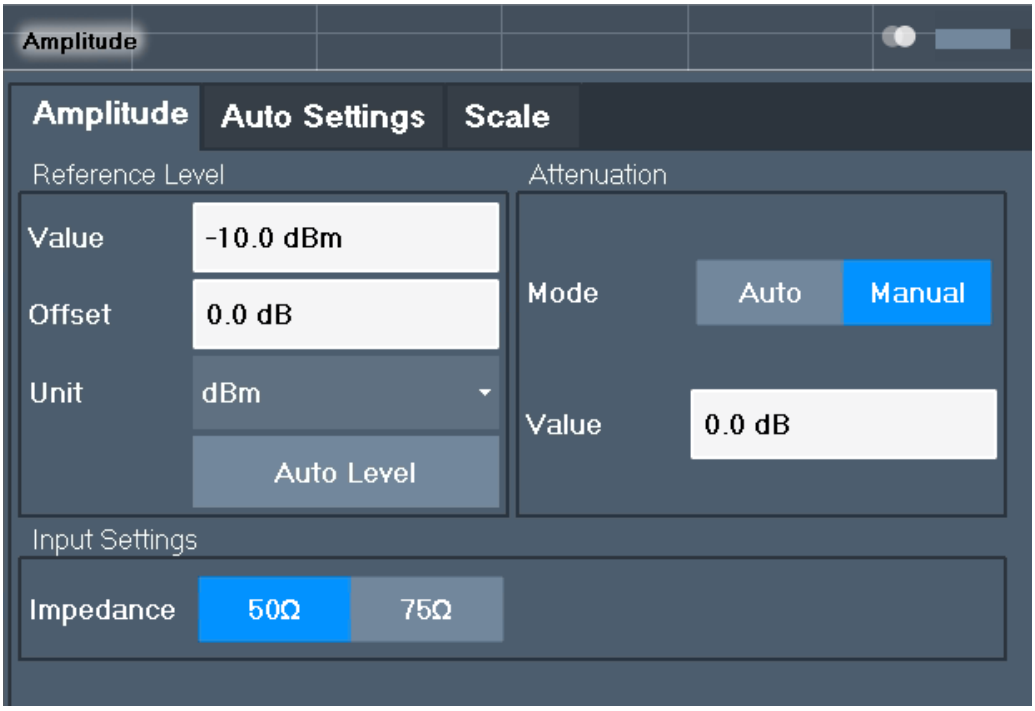
For background information on amplitude settings see the R&S ZNL User Manual.

The "Auto Settings" are described in Chapter 5.9, "Adjusting Settings Automatically", on page 57.

5.4.1 Amplitude Settings

Access: "Overview" > "Amplitude"

Amplitude settings determine how the R&S ZNL must process or display the expected input power levels.



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

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 123

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

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

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 124

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

The following units are available and directly convertible:
- dBm
- dBmV
- dBµV
- dBµA
- dBpW
- Volt
- Ampere
- Watt

Remote command:
`INPut<ip>:IMPedance` on page 111
`CALCulate<n>:UNIT:POWer` on page 123

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

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

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

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (MeastimeManual)" on page 59).

Remote command:
`[SENSe:]ADJust:LEVel` on page 144

Attenuation Mode / Value
The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). This ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 10 dB steps down to 0 dB. Other entries are rounded to the next integer value. The range is specified in the data sheet. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload may lead to hardware damage.

Remote command:
`INPut<ip>:ATTenuation` on page 124
`INPut<ip>:ATTenuation:AUTO` on page 125

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

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

This value also affects the unit conversion (see "Reference Level" on page 43).

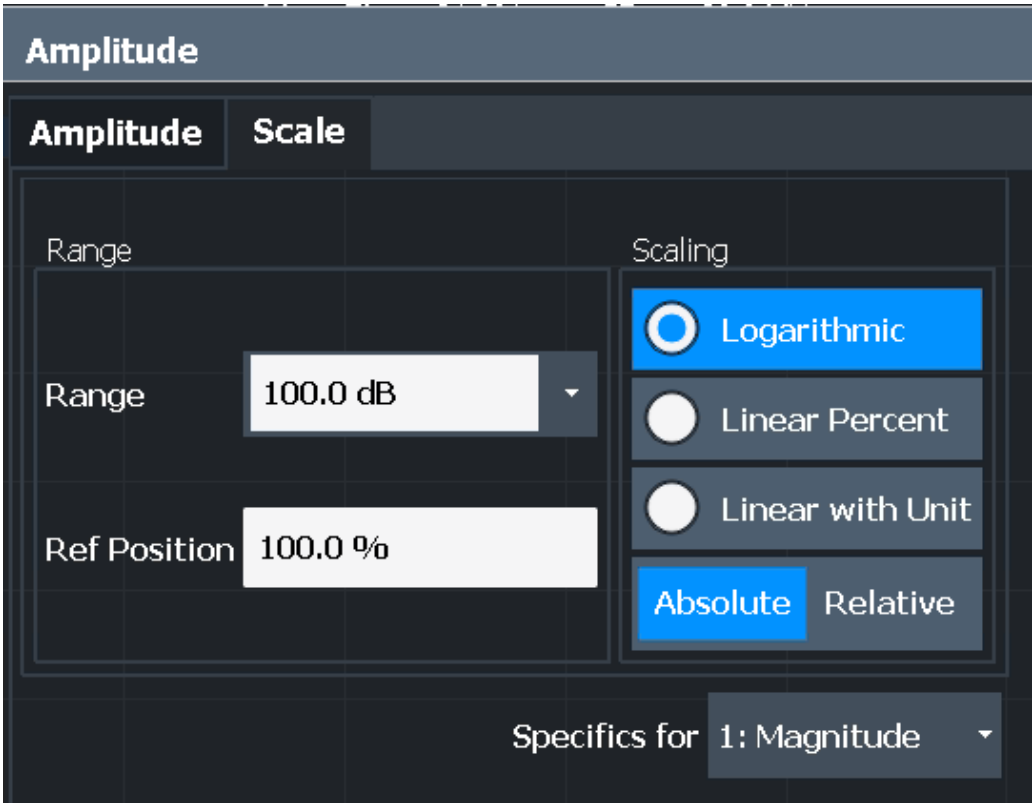
Remote command:
`INPut<ip>:IMPedance` on page 111

5.4.2 Scaling the Y-Axis

The individual scaling settings that affect the vertical axis are described here.

Access: "Overview" > "Amplitude" > "Scale" tab

Or: [AMPT] > "ScaleConfig"



Range
Defines the displayed y-axis range in dB.

The default value is 100 dB.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 125

Ref Level Position
Defines the reference level position, i.e. the position of the maximum AD converter value on the level axis in %.

0 % corresponds to the lower and 100 % to the upper limit of the diagram.

Values from -120 % to +600 % are available. Larger values are useful for small scales, such as a power range of 10 dB or 20 dB, and low signal levels, for example 60 dB below the reference level. In this case, large reference level position values allow you to see the trace again.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 126

Scaling
Defines the scaling method for the y-axis.

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

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 127
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE` on page 126

Y-Axis Max
Defines the maximum value of the y-axis in the currently selected diagram in either direction (in Volts). Thus, the y-axis scale starts at -<Y-Axis Max> and ends at +<Y-Axis Max>.

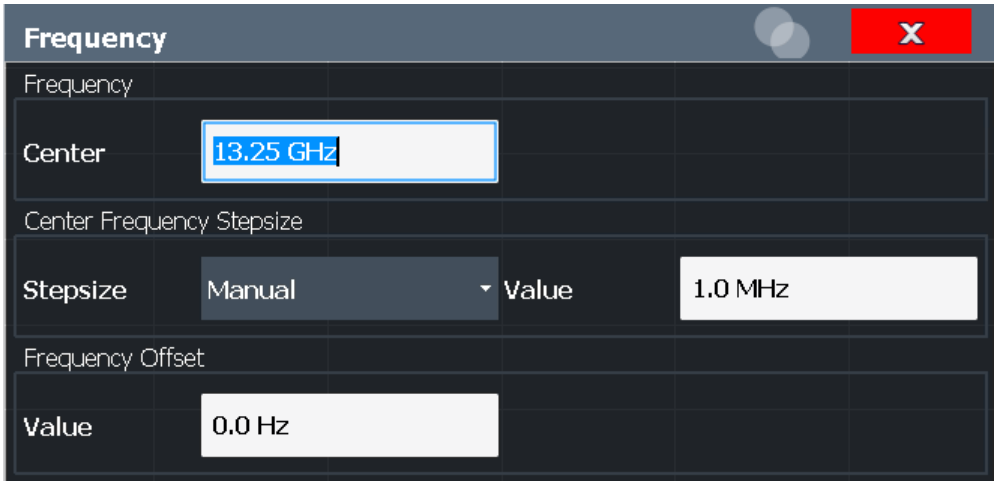
The maximum y-axis value depends on the current reference level. If the reference level is changed, the "Y-Axis Max" value is automatically set to the new reference level (in V).

This command is only available if the evaluation mode for the I/Q Analyzer is set to "I/Q-Vector" or "Real/Imag (I/Q)".

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 125

5.5 Frequency Settings

Access: "Overview" > "Frequency"



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

The allowed range of values for the center frequency depends on the frequency span.

span > 0: $span_{min}/2 \leq f_{center} \leq f_{max} - span_{min}/2$

f_{max} and $span_{min}$ depend on the instrument and are specified in the data sheet.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 128

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

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

"= Center" Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.

"Manual" Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
`[SENSe:]FREQuency:CENTer:STEP` on page 128

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

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

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

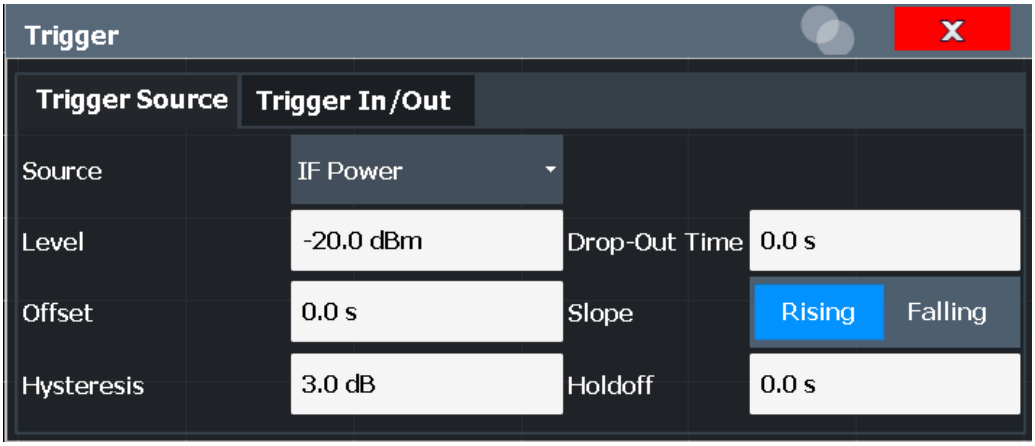
The allowed values range from -1 THz to 1 THz. The default setting is 0 Hz.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 129

5.6 Trigger Settings

Access: "Overview" > "Trigger"(> "Trigger In/Out")

Trigger settings determine when the input signal is measured.



Conventional gating as in the Spectrum application is not available for the I/Q Analyzer; however, a special gating mode is available in remote control, see Chapter 9.4.4.2, "Configuring I/Q Gating", on page 133.

For step-by-step instructions on configuring triggered measurements, see the R&S ZNL User Manual.

Trigger Source
The trigger settings define the beginning of a measurement.

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

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 132

Free Run ← Trigger Source ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 132

ExternalTrigger 1 ← Trigger Source ← Trigger Source
Data acquisition starts when the TTL signal fed into the trigger input connector of the R&S ZNL meets or exceeds the specified trigger level.

(See "Trigger Level" on page 50).

Remote command:
`TRIG:SOUR EXT`
See `TRIGger[:SEQuence]:SOURce` on page 132

IF Power ← Trigger Source ← Trigger Source
The R&S ZNL starts capturing data as soon as the trigger level is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger bandwidth at the third IF depends on the RBW and sweep type.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

This trigger source is only available for RF input.

For details on available trigger levels and trigger bandwidths, see the data sheet.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 132

I/Q Power ← Trigger Source ← Trigger Source
This trigger source is only available in the I/Q Analyzer application and in applications that process I/Q data.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the bandwidth setting for I/Q data acquisition.

Remote command:
`TRIG:SOUR IQP`, see `TRIGger[:SEQuence]:SOURce` on page 132

Time ← Trigger Source ← Trigger Source
Triggers in a specified "Repetition Interval" on page 50.

Remote command:
TRIG:SOUR TIME, see TRIGger[:SEQuence]:SOURce on page 132

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

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

Remote command:
TRIGger[:SEQuence]:LEVel:IFPower on page 131
TRIGger[:SEQuence]:LEVel:IQPower on page 131
TRIGger[:SEQuence]:LEVel[:EXTernal<port>] on page 131

Repetition Interval ← Trigger Source
Defines the repetition interval for a time trigger. The shortest interval is 2 ms.

The repetition interval should be set to the exact pulse period, burst length, frame length or other repetitive signal characteristic.

Remote command:
TRIGger[:SEQuence]:TIME:RINTerval on page 133

Drop-Out Time ← Trigger Source
Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:
TRIGger[:SEQuence]:DTIMe on page 129

Trigger Offset ← Trigger Source
Defines the time offset between the trigger event and the start of the sweep.

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger) Only possible for zero span (e.g. I/Q Analyzer application) and gated trigger switched off Maximum allowed range limited by the sweep time: $Pretrigger_{max}$ = $sweep\ time_{max}$

Tip: To determine the trigger point in the sample (for "External" or "IF Power" trigger source), use the TRACe:IQ:TPISample? command.

For the "Time" trigger source, this function is not available.

Remote command:
TRIGger[:SEQuence]:HOLDoff[:TIME] on page 130

Hysteresis ← Trigger Source
Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

Remote command:
TRIGger[:SEQuence]:IFPower:HYSTeresis on page 130

Trigger Holdoff ← Trigger Source
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
TRIGger[:SEQuence]:IFPower:HOLDoff on page 130

Slope ← Trigger Source
For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

Remote command:
TRIGger[:SEQuence]:SLOPe on page 132

5.7 Data Acquisition and Bandwidth Settings

Access: "Overview" > "Bandwidth"

5.7.1 Data Acquisition

Access: "Overview" > "Bandwidth" > "Data Acquisition" tab

The data acquisition settings define which parts of the input signal are captured for further evaluation in the applications.

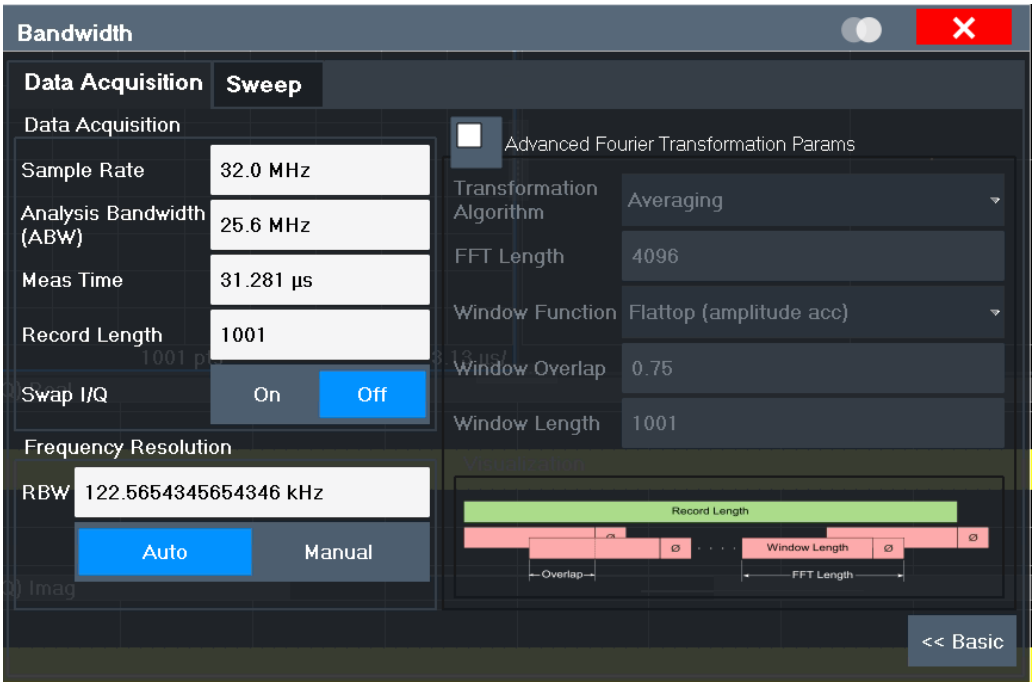


Figure 5-3: Data acquisition settings with advanced FFT parameters

Sample Rate
Defines the I/Q data sample rate of the R&S ZNL. This value is dependent on the defined Analysis Bandwidth and the defined signal source.

sample rate = analysis bandwidth / 0.8

Remote command:
`TRACe:IQ:SRATe` on page 141

Analysis Bandwidth
Defines the flat, usable bandwidth of the final I/Q data. This value is dependent on the defined Sample Rate and the defined signal source.

*analysis bandwidth = 0.8 * sample rate*

Remote command:
`TRACe:IQ:BWIDth` on page 139

Meas Time
Defines the I/Q acquisition time. By default, the measurement time is calculated as the number of I/Q samples ("Record Length") divided by the sample rate. If you change the measurement time, the Record Length is automatically changed, as well.

Remote command:
`[SENSe:]SWEep:TIME` on page 157

Record Length
Defines the number of I/Q samples to record. By default, the number of sweep points is used. The record length is calculated as the measurement time multiplied by the sample rate. If you change the record length, the Meas Time is automatically changed, as well.

Note: For the I/Q vector result display, the number of I/Q samples to record ("Record Length") must be identical to the number of trace points to be displayed ("Sweep Points"). Thus, the sweep points are not editable for this result display. If the "Record Length" is edited, the sweep points are adapted automatically.

Remote command:
`TRACe:IQ:RLENgth` on page 139
`TRACe:IQ:SET` on page 140

Swap I/Q
Activates or deactivates the inverted I/Q modulation. If the I and Q parts of the signal from the DUT are interchanged, the R&S ZNL can do the same to compensate for it.

On	I and Q signals are interchanged Inverted sideband, Q+j*I
Off	I and Q signals are not interchanged Normal sideband, I+j*Q

Remote command:
`[SENSe:]SWAPiq` on page 139

RBW
Defines the resolution bandwidth for Spectrum results. The available RBW values depend on the sample rate and record length.

(See Chapter 4.2.4, "Frequency Resolution of FFT Results - RBW", on page 24).

Depending on the selected RBW mode, the value is either determined automatically or can be defined manually. As soon as you enter a value in the input field, the RBW mode is changed to "Manual".

If the "Advanced Fourier Transformation Params" option is enabled, advanced FFT mode is selected and the RBW cannot be defined directly.

Note that the RBW is correlated with the Sample Rate and Record Length (and possibly the Window Function and Window Length). Changing any one of these parameters may cause a change to one or more of the other parameters. For more information see Chapter 4.2, "Basics on FFT", on page 20.

"Auto mode" (Default) The RBW is determined automatically depending on the Sample Rate and Record Length.

"Manual mode" The RBW can be defined by the user.
The user-defined RBW is used and the Window Length (and possibly Sample Rate) are adapted accordingly.

"Advanced FFT mode" This mode is used if the "Advanced Fourier Transformation Params" option is enabled.
The RBW is determined by the advanced FFT parameters.

Remote command:
`[SENSe:]IQ:BWIDth:MODE` on page 136
`[SENSe:]IQ:BWIDth:RESolution` on page 137

Advanced FFT mode / Basic Settings
Shows or hides the "Advanced Fourier Transformation" parameters in the "Data Acquisition" dialog box.

Note that if the advanced FFT mode is used, the RBW settings are not available.

TransformationAlgorithm ← Advanced FFT mode / Basic Settings
Defines the FFT calculation method.

"Single" One FFT is calculated for the entire record length; if the FFT Length is larger than the record length, zeros are appended to the captured data.

"Averaging" Several overlapping FFTs are calculated for each record; the results are combined to determine the final FFT result for the record. The number of FFTs to be averaged is determined by the Window Overlap and the Window Length.

Remote command:
`[SENSe:]IQ:FFT:ALGorithm` on page 137

FFT Length ← Advanced FFT mode / Basic Settings
Defines the number of frequency points determined by each FFT calculation. The more points are used, the higher the resolution in the spectrum becomes, but the longer the calculation takes.

Note: If you enter the value manually, any integer value from 3 to 524288 is available.

Remote command:
`[SENSe:]IQ:FFT:LENGth` on page 138

Window Function ← Advanced FFT mode / Basic Settings
In the I/Q analyzer you can select one of several FFT window types.

The following window types are available:
- Blackman-Harris
- Flattop
- Gauss
- Rectangular
- 5-Term

Remote command:
[SENSe:]IQ:FFT:WINDow:TYPE on page 138

Window Overlap ← Advanced FFT mode / Basic Settings
Defines the part of a single FFT window that is re-calculated by the next FFT calculation when using multiple FFT windows.

Remote command:
[SENSe:]IQ:FFT:WINDow:OVERlap on page 138

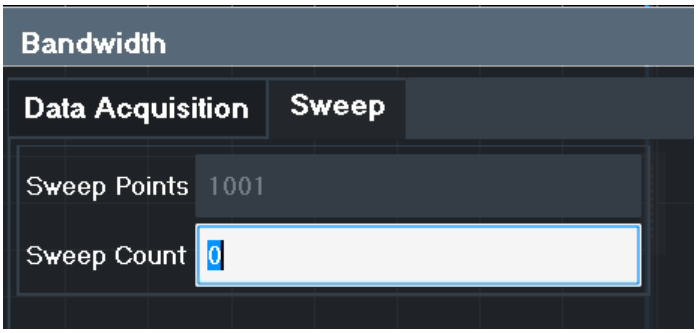
Window Length ← Advanced FFT mode / Basic Settings
Defines the number of samples to be included in a single FFT window in averaging mode. (In single mode, the window length corresponds to the "Record Length" on page 53.)

However, the window length may not be longer than the FFT Length.

Remote command:
[SENSe:]IQ:FFT:WINDow:LENGth on page 138

5.7.2 Sweep Settings

Access: "Overview" > "Bandwidth" > "Sweep" tab



Sweep Points
In the I/Q Analyzer application, a specific frequency bandwidth is swept for a specified measurement time. During this time, a defined number of samples (= "Record Length") are captured. These samples are then evaluated by the applications. Therefore, in this case the number of sweep points does not define the amount of data to be acquired, but rather the number of trace points that are evaluated and displayed in the result diagrams.

Note: For some result displays, the sweep points may not be editable as they are determined automatically, or restrictions may apply. For the I/Q vector result display, the number of I/Q samples to record ("Record Length") must be identical to the number

of trace points to be displayed ("Sweep Points"). Thus, the sweep points are not editable for this result display. If the "Record Length" is edited, the sweep points are adapted automatically. For record lengths outside the valid range of sweep points, i.e. less than 101 points or more than 100001 points, the diagram does not show valid results. Using fewer than 4096 sweep points with a detector other than "Auto Peak" may lead to wrong level results. For details see "Combining results - trace detector" on page 22.

Remote command:
`[SENSe:]SWEep[:WINDow<n>]:POINts` on page 156

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

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

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

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

Remote command:
`[SENSe:]SWEep:COUNt` on page 156
`[SENSe:]AVERage<n>:COUNt` on page 163

Continuous Sweep / Run Cont
After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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 setup. However, the sweep mode only takes effect the next time the Sequencer activates that channel setup, and only for a channel-defined sequence. In this case, a channel setup in continuous sweep mode is swept repeatedly.
Furthermore, the [RUN CONT] key controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 154

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

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

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel setup. However, the sweep mode

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

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

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

Remote command:
`INITiate<n>[:IMMediate]` on page 154

ContinueSingleSweep
After triggering, repeats the number of sweeps set in "Sweep Count", without deleting the trace of the last measurement.

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

Remote command:
`INITiate<n>:CONMeas` on page 153

5.8 Display Configuration

Access: "Overview" > "Display Config"

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

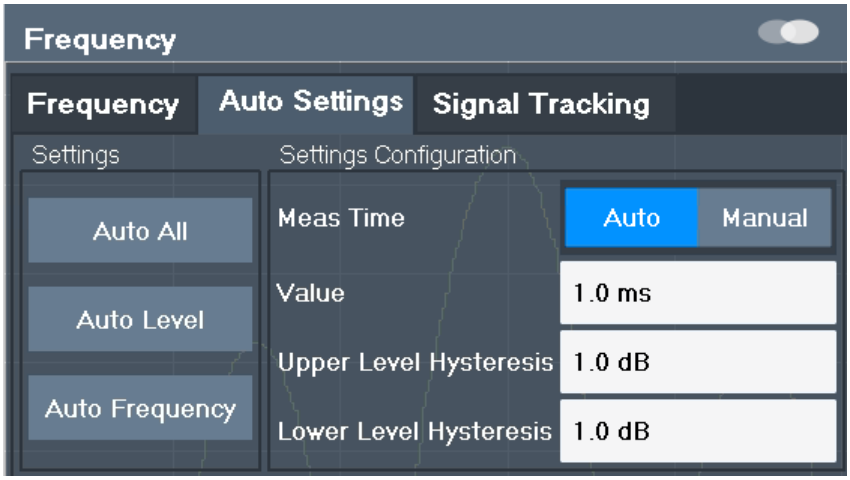
For a description of the available evaluation methods see Chapter 3, "Measurement and Result Displays", on page 13.

Up to 6 evaluations can be displayed in the I/Q Analyzer at any time, including several graphical diagrams, marker tables or peak lists.

The selected evaluation method not only affects the result display in a window, but also the results of the trace data query in remote control (see `TRACe<n>[:DATA]?` on page 211).

5.9 Adjusting Settings Automatically

Access: "Overview" > "Amplitude"/"Frequency" > "Auto Settings"



Some settings can be adjusted by the R&S ZNL automatically according to the current measurement settings. In order to do so, a measurement is performed. You can configure this measurement.

Adjusting settings automatically during triggered measurements

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

- (default:) The measurement for adjustment waits for the next trigger
- The measurement for adjustment is performed without waiting for a trigger.
  The trigger source is temporarily set to "Free Run". After the measurement is completed, the original trigger source is restored. The trigger level is adjusted as follows:
  - For IF Power and RF Power triggers:
    Trigger Level = Reference Level - 15 dB
  - For Video trigger:
    Trigger Level = 85 %

Remote command:

`[SENSe:]ADJust:CONFigure:TRIGger` on page 144

Adjusting all Determinable Settings Automatically (Auto All)

Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Frequency
- Auto Level

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

Adjusting the Center Frequency Automatically (Auto Frequency)
The R&S ZNL adjusts the center frequency automatically.

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

Remote command:
[SENSe:]ADJust:FREQuency on page 144

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

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

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

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (MeastimeManual)" on page 59).

Remote command:
[SENSe:]ADJust:LEVel on page 144

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

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 143

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

Note: The maximum possible measurement duration depends on the currently selected measurement and the installed (optional) hardware. Thus, the measurement duration actually used to determine the automatic settings may be shorter than the value you define here.

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 143
[SENSe:]ADJust:CONFigure:DURation on page 142

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

Remote command:
`[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer` on page 144

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

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

6 Analysis

Access: "Overview" > "Analysis"

General result analysis settings concerning the trace, markers etc. are identical to the analysis functions in the Spectrum application, except for the lines and special marker functions, which are not available for I/Q data.

The remote commands required to perform these tasks are described in Chapter 6, "Analysis", on page 61.

6.1 Trace Settings

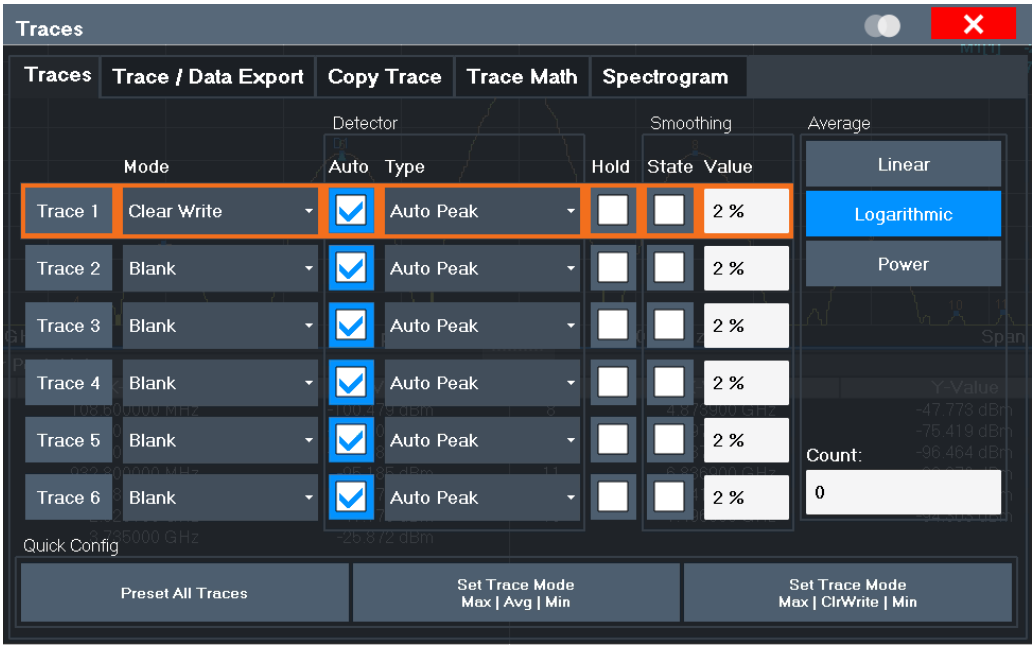
Access: "Overview" > "Analysis" > "Traces"

Or: [TRACE] > Trace

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

Trace data can also be exported to an ASCII file for further analysis. For details see Chapter 6.3, "Trace / Data Export Configuration", on page 70.

For I/Q Vector evaluation mode, only 1 trace is available and the detector is not editable.



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

Remote command:
Selected via numeric suffix of:`TRACe<1...6>` commands
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 160

TraceMode
Defines the update mode for subsequent traces.

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

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

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

"Average" The average is formed over several sweeps.
The Sweep/Average Count determines the number of averaging procedures.

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

"Blank" Removes the selected trace from the display.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:MODE on page 158

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

The trace detector is used to combine multiple FFT window results to create the final spectrum. (Note: in previous versions of the R&S ZNL, the I/Q Analyzer always used the linear average detector.) If necessary, the trace detector is also used to reduce the number of calculated frequency points (defined by the FFT length) to the defined number of sweep points. By default, the Autopeak trace detector is used.

Note: Using a detector other than Auto Peak and fewer than 4096 sweep points may lead to wrong level results. For details see "Combining results - trace detector" on page 22.

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

"Type" Defines the selected detector type.

Remote command:
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] on page 162
[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO on page 162

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

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

The default setting is off.

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous on page 159

Average Mode
Defines the mode with which the trace is averaged over several sweeps.

This setting is generally applicable if trace mode "Average" is selected. For FFT sweeps, the setting also affects the VBW (regardless of whether or not the trace is averaged).

(See the chapter on ACLR power measurements in the R&S ZNL User Manual.)

How many sweeps are averaged is defined by the "Sweep/Average Count" on page 56.

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

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

"Power" Activates linear power averaging.
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.
Use this mode to average power values in Volts or Amperes correctly. In particular, for small VBW values (smaller than the RBW), use power averaging mode for correct power measurements in FFT sweep mode.

Remote command:
`[SENSe:]AVERage<n>:TYPE` on page 161

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

Function	Trace Settings	
Preset All Traces	Trace 1:	Clear Write
	Traces 2-6:	Blank
Set Trace Mode Max | Avg | Min	Trace 1:	Max Hold
	Trace 2:	Average
	Trace 3:	Min Hold
	Traces 4-6:	Blank
Set Trace Mode Max | ClrWrite | Min	Trace 1:	Max Hold
	Trace 2:	Clear Write
	Trace 3:	Min Hold
	Traces 4-6:	Blank

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

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe]` on page 160

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

Or: [TRACE] > "Copy Trace"

Copies trace data to another trace.

The first group of buttons (labeled "Trace 1" to "Trace 6") selects the source trace. The second group of buttons (labeled "Copy to Trace 1" to "Copy to Tace 6") selects the destination.

Remote command:
`TRACe<n>:COPY` on page 163

6.2 Spectrogram Settings

Access: [TRACE] > "Spectrogram Config"

The individual settings available for spectrogram display are described here. For settings on color mapping, see Chapter 6.2.2, "Color Map Settings", on page 68.

Settings concerning the frames and how they are handled during a sweep are provided as additional sweep settings for spectrogram display.

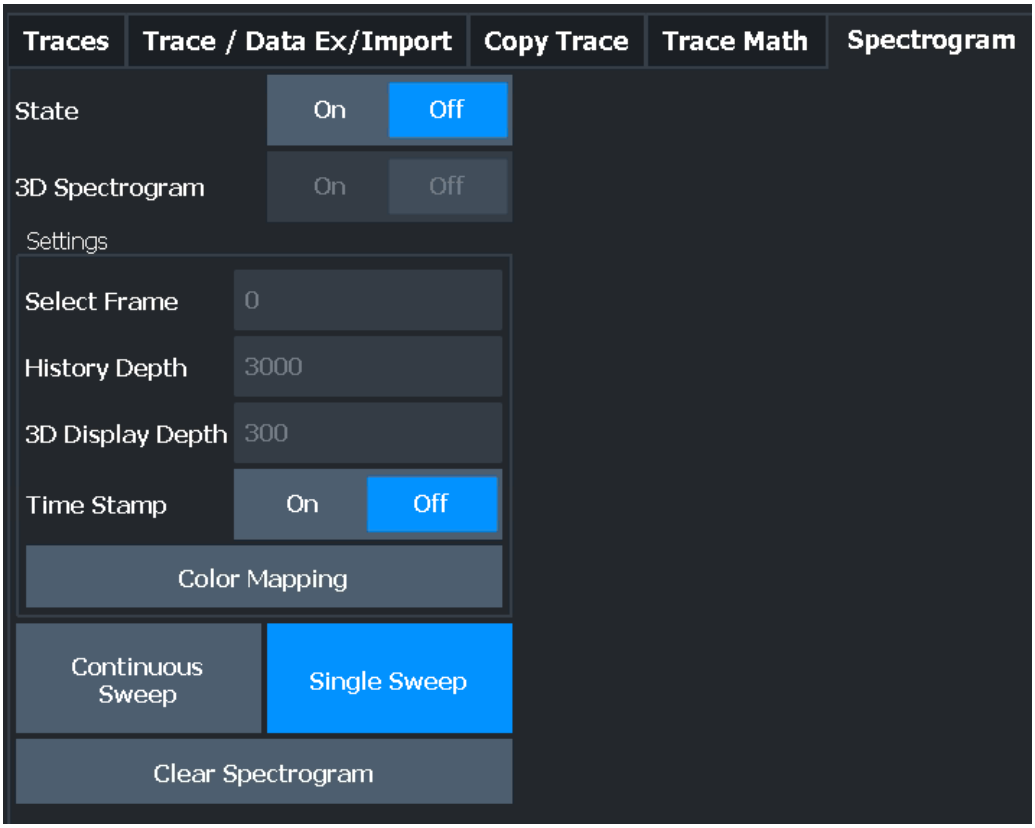
See Chapter 5.7.2, "Sweep Settings", on page 55.

Search functions for spectrogram markers are described in Chapter 6.4.2.2, "Marker Search Settings for Spectrograms", on page 81.

6.2.1 General Spectrogram Settings

Access: [TRACE] > "Spectrogram Config"

This section describes general settings for spectrogram display.



State
Activates and deactivates a Spectrogram subwindow.

"On" Displays the Spectrogram as a subwindow in the original result display.

"Off" Closes the Spectrogram subwindow.

Remote command:
`CALCulate<n>:SPECtrogram:LAYout` on page 167

3D Spectrogram State
Activates and deactivates a 3-dimensional spectrogram. As opposed to the common 2-dimensional spectrogram, the power is not only indicated by a color mapping, but also in a third dimension, the z-axis.

For details see the R&S ZNL User Manual.

Remote command:
CALCulate<n>:SPECtrogram:THReedim[:STATe] on page 167

Select Frame
Selects a specific frame, loads the corresponding trace from the memory, and displays it in the Spectrum window.

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

This function is only available in single sweep mode or if the sweep is stopped, and only if a spectrogram is selected.

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

For more details see the R&S ZNL User Manual.

Remote command:
CALCulate<n>:SPECtrogram:FRAMe:SELect on page 166

History Depth
Sets the number of frames that the R&S ZNL stores in its memory.

The maximum number of frames depends on the "Sweep Points" on page 55.

For an overview of the maximum number of frames depending on the number of sweep points, see the R&S ZNL User Manual.

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

Remote command:
CALCulate<n>:SPECtrogram:HDEPth on page 166

3-D Display Depth
Defines the number of frames displayed in a 3-dimensional spectrogram.

For details see the R&S ZNL User Manual.

Time Stamp
Activates and deactivates the timestamp. The timestamp shows the system time while the measurement is running. In single sweep mode or if the sweep is stopped, the timestamp shows the time and date of the end of the sweep.

When active, the timestamp replaces the display of the frame number.

Remote command:
CALCulate<n>:SPECtrogram:TSTamp[:STATe] on page 169
CALCulate<n>:SPECtrogram:TSTamp:DATA? on page 168

Color Mapping
Opens the "Color Mapping" dialog.

For details see the R&S ZNL User Manual.

Continuous Sweep / Run Cont
After triggering, starts the sweep and repeats it continuously until stopped. This is the default setting.

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 setup. However, the sweep mode only takes effect the next time the Sequencer activates that channel setup, and only for a channel-defined sequence. In this case, a channel setup in continuous sweep mode is swept repeatedly.
Furthermore, the [RUN CONT] key controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

Remote command:
`INITiate<n>:CONTinuous` on page 154

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

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

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

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

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

Remote command:
`INITiate<n>[:IMMediate]` on page 154

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

This function is only available if a spectrogram is selected.

Remote command:
`CALCulate<n>:SPECtrogram:CLEar[:IMMediate]` on page 165

6.2.2 Color Map Settings

Access: "Overview" > "Analysis" > "Traces" > "Spectrogram" > "Color Mapping"

or: [TRACE] > "Spectrogram Config" > "Color Mapping"

In addition to the available color settings, the dialog box displays the current color map and provides a preview of the display with the current settings.

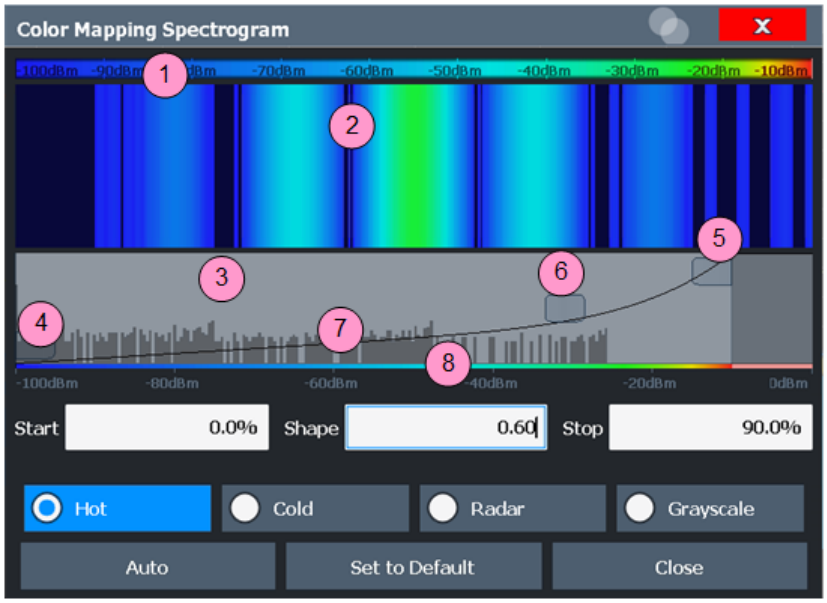


Figure 6-1: Color Mapping dialog box

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

Start / Stop
Defines the lower and upper boundaries of the value range of the spectrogram.

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer` on page 170
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer` on page 170

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

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

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe` on page 170

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

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe]` on page 171

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

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

Remote command:
`DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault` on page 170

Close
Saves the changes and closes the dialog box.

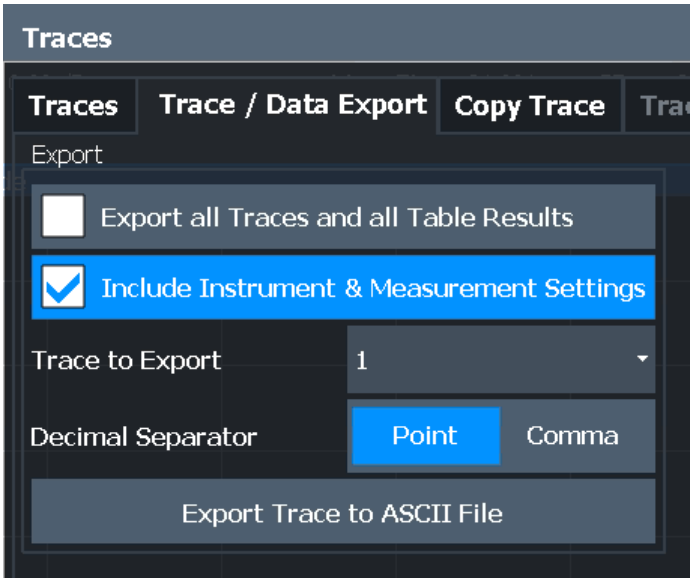
6.3 Trace / Data Export Configuration

Access: "Save" > "Export" > "Trace Export Configuration"

Or: [TRACE] > Trace > "Trace / Data Export"

The R&S ZNL provides various evaluation methods for the results of the performed measurements. However, you may want to evaluate the data with other, external applications. In this case, you can export the measurement data to an ASCII file.

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



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

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

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

Remote command:
`FORMat:DEXPort:TRACes` on page 215

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

Remote command:
`FORMat:DEXPort:HEADer` on page 214

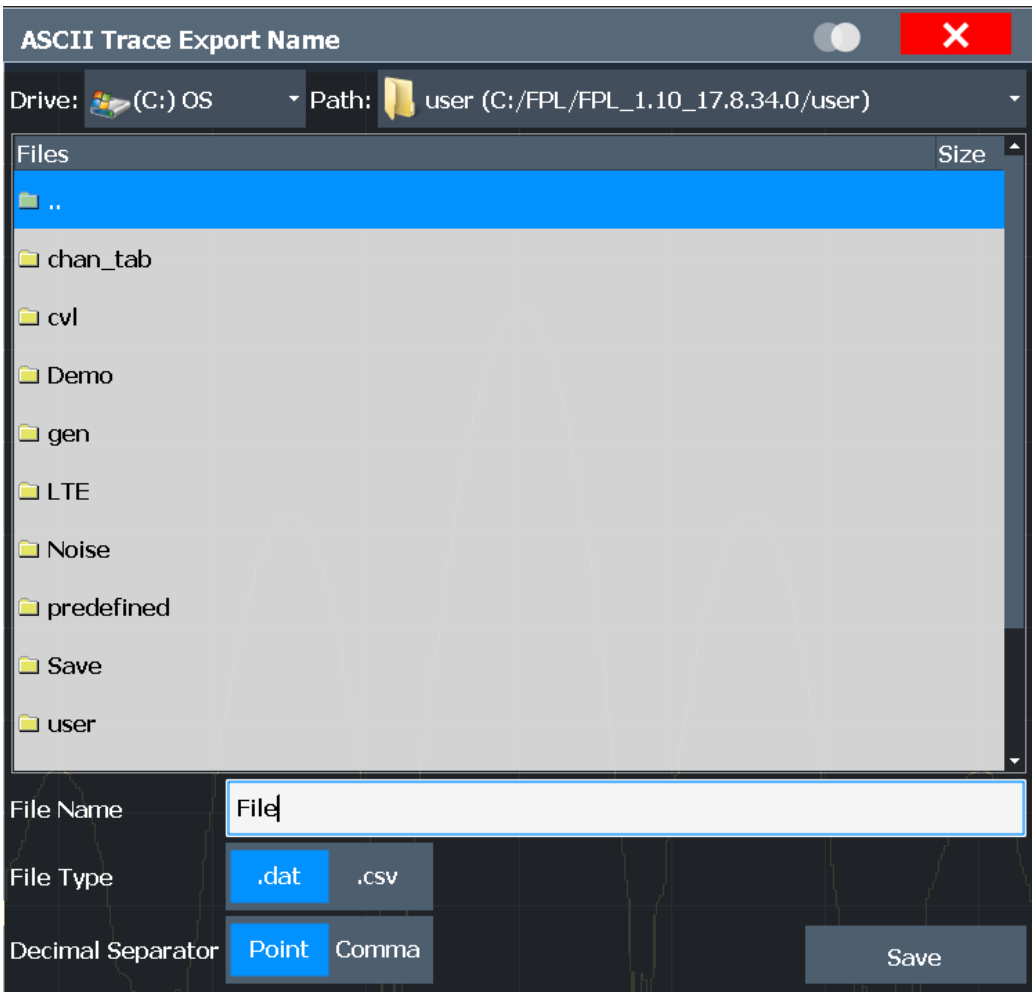
Trace to Export
Defines an individual trace to be exported to a file.

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

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

Remote command:
FORMat:DEXPort:DSEParator on page 214

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



Remote command:
MMEMory:STORe<n>:TRACe on page 215

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

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

Remote command:
FORMat:DEXPort:FORMat on page 214

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

Remote command:
`FORMat:DEXPort:DSEParator` on page 214

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

Remote command:
not supported

6.4 Marker Usage

Access: "Overview" > "Analysis"

The following marker settings and functions are available in the I/Q Analyzer application.

For "I/Q-Vector" displays markers are not available.

In the I/Q Analyzer application, the resolution with which the frequency can be measured with a marker is always the filter bandwidth, which is derived from the defined sample rate.

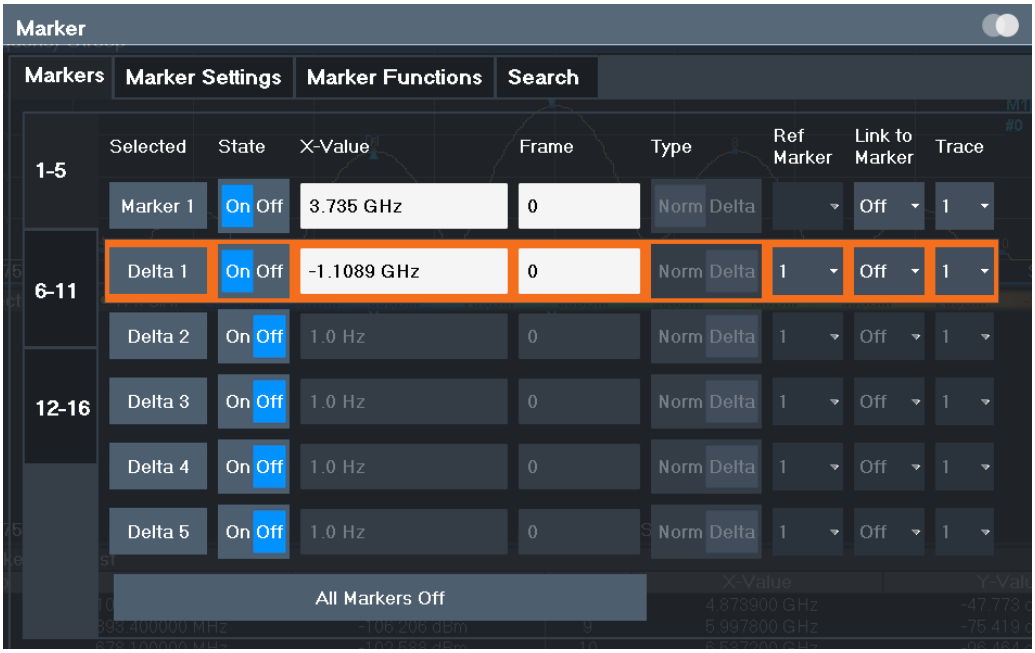
6.4.1 Marker Settings

Or: [MKR] > "MarkerConfig"

The remote commands required to define these settings are described in Chapter 9.7.3.1, "Setting Up Individual Markers", on page 172.

6.4.1.1 Individual Marker Setup

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



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

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

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

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 176
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 174

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

Remote command:
CALCulate<n>:MARKer<m>:X on page 177
CALCulate<n>:DELTamarker<m>:X on page 175

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

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe on page 184
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe on page 189

Marker Type
Toggles the marker type.

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

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

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

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

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 176
CALCulate<n>:DELTamarker<m>[:STATe] on page 174

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

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

Remote command:
CALCulate<n>:DELTamarker<m>:MREFerence on page 174

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

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

Remote command:
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> on page 176
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> on page 173
CALCulate<n>:DELTamarker<m>:LINK on page 172

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

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

Remote command:
CALCulate<n>:MARKer<m>:TRACe on page 177

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

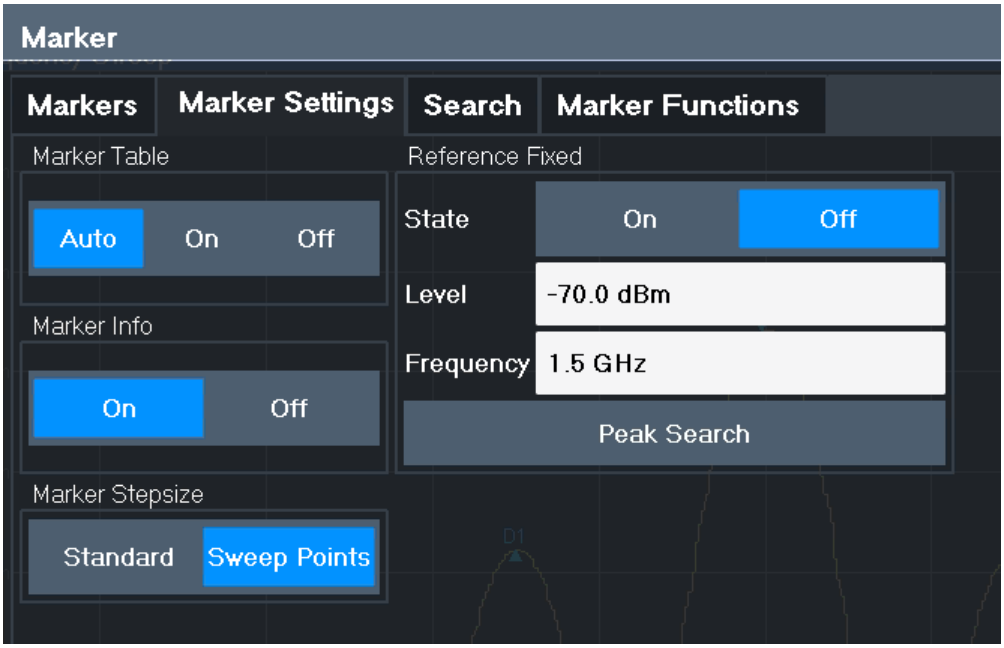
Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 176
CALCulate<n>:DELTamarker<m>[:STATe] on page 174

All Markers Off
Deactivates all markers in one step.

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

6.4.1.2 General Marker Settings

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



Marker Table Display
Defines how the marker information is displayed.

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

"Off" No separate marker table is displayed.
If Marker Info is active, the marker information is displayed within the diagram area.

"Auto" (Default) If more than two markers are active, the marker table is displayed automatically.
If Marker Info is active, the marker information for up to two markers is displayed in the diagram area.

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 178

Marker Info
Turns the marker information displayed in the diagram on and off.

Remote command:
DISPlay[:WINDow<n>]:MINFo[:STATe] on page 178

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

"Standard" The marker position is moved in steps of (Span/1000), which corresponds approximately to the number of pixels for the default display of 1001 sweep points. This setting is most suitable to move the marker over a larger distance.

"Sweep Points" The marker position is moved from one sweep point to the next. This setting is required for a very precise positioning if more sweep points are collected than the number of pixels that can be displayed on the screen. It is the default mode.

Remote command:
CALCulate<n>:MARKer<m>:X:SSIZe on page 178

6.4.2 Marker Search Settings and Positioning Functions

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

or: [MKR TO]

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

For more information on searching for signal peaks see Chapter 6.4.4.2, "Marker Peak List", on page 92.

In I/Q Analyzer mode, the search settings for "Real/Imag (I/Q)" evaluation include an additional parameter, see "Branch for Peaksearch" on page 81.

Note that in the Spectrum diagram in I/Q mode, a peak search is performed only within the indicated Analysis Bandwidth, unless you specify Search Limits (Left / Right) in the marker settings.

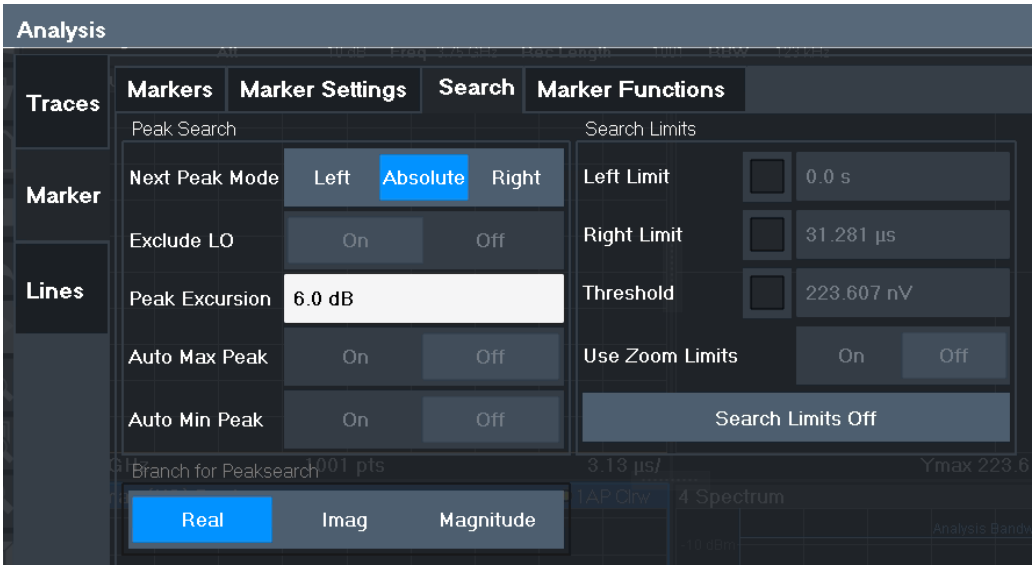
The remote commands required to define these settings are described in Chapter 9.7.3.5, "Positioning the Marker", on page 193.

6.4.2.1 Marker Search Settings

Access: [MKR TO] > "Search Config"

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

For Spectrograms, special marker settings are available, see Chapter 6.4.2.2, "Marker Search Settings for Spectrograms", on page 81.



Search Mode for Next Peak

Selects the search mode for the next peak search.

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

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

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

Remote command:
Chapter 9.7.3.5, "Positioning the Marker", on page 193

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

"On" The minimum frequency included in the peak search range is ≥ 5 × resolution bandwidth (RBW).
Due to the interference by the first local oscillator to the first intermediate frequency at the input mixer, the LO is represented as a signal at 0 Hz. To avoid the peak marker jumping to the LO signal at 0 Hz, this frequency is excluded from the peak search.

"Off" No restriction to the search range. The frequency 0 Hz is included in the marker search functions.

Remote command:
`CALCulate<n>:MARKer<m>:LOEXclude` on page 179

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

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

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 6.4.4.2, "Marker Peak List", on page 92.

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 179

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

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

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:AUTO` on page 193
`CALCulate<n>:MARKer<m>:MINimum:AUTO` on page 195

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

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

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 181
`CALCulate<n>:MARKer<m>:X:SLIMits:LEFT` on page 181
`CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt` on page 182

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

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

Use Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom.

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

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

Remote command:
`CALCulate<n>:MARKer<m>:X:SLIMits[:STATe]` on page 181
`CALCulate<n>:THReshold:STATe` on page 183

Branch for Peaksearch
Defines which data is used for marker search functions in I/Q data.

This function is only available for the display configuration "Real/Imag (I/Q)" (see "Real/Imag (I/Q)" on page 15).

Note: The search settings apply to all markers, not only the currently selected one.

"Real"
: Marker search functions are performed on the real trace of the I/Q measurement.

"Imag"
: Marker search functions are performed on the imaginary trace of the I/Q measurement.

"Magnitude"
: Marker search functions are performed on the magnitude of the I and Q data.

Remote command:
`CALCulate<n>:MARKer<m>:SEARch` on page 180

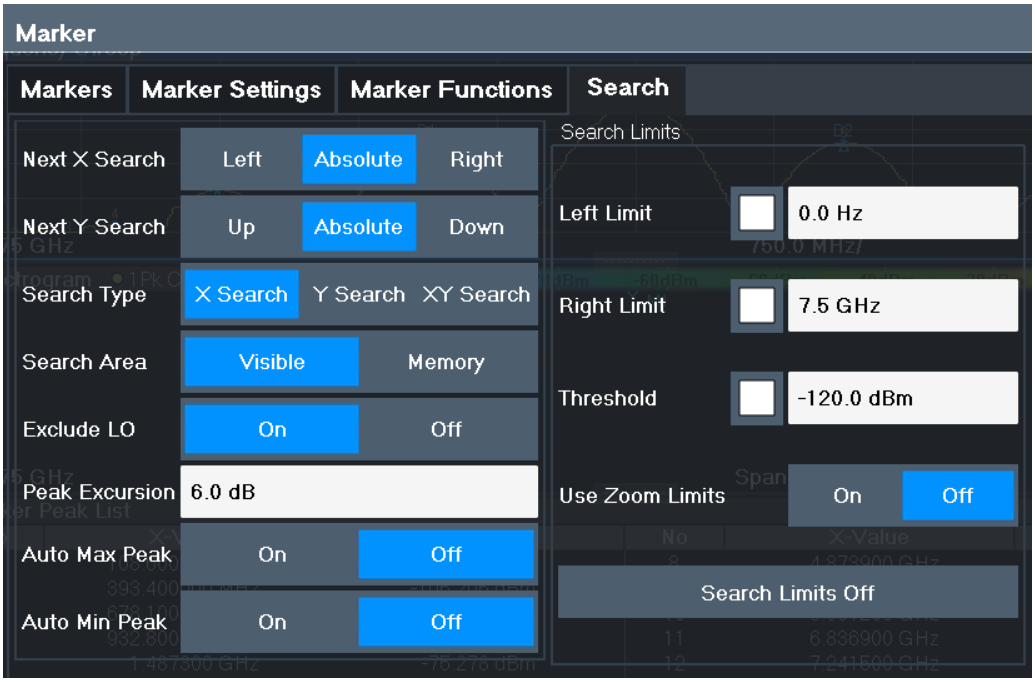
6.4.2.2 Marker Search Settings for Spectrograms

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

or: [MKR TO] > "Search Config"

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

These settings are only available for spectrogram displays.



Search Mode for Next Peak in X-Direction
Selects the search mode for the next peak search within the currently selected frame.

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

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

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

Remote command:
Chapter 9.7.3.5, "Positioning the Marker", on page 193

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

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

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

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

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe on page 186
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe on page 190
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow on page 186
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow on page 191
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT on page 186
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT on page 191
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe on page 187
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe on page 191
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow on page 187
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow on page 192
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT on page 187
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT on page 192

Marker Search Type
Defines the type of search to be performed in the spectrogram.

"X-Search" Searches only within the currently selected frame.

"Y-Search" Searches within all frames but only at the current frequency position.

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

Remote command:
Defined by the search function, see Chapter 9.7.3.4, "Marker Search (Spectrograms)", on page 183

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

"Visible" Only the visible frames are searched.

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

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:SAREa on page 185
CALCulate<n>:DELTamarker<m>:SPECtrogram:SAREa on page 189

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

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

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 6.4.4.2, "Marker Peak List", on page 92.

Remote command:
CALCulate<n>:MARKer<m>:PEXCursion on page 179

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

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

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 181
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 181
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt on page 182

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

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

Use Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom.

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

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

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 181
CALCulate<n>:THReshold:STATe on page 183

6.4.2.3 Positioning Functions

Access: [MKR ->]

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

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

Remote command:
CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 194
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK] on page 197

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

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 194
CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 194
CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 193
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 197
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 197
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 196

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

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

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

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

Remote command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 195
CALCulate<n>:MARKer<m>:MINimum:LEFT on page 195
CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 196
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 198
CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 198
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 198

Center Frequency = Marker Frequency
Sets the center frequency to the selected marker or delta marker frequency. A peak can thus be set as center frequency, for example to analyze it in detail with a smaller span.

This function is not available for zero span measurements.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:CENTer on page 127

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

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:REFerence on page 123

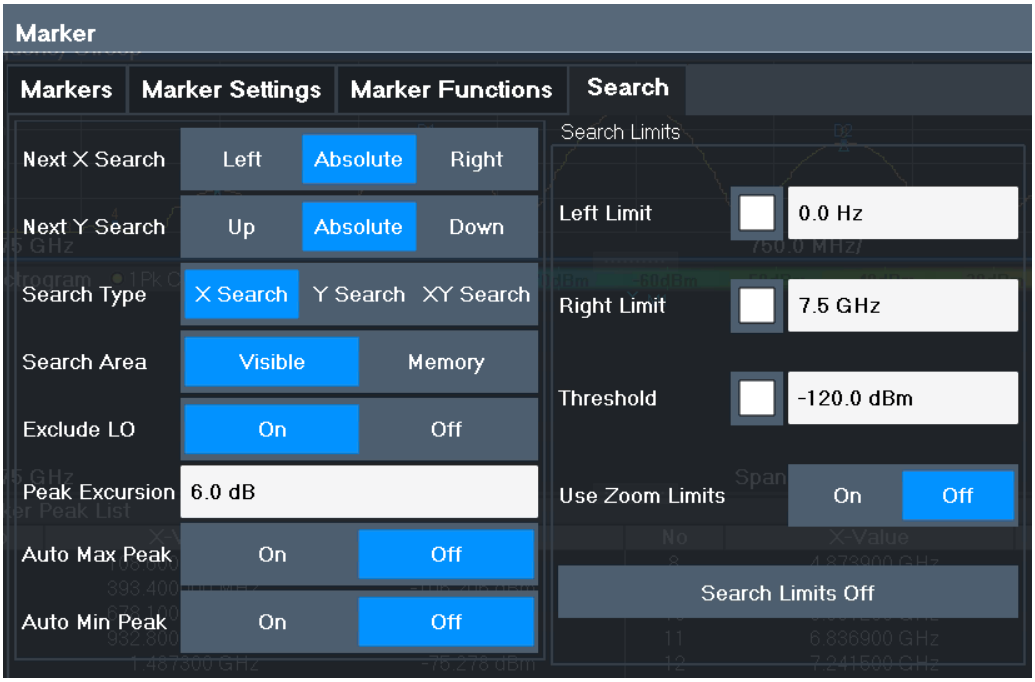
6.4.3 Marker Search Settings for Spectrograms

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

or: [MKR TO] > "Search Config"

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

These settings are only available for spectrogram displays.



Search Mode for Next Peak in X-Direction
Selects the search mode for the next peak search within the currently selected frame.

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

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

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

Remote command:
Chapter 9.7.3.5, "Positioning the Marker", on page 193

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

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

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

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

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe on page 186
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe on page 190
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow on page 186
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow on page 191
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT on page 186
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT on page 191
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe on page 187
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe on page 191
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow on page 187
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow on page 192
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT on page 187
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT on page 192

Marker Search Type
Defines the type of search to be performed in the spectrogram.

"X-Search" Searches only within the currently selected frame.

"Y-Search" Searches within all frames but only at the current frequency position.

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

Remote command:
Defined by the search function, see Chapter 9.7.3.4, "Marker Search (Spectrograms)", on page 183

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

"Visible" Only the visible frames are searched.

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

Remote command:
CALCulate<n>:MARKer<m>:SPECtrogram:SAREa on page 185
CALCulate<n>:DELTamarker<m>:SPECtrogram:SAREa on page 189

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

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

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 6.4.4.2, "Marker Peak List", on page 92.

Remote command:
CALCulate<n>:MARKer<m>:PEXCursion on page 179

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

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

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 181
CALCulate<n>:MARKer<m>:X:SLIMits:LEFT on page 181
CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt on page 182

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

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

Use Zoom Limits ← Search Limits
If activated, the peak search is restricted to the active zoom area defined for a single zoom.

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

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

Remote command:
CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] on page 181
CALCulate<n>:THReshold:STATe on page 183

6.4.4 Marker Functions

Some special marker functions are available in the I/Q Analyzer application.

6.4.4.1 Measuring the Power in a Channel (Band Power Marker)

Access: "Overview" > "Analysis" > "Marker Functions" > "Band Power" > "BandPower-Config"

or: [MKR] > "Select Marker Function" > "Band Power"

To determine the noise power in a transmission channel, you can use a noise marker and multiply the result with the channel bandwidth. However, the results are only accurate for flat noise.

Band power markers allow you to measure the integrated power for a defined span (band) around a marker (similar to ACP measurements). By default, 5 % of the current span is used. The span is indicated by limit lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

The results can be displayed either as a power (dBm) or density (dBm/Hz) value and are indicated in the marker table for each band power marker.

Relative band power markers

The results for band power markers which are defined as *delta* markers and thus have a reference value can also be calculated as reference power values (in dB).

In this case, the result of the band power deltamarker is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.

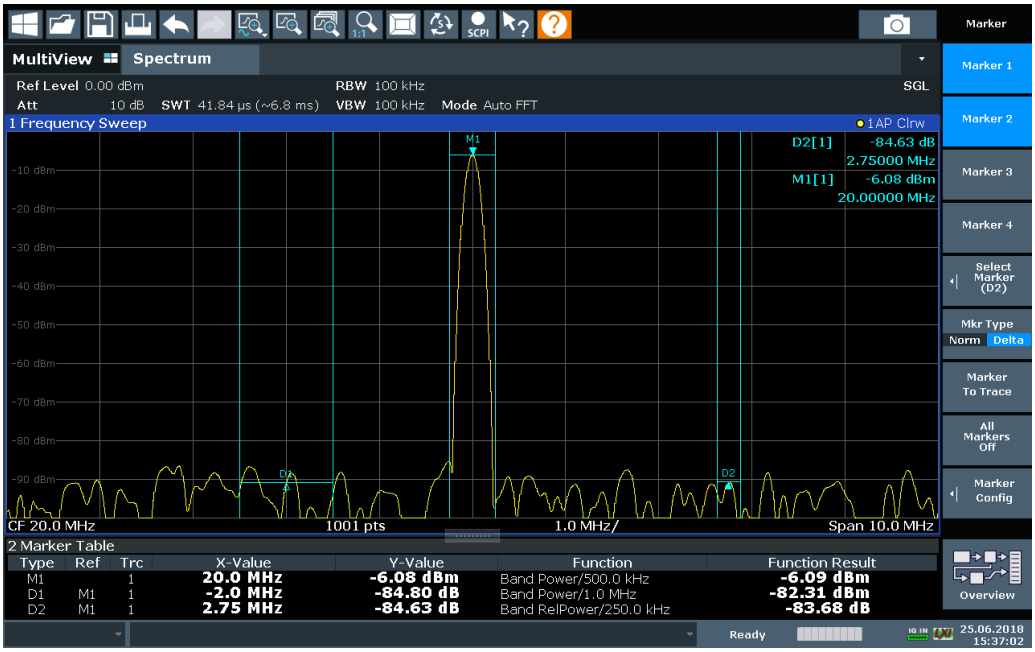
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]

The measured power for the reference marker may be an absolute power at a single point (if the reference marker is not a band power marker), or the power in a band (if the reference marker is a band power marker itself).

If the reference marker for the band power marker is also a delta marker, the absolute power level for the reference marker is used for calculation.

For the I/Q Analyzer application, band power markers are only available for Spectrum displays.

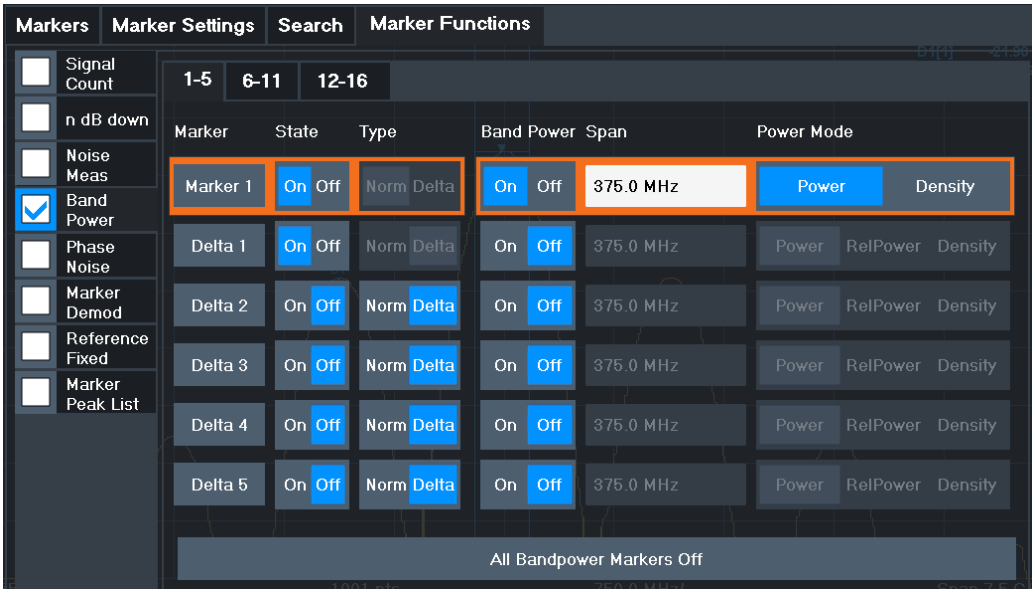
The entire band must lie within the display. If it is moved out of the display, the result cannot be calculated (indicated by "- - -" as the "Function Result"). However, the width of the band is maintained so that the band power can be calculated again when it returns to the display.



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

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

The individual marker settings correspond to those defined in the "Marker" dialog box (see Chapter 6.4.1.1, "Individual Marker Setup", on page 73). Any settings to the marker state or type changed in the "Marker Function" dialog box are also changed in the "Marker" dialog box and vice versa.



Remote commands:

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] on page 200

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult? on page 200

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

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

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

For details see Chapter 6.4.4.1, "Measuring the Power in a Channel (Band Power Marker)", on page 89.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] on page 200
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] on page 202

Span
Defines the span (band) around the marker for which the power is measured.

The span is indicated by lines in the diagram. You can easily change the span by moving the limit lines in the diagram. They are automatically aligned symmetrically to the marker frequency. They are also moved automatically if you move the marker on the screen.

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN on page 200
CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN on page 202

Power Mode
Defines the mode of the power measurement result.

For Analog Modulation Analysis, the power mode is not editable for AM, FM, or PM spectrum results. In this case, the marker function does not determine a power value, but rather the deviation within the specified span.

"Power"	The result is an absolute power level. The power unit depends on the Unit setting.
"Relative-Power"	This setting is only available for a delta band power marker. The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker (see "Reference Marker" on page 75). The powers are subtracted logarithmically, so the result is a dB value. *[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]* For details see "Relative band power markers" on page 89

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

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE` on page 199
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE` on page 201

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

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe]` on page 200
`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe]` on page 202

6.4.4.2 Marker Peak List

Access: "Overview" > "Analysis" > "Marker Functions" > "Marker Peak List"

Or: [MKR] > "Select Marker Function" > "Marker Peak List"

A common measurement task is to determine peak values, i.e. maximum or minimum signal levels. The R&S ZNL provides various peak search functions and applications:

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

Peak search limits

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

When is a peak a peak? - Peak excursion

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

Effect of peak excursion settings (example)

The following figure shows a trace to be analyzed.

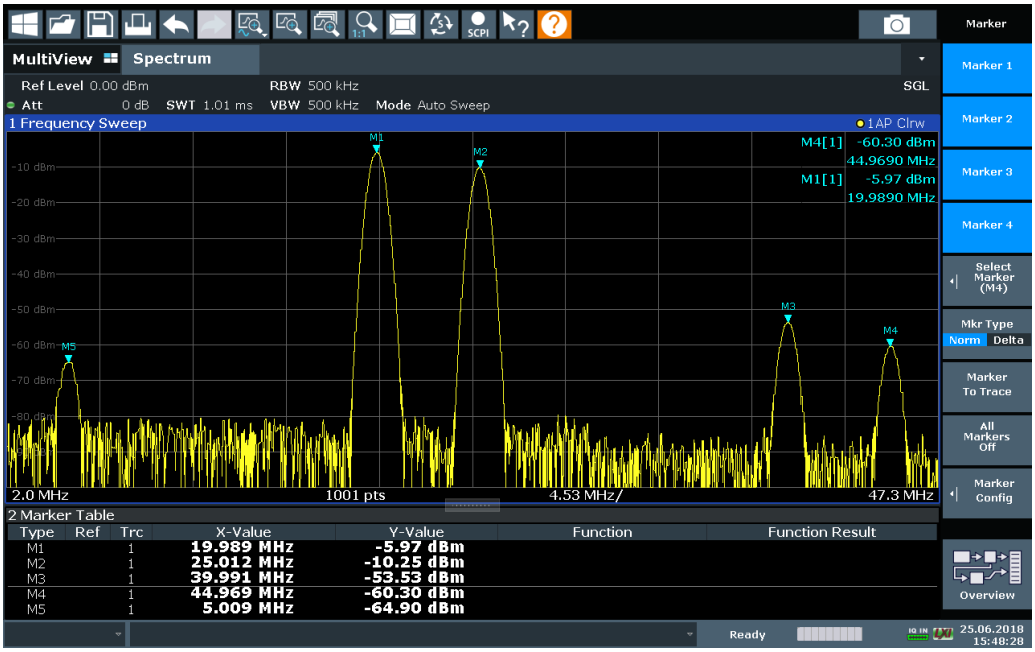


Figure 6-2: Trace example

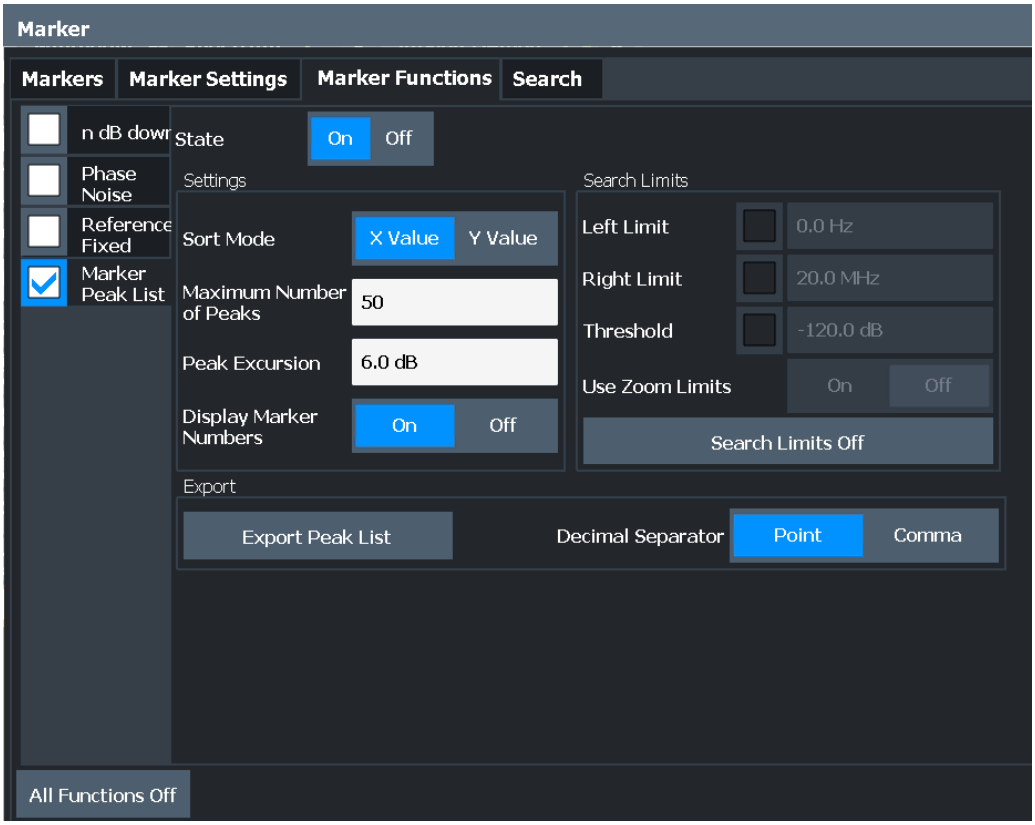
The following table lists the peaks as indicated by the marker numbers in the diagram above, as well as the minimum decrease in amplitude to either side of the peak:

Marker #	Min. amplitude decrease to either side of the signal
1	80 dB
2	80 dB
3	55 dB
4	39 dB
5	32 dB

In order to eliminate the smaller peaks M3, M4 and M5 in the example above, a peak excursion of at least 60 dB is required. In this case, the amplitude must rise at least 60 dB before falling again before a peak is detected.

Marker peak list

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



Remote commands:

`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe` on page 205

`TRAC? LIST`, see `TRACe<n>[:DATA]?` on page 211

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

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

Remote command:
`CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe` on page 205

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

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT on page 205

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

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE on page 204

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

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

For Analog Modulation Analysis, the unit and value range depend on the selected result display type.

For more information, see Chapter 6.4.4.2, "Marker Peak List", on page 92.

Remote command:
CALCulate<n>:MARKer<m>:PEXCursion on page 179

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

Remote command:
CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe] on page 203

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

Remote command:
MMEMory:STORe<n>:PEAK on page 206
FORMat:DEXPort:DSEParator on page 214

6.4.4.3 Deactivating All Marker Functions

Access: "Overview" > "Analysis" > "Marker Functions" > "All Functions Off"

Or: [MKR] > "All Functions Off"

All special marker functions can be deactivated in one step.

Remote command:

7 How to Perform Measurements in the I/Q Analyzer Application

The following step-by-step instructions demonstrate how to capture I/Q data on the R&S ZNL and how to analyze data in the I/Q Analyzer application.

7.1 How to Capture Baseband (I/Q) Data as RF Input

By default, the I/Q Analyzer assumes the I/Q data is modulated on a carrier frequency and input via the "RF Input" connector on the R&S ZNL.

1. Select the [MODE] key and select the "I/Q Analyzer" application.
2. Select the "Overview" softkey to display the "Overview" for an I/Q Analyzer measurement.
3. Select the "Input" button to select and configure the "RF Input" signal source.
4. Select the "Amplitude" button to define the attenuation, reference level or other settings that affect the input signal's amplitude and scaling.
5. Select the "Frequency" button to define the input signal's center frequency.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an I/Q Power trigger to start capturing data only when a specific power is exceeded.
7. Select the "Bandwidth" button and define the bandwidth parameters for data acquisition:
   - "Sample Rate" or "Analysis Bandwidth" the span of the input signal to be captured for analysis, or the rate at which samples are captured (both values are correlated)
   - "Measurement Time" how long the data is to be captured
   - "Record Length": the number of samples to be captured (also defined by sample rate and measurement time)
8. Select the "Display Config" button and select up to six displays that are of interest to you.
   Arrange them on the display to suit your preferences.
9. Exit the SmartGrid mode.
10. Start a new sweep with the defined settings.
    a) Select the Sequencer icon ( ) from the toolbar.
    b) Set the Sequencer state to "Off".

c) Select the [RUN SINGLE] key.

7.2 How to Analyze Data in the I/Q Analyzer

1. Select the [MODE] key and select the "I/Q Analyzer" application.
2. Select the "Overview" softkey to display the "Overview" for an I/Q Analyzer measurement.
3. Select the "Display Config" button and select up to six displays that are of interest to you.
   Arrange them on the display to suit your preferences.
4. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
5. Select the "Analysis" button in the "Overview" to make use of the advanced analysis functions in the displays.
   - Configure a trace to display the average over a series of sweeps (on the "Trace" tab; if necessary, increase the "Average Count").
   - Configure markers and delta markers to determine deviations and offsets within the signal (on the "Marker" tab).

8 How to Export and Import I/Q Data

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

Capturing and exporting I/Q data

1. Press the [PRESET] key.
2. Press the [MODE] key and select the I/Q Analyzer application or any other application that supports I/Q data.
3. Configure the data acquisition.
4. Press the [RUN SINGLE] key to perform a single sweep measurement.
5. Select the "Save" icon in the toolbar.
6. Select the "I/Q Export" softkey.
7. In the file selection dialog box, select a storage location and enter a file name.
8. Select "Save".

   The captured data is stored to a file with the extension `.iq.tar`.

Importing I/Q data

1. Press the [MODE] key and select the "I/Q Analyzer" or any other application that supports I/Q data.
2. If necessary, switch to single sweep mode by pressing the [RUN SINGLE] key.
3. Select the "Open" icon in the toolbar.
4. Select the "I/Q Import" softkey.
5. Select the storage location and the file name with the `.iq.tar` file extension.
6. Select "Open".

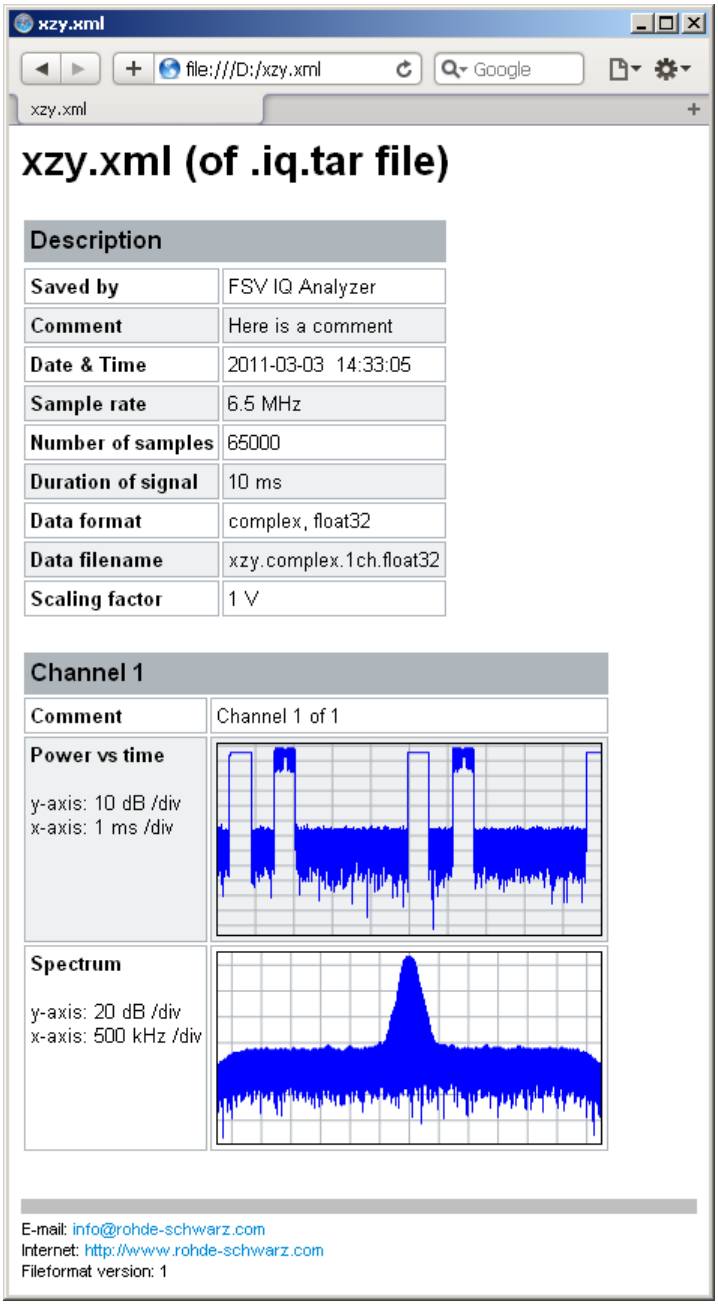
   The stored data is loaded from the file and displayed in the current application.

Previewing the I/Q data in a web browser

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

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

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



9 Remote Commands to Perform Measurements with I/Q Data

The following commands are specific to performing measurements in the I/Q Analyzer application in a remote environment. The R&S ZNL must already be set up for remote operation in a network as described in the base unit manual.

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

In particular, this includes:

- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers

The following tasks specific to the I/Q Analyzer application are described here:

9.1 Introduction

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

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

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

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

Remote command examples

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

9.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

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

9.1.2 Long and Short Form

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

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

Example:

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

9.1.3 Numeric Suffixes

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

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

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

Example:

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

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

9.1.4 Optional Keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

9.1.5 Alternative Keywords

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

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

9.1.6 SCPI Parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters may have different forms of values.

9.1.6.1 Numeric Values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

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

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

9.1.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

9.1.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see Chapter 9.1.2, "Long and Short Form", on page 101.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

9.1.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

9.1.6.5 Block Data

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

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

9.2 Common Suffixes

In the I/Q Analyzer application, the following common suffixes are used in remote commands:

Table 9-1: Common suffixes used in remote commands in the I/Q Analyzer application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 6	Window (**in the currently selected channel setup**)
<t>	1 to 6	Trace
	1 to 8	Limit line

9.3 Activating I/Q Analyzer Measurements

I/Q Analyzer measurements require a special channel setup on the R&S ZNL. It can be activated using the common `INSTrument:CREate[:NEW]` or `INSTrument:CREate:REPLace` commands. In this case, some - but not all - parameters from the previously selected application are passed on to the I/Q Analyzer channel setup. In order to retain *all* relevant parameters from the current application for the I/Q measurement, use the `TRACe:IQ[:STATe]` command to change the application of the current channel setup.

A measurement is started immediately with the default settings when the channel setup is activated.

Different remote modes available

In remote control, two different modes for the I/Q Analyzer measurements are available:

- A quick mode for pure data acquisition
  This mode is activated by default with the `TRACe:IQ[:STATe]` command. The evaluation functions are not available; however, performance is slightly improved.
- A more sophisticated mode for acquisition and analysis.
  This mode is activated when a new channel setup is opened for the I/Q Analyzer application (`INST:CRE:NEW`/ `INST:CRE:REPL`) or by an additional command (see `TRACe:IQ:EVAL` on page 109).

INSTrument:CREate:DUPLicate

This command duplicates the currently selected channel setup, i.e creates a new channel setup of the same type and with the identical measurement settings. The name of the new channel setup is the same as the copied channel setup, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer 2").

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

Usage: Event

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

This command adds an additional measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 107.

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

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

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

This command replaces a channel setup with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel setup.
For a list of available channel setup types see `INSTrument:LIST?` on page 107.

<ChannelName2> String containing the name of the new channel setup.
Note: If the specified name for a new channel setup already exists, the default name, extended by a sequential number, is used for the new channel setup (see `INSTrument:LIST?` on page 107).
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a channel setup.

Setting parameters:

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

Usage: Setting only

INSTrument:LIST?

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

Return values:

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

Example:
```
INST:LIST?
```
Result for 3 channel setups:
```
'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'
```

Usage: Query only

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

Application	<ChannelType> Parameter	Default Channel Setup Name*)
Spectrum	SANALYZER	Spectrum
Analog Modulation Analysis	ADEM	Analog Demod
I/Q Analyzer	IQ	IQ Analyzer
Noise Figure Measurements	NOISE	Noise
Vector Signal Analysis (VSA)	DDEM	VSA
Network analysis	Vna	VNA
Note: the default channel setup name is also listed in the table. If the specified name for a new channel setup already exists, the default name, extended by a sequential number, is used for the new channel setup.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a channel setup.

Setting parameters:

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

<ChannelName2> String containing the new channel setup name.
Note that you cannot assign an existing channel setup name to a new channel setup; this will cause an error.
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Usage: Setting only

INSTrument[:SELect] <ChannelType> | <ChannelName>

This command activates a new channel setup with the defined channel setup type, or selects an existing channel setup with the specified name.

Also see

- `INSTrument:CREate[:NEW]` on page 106

Parameters:

<ChannelType> Channel type of the new channel setup.
For a list of available channel setup types see `INSTrument:LIST?` on page 107.

<ChannelName> String containing the name of the channel setup.

Example:
```
INST IQ
INST 'MyIQSpectrum'
```
Selects the channel setup named 'MyIQSpectrum' (for example before executing further commands for that channel setup).

SYSTem:PRESet:CHANnel[:EXEC]

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

Use `INST:SEL` to select the channel setup.

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

Usage: Event

Manual operation: See "Preset Channel Setup" on page 30

TRACe:IQ:EVAL <State>

This command turns I/Q data analysis on and off.

Before you can use this command, you have to turn on the I/Q data acquisition using `INST:CRE:NEW IQ` or `INST:CRE:REPL`, or using the `TRACe:IQ[:STATe]` command to replace the current channel setup while retaining the settings.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `TRAC:IQ ON`
Enables I/Q data acquisition
`TRAC:IQ:EVAL ON`
Enables the I/Q data analysis mode.

TRACe:IQ[:STATe] <State>

Executing this command also has the following effects:

- The sweep, amplitude, input and trigger settings from the previous application are retained
- All measurements from the previous application (e.g. Spectrum) are turned off
- All traces are set to "Blank" mode
- The I/Q data analysis mode is turned off (`TRAC:IQ:EVAL OFF`, if previous application was also I/Q Analyzer)

Note: To turn trace display back on or to enable the evaluation functions of the I/Q Analyzer, execute the `TRAC:IQ:EVAL ON` command (see `TRACe:IQ:EVAL` on page 109).

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `TRAC:IQ ON`
Switches on I/Q data acquisition

9.4 Configuring I/Q Analyzer Measurements

The following commands configure the I/Q Analyzer measurements.

9.4.1 Configuring the Data Input and Output

The following commands are required to configure data input and output.

9.4.1.1 RF Input

INPut<ip>:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer for the R&S ZNL after an overload condition occurred and the protection mechanism intervened. The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

The command works only if the overload condition has been eliminated first.

For details on the protection mechanism see "RF Input Protection" on page 34.

Suffix:
<ip> 1 | 2
irrelevant

Example: `INP:ATT:PROT:RES`

INPut<ip>:IMPedance <Impedance>

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

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<Impedance> 50 | 75
*RST: 50 Ω
Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See "Impedance" on page 34
See "Unit" on page 43

INPut<ip>:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S ZNL.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<Source> **RF**
Radio Frequency ("RF INPUT" connector)
*RST: RF

Manual operation: See "Radio Frequency State" on page 34

9.4.1.2 Input from I/Q Data Files

The input for measurements can be provided from I/Q data files. The commands required to configure the use of such files are described here.

For details see Chapter 4.3, "Basics on Input from I/Q Data Files", on page 26.

Useful commands for retrieving results described elsewhere:

- `INPut<ip>:SELect` on page 111

Remote commands exclusive to input from I/Q data files:

INPut<ip>:FILE:PATH <FileName>[, <AnalysisBW>]

This command selects the I/Q data file to be used as input for further measurements.

The I/Q data must have a specific format as described in Chapter C, "I/Q Data File Format (iq-tar)", on page 225.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<FileName> String containing the path and name of the source file. The file extension is `*.iq.tar`.

<AnalysisBW> Optionally: The analysis bandwidth to be used by the measurement. The bandwidth must be smaller than or equal to the bandwidth of the data that was stored in the file.
Default unit: HZ

Example: `INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'`
Uses I/Q data from the specified file as input.

9.4.1.3 Working with Power Sensors

The following commands describe how to work with power sensors.

These commands require the use of a Rohde & Schwarz power sensor. For a list of supported sensors, see the data sheet.

The [Sensor] connector is provided by the "Additional Interfaces" option R&S FPL1-B5. Additionally, the power sensor measurement requires the option R&S FPL1-K9.

Configuring Power Sensors

SYSTem:COMMunicate:RDEVice:PMETer<p>:CONFigure:AUTO[:STATe] <State>

This command turns automatic assignment of a power sensor to the power sensor index on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `SYST:COMM:RDEV:PMET:CONF:AUTO OFF`

Manual operation: See "Select" on page 37

SYSTem:COMMunicate:RDEVice:PMETer<p>:COUNt?

This command queries the number of power sensors currently connected to the R&S ZNL.

Suffix:
<p> Power sensor index

Return values:
<NumberSensors> Number of connected power sensors.

Example: `SYST:COMM:RDEV:PMET:COUN?`

Usage: Query only

Manual operation: See "Select" on page 37

SYSTem:COMMunicate:RDEVice:PMETer<p>:DEFine <Placeholder>, <Type>, <Interface>, <SerialNo>

This command assigns the power sensor with the specified serial number to the selected power sensor index (configuration).

The query returns the power sensor type and serial number of the sensor assigned to the specified index.

Suffix:
<p> Power sensor index

Parameters:
<Placeholder> Currently not used

<Type> Detected power sensor type, e.g. "NRP-Z81".

<Interface> Interface the power sensor is connected to; always "USB"

<SerialNo> Serial number of the power sensor assigned to the specified index

Example: `SYST:COMM:RDEV:PMET2:DEF '','NRP-Z81','','123456'`
Assigns the power sensor with the serial number '123456' to the configuration "Power Sensor 2".
`SYST:COMM:RDEV:PMET2:DEF?`
Queries the sensor assigned to "Power Sensor 2".
Result:
`'','NRP-Z81','USB','123456'`
The NRP-Z81 power sensor with the serial number '123456' is assigned to the "Power Sensor 2".

Manual operation: See "Select" on page 37

Configuring Power Sensor Measurements

CALibration:PMETer<p>:ZERO:AUTO ONCE

This command zeroes the power sensor.

Note that you have to disconnect the signals from the power sensor input before you start to zero the power sensor. Otherwise, results are invalid.

Suffix:
<p> Power sensor index

Example: `CAL:PMET2:ZERO:AUTO ONCE;*WAI`
Starts zeroing the power sensor 2 and delays the execution of further commands until zeroing is concluded.

Usage: Event

Manual operation: See "Zeroing Power Sensor" on page 37

CALCulate<n>:PMETer<p>:RELative[:MAGNitude] <RefValue>

This command defines the reference value for relative measurements.

Suffix:
<n> Window

<p> Power sensor index

Parameters:
<RefValue> Range: -200 dBm to 200 dBm
*RST: 0
Default unit: DBM

Example: `CALC:PMET2:REL -30`
Sets the reference value for relative measurements to -30 dBm for power sensor 2.

Manual operation: See "Reference Value" on page 38

CALCulate<n>:PMETer<p>:RELative[:MAGNitude]:AUTO ONCE

This command sets the current measurement result as the reference level for relative measurements.

Suffix:
<n> Window

<p> Power sensor index

Example: `CALC:PMET2:REL:AUTO ONCE`
Takes the current measurement value as reference value for relative measurements for power sensor 2.

Usage: Event

Manual operation: See "Setting the Reference Level from the Measurement Meas -> Ref" on page 38

CALCulate<n>:PMETer<p>:RELative:STATe <State>

This command turns relative power sensor measurements on and off.

Suffix:
<n> Window

<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:PMET2:REL:STAT ON`
Activates the relative display of the measured value for power sensor 2.

FETCh:PMETer<p>?

This command queries the results of power sensor measurements.

Suffix:
<p> Power sensor index

Usage: Query only

READ:PMETer<p>?

This command initiates a power sensor measurement and queries the results.

Suffix:
<p> Power sensor index

Usage: Query only

[SENSe:]PMETer<p>:DCYCle[:STATe] <State>

This command turns the duty cycle correction on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:DCYC:STAT ON`

Manual operation: See "Duty Cycle" on page 39

[SENSe:]PMETer<p>:DCYCle:VALue <Percentage>

This command defines the duty cycle for the correction of pulse signals.

The power sensor uses the duty cycle in combination with the mean power to calculate the power of the pulse.

Suffix:
<p> Power sensor

Parameters:
<Percentage> Range: 0.001 to 99.999
*RST: 99.999
Default unit: %

Example: `PMET2:DCYC:STAT ON`
Activates the duty cycle correction.
`PMET2:DCYC:VAL 0.5`
Sets the correction value to 0.5%.

Manual operation: See "Duty Cycle" on page 39

[SENSe:]PMETer<p>:FREQuency <Frequency>

This command defines the frequency of the power sensor.

Suffix:
<p> Power sensor index

Parameters:
<Frequency> The available value range is specified in the data sheet of the power sensor in use.
*RST: 50 MHz
Default unit: HZ

Example: `PMET2:FREQ 1GHZ`
Sets the frequency of the power sensor to 1 GHz.

Manual operation: See "Frequency Manual" on page 37

[SENSe:]PMETer<p>:FREQuency:LINK <Coupling>

This command selects the frequency coupling for power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<Coupling> **CENTer**
Couples the frequency to the center frequency of the analyzer

MARKer1
Couples the frequency to the position of marker 1

OFF
Switches the frequency coupling off

*RST: CENTer

Example: `PMET2:FREQ:LINK CENT`
Couples the frequency to the center frequency of the analyzer

Manual operation: See "Frequency Coupling" on page 38

[SENSe:]PMETer<p>:MTIMe <Duration>

This command selects the duration of power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<Duration> SHORt | NORMal | LONG

*RST: NORMal

Example: `PMET2:MTIM SHOR`
Sets a short measurement duration for measurements of stationary high power signals for the selected power sensor.

Manual operation: See "Meas Time/Average" on page 38

[SENSe:]PMETer<p>:MTIMe:AVERage:COUNt <NumberReadings>

This command sets the number of power readings included in the averaging process of power sensor measurements.

Extended averaging yields more stable results for power sensor measurements, especially for measurements on signals with a low power, because it minimizes the effects of noise.

Suffix:
<p> Power sensor index

Parameters:
<NumberReadings> An average count of 0 or 1 performs one power reading.

Range: 0 to 256
Increment: binary steps (1, 2, 4, 8, ...)

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.
`PMET2:MTIM:AVER:COUN 8`
Sets the number of readings to 8.

Manual operation: See "Average Count (Number of Readings)" on page 39

[SENSe:]PMETer<p>:MTIMe:AVERage[:STATe] <State>

This command turns averaging for power sensor measurements on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:MTIM:AVER ON`
Activates manual averaging.

Manual operation: See "Meas Time/Average" on page 38

[SENSe:]PMETer<p>:ROFFset[:STATe] <State>

This command includes or excludes the reference level offset of the analyzer for power sensor measurements.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET2:ROFF OFF`
Takes no offset into account for the measured power.

Manual operation: See "Use Ref Level Offset" on page 38

[SENSe:]PMETer<p>:SOFFset <SensorOffset>

Takes the specified offset into account for the measured power. Only available if `[SENSe:]PMETer<p>:ROFFset[:STATe]` is disabled.

Suffix:
<p> Power sensor index

Parameters:
<SensorOffset> Default unit: DB

Example: `PMET2:TRIG:SOFF 0.001`

Manual operation: See "Sensor Level Offset" on page 39

[SENSe:]PMETer<p>[:STATe] <State>

This command turns a power sensor on and off.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1 ON`
Switches the power sensor measurements on.

Manual operation: See "State" on page 37
See "Select" on page 37

[SENSe:]PMETer<p>:UPDate[:STATe] <State>

This command turns continuous update of power sensor measurements on and off.

If on, the results are update even if a single sweep is complete.

Suffix:
<p> Power sensor index

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `PMET1:UPD ON`
The data from power sensor 1 is updated continuously.

Manual operation: See "Continuous Value Update" on page 37

UNIT<n>:PMETer<p>:POWer <Unit>

This command selects the unit for absolute power sensor measurements.

Suffix:
<n> irrelevant

<p> Power sensor index

Parameters:
<Unit> DBM | WATT | W | DB | PCT

*RST: DBM

Example: `UNIT:PMET:POW DBM`

Manual operation: See "Unit/Scale" on page 38

UNIT<n>:PMETer<p>:POWer:RATio <Unit>

This command selects the unit for relative power sensor measurements.

Suffix:
<n> irrelevant

<p> Power sensor index

Parameters:
<Unit> DB | PCT

*RST: DB

Example: `UNIT:PMET:POW:RAT DB`

Manual operation: See "Unit/Scale" on page 38

9.4.1.4 Configuring the Outputs

The following commands are required to provide output from the R&S ZNL.

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled [noise source control] on the R&S ZNL on and off.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source Control" on page 41

SYSTem:SPEaker[:STATe] <State>

This command switches the built-in loudspeaker on or off for demodulated signals. This setting applies only to the current application.

The command is available in the time domain in Spectrum mode and in Analog Modulation Analysis mode.

To set the volume, use the `SYSTem:SPEaker:VOLume` command.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
SYST:SPE ON
SYST:SPE:VOL 0.5
```
Sets the loudspeaker to half the full volume.

SYSTem:SPEaker:VOLume <Volume>

This command defines the volume of the built-in loudspeaker for demodulated signals. This setting is maintained for all applications.

The command is available in the time domain in Spectrum mode and in Analog Modulation Analysis mode.

Note that you must switch the loudspeaker on first, using the `SYSTem:SPEaker[:STATe]` command.

Parameters:

<Volume> Percentage of the maximum possible volume.

Range: 0 to 1
*RST: 0.5

Example:
```
SYST:SPE:VOL 0
```
Switches the loudspeaker to mute.

9.4.2 Configuring the Vertical Axis (Amplitude, Scaling)

The following commands are required to configure the amplitude and vertical axis settings in a remote environment.

9.4.2.1 Amplitude Settings

Useful commands for amplitude configuration described elsewhere:

- `[SENSe:]ADJust:LEVel` on page 144

Remote commands exclusive to amplitude configuration:

CALCulate<n>:MARKer<m>:FUNCtion:REFerence

This command matches the reference level to the power level of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK2:FUNC:REF`
Sets the reference level to the level of marker 2.

Manual operation: See "Reference Level = Marker Level" on page 85

CALCulate<n>:UNIT:POWer <Unit>
UNIT<n>:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all power-based measurement windows with absolute values.

Suffix:
<n> irrelevant

Parameters:
<Unit> (Units based on 1 MHz require installed R&S FPL1-K54 (EMI measurements) option.)

*RST: dBm

Example: `UNIT:POW DBM`
Sets the power unit to dBm.

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

This command defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:
<n> irrelevant

<t> irrelevant

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm
Default unit: DBM

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

Manual operation: See "Reference Level" on page 43

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces in all windows).

Suffix:

<n> irrelevant

<t> irrelevant

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB
Default unit: DB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 43

9.4.2.2 Configuring the Attenuation

INPut<ip>: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.

Suffix:

<ip> 1 | 2
irrelevant

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB (with optional electr. attenuator: 1 dB)
*RST: 10 dB (AUTO is set to ON)
Default unit: DB

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

Manual operation: See "Attenuation Mode / Value" on page 44

INPut<ip>:EATT:AUTO <State>
INPut<ip>:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S ZNL determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

For the R&S ZNL, these commands are identical.

Suffix:
<ip> 1 | 2
irrelevant

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Manual operation: See "Attenuation Mode / Value" on page 44

9.4.2.3 Scaling the Y-Axis

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the display range of the y-axis (for all traces).

Note that the command works only for a logarithmic scaling. You can select the scaling with `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing`.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Range> Range: 1 dB to 200 dB
*RST: 100 dB
Default unit: HZ

Example: `DISP:TRAC:Y 110dB`

Manual operation: See "Range" on page 45
See "Y-Axis Max" on page 46

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

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

Suffix:
<n> Window

<t> irrelevant

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

This command selects the type of scaling of the y-axis (for all traces).

When the display update during remote control is off, this command has no immediate effect.

Suffix:
<n> Window

<w> subwindow

<t> irrelevant

Parameters:
<Mode> **ABSolute**
absolute scaling of the y-axis

RELative
relative scaling of the y-axis

*RST: ABSolute

Example: `DISP:TRAC:Y:MODE REL`

Manual operation: See "Scaling" on page 45

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid (for all traces).

The R&S ZNL adjusts the scaling of the y-axis accordingly.

Suffix:
<n> Window

<t> irrelevant

Example: `DISP:TRAC:Y:RPOS 50PCT`

Manual operation: See "Ref Level Position" on page 45

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing <ScalingType>

This command selects the scaling of the y-axis (for all traces, <t> is irrelevant).

Suffix:
<n> Window

<w> subwindow

<t> Trace

Parameters:
<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`
Selects linear scaling in %.

Manual operation: See "Scaling" on page 45

9.4.3 Frequency

CALCulate<n>:MARKer<m>:FUNCtion:CENTer

This command matches the center frequency to the frequency of a marker.

If you use the command in combination with a delta marker, that delta marker is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK2:FUNC:CENT`
Sets the center frequency to the frequency of marker 2.

Manual operation: See "Center Frequency = Marker Frequency" on page 85

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency" on page 47

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see `[SENSe:]FREQuency:CENTer` on page 128.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
//Set the center frequency to 110 MHz.
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Center Frequency Stepsize" on page 47

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

This command couples or decouples the center frequency step size to the span.

In time domain (zero span) measurements, the center frequency is coupled to the RBW.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example:
```
FREQ:CENT:STEP:AUTO ON
```
Activates the coupling of the step size to the span.

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

See also "Frequency Offset" on page 47.

Parameters:

<Offset>
Range: -1 THz to 1 THz
*RST: 0 Hz
Default unit: HZ

Example: `FREQ:OFFS 1GHZ`

Manual operation: See "Frequency Offset" on page 47

9.4.4 Triggering

The following remote commands are required to configure a triggered measurement in a remote environment. More details are described for manual operation in Chapter 5.6, "Trigger Settings", on page 48.

*OPC should be used after requesting data. This will hold off any subsequent changes to the selected trigger source, until after the sweep is completed and the data is returned.

9.4.4.1 Configuring the Triggering Conditions

The following commands are required to configure a triggered measurement.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See "Drop-Out Time" on page 50

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

Defines the time offset between the trigger event and the start of the sweep.

Parameters:

<Offset> For measurements in the frequency domain, the range is 0 s to 30 s.
For measurements in the time domain, the range is the negative sweep time to 30 s.

*RST: 0 s
Default unit: S

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 50

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

This command defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example: `TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 51

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB
Default unit: DB

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 50

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

In the I/Q Analyzer application, only `EXTernal1` is supported.

Parameters:
<TriggerLevel> For the R&S ZNL, the external trigger level is always 1.4 V. It cannot be changed.
*RST: 1.4 V

Manual operation: See "Trigger Level" on page 50

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

This command defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:
<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.
*RST: -10 dBm
Default unit: DBM

Example: `TRIG:LEV:IFP -30DBM`

Manual operation: See "Trigger Level" on page 50

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

This command defines the magnitude the I/Q data must exceed to cause a trigger event.

Note that any RF attenuation is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:
<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm
Default unit: DBM

Example: `TRIG:LEV:IQP -30DBM`

Manual operation: See "Trigger Level" on page 50

TRIGger[:SEQuence]:SLOPe <Type>

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 51

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

For details on trigger sources see "Trigger Source" on page 49.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

IFPower
Second intermediate frequency

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications.

VIDeo
Video mode is available in the time domain and only in the Spectrum application.

BBPower
Baseband power (for digital input via the optional Digital Baseband Interface

*RST: IMMediate

Example: `TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation: See "Trigger Source" on page 49
See "Free Run" on page 49
See "ExternalTrigger 1" on page 49
See "IF Power" on page 49
See "I/Q Power" on page 49
See "Time" on page 49

TRIGger[:SEQuence]:TIME:RINTerval <Interval>

This command defines the repetition interval for the time trigger.

Parameters:

<Interval> 2.0 ms to 5000

Range: 2 ms to 5000 s
*RST: 1.0 s
Default unit: S

Example: `TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 50`
The sweep starts every 50 s.

Manual operation: See "Repetition Interval" on page 50

9.4.4.2 Configuring I/Q Gating

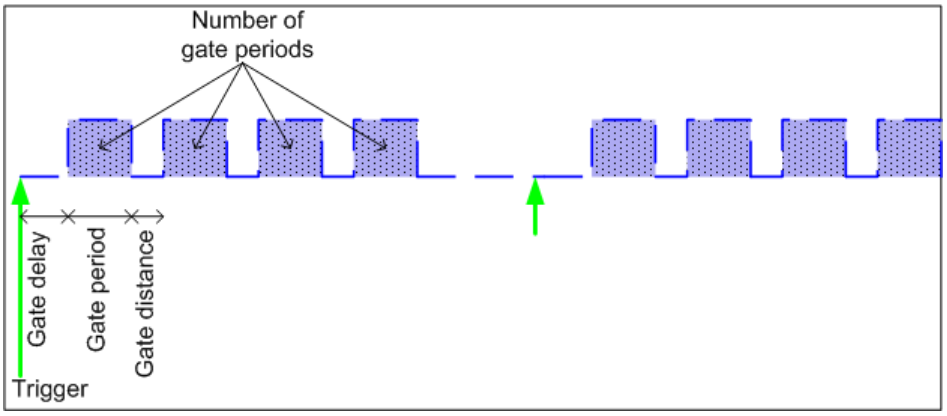
Usually in spectrum analysis, measurements are based on a certain length of time called the gate area. With I/Q gating, you can define the gate area using the gate length, the distance between the capture periods and the number of periods. The gate length and the distance between the capture periods are specified in samples.

I/Q gating is only available using remote commands; manual configuration is not possible.

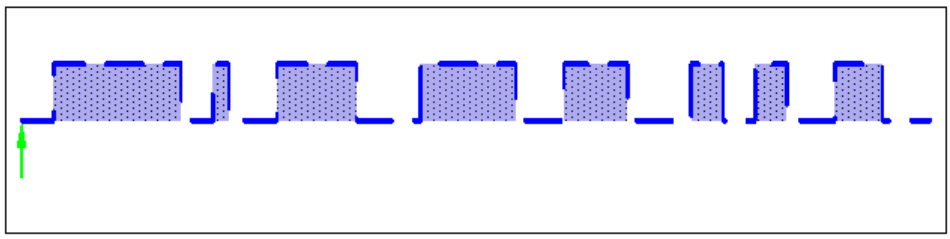
It is only possible up to a bandwidth of 12.8 MHz.

Using I/Q gating, the gate area can be defined using the following methods:

- Edge triggered capturing
  After a trigger signal, the gate period is defined by a gate length and a gate distance. All data in the gate period is captured until the required number of samples has been captured.



- Level triggered capturing
  After a trigger signal, all data is captured in which the gate signal is set to 1, which means it has exceeded a level. In this case, the gate signal can be generated by the IFP trigger, for example: each time the IFP level is exceeded, the IFP trigger signal is set to 1 and the samples in this area are captured as gate samples.



The number of complex samples to be captured prior to the trigger event can be selected (see `TRACe:IQ:SET` on page 140) for all available trigger sources, except for "Free Run".

TRACe:IQ:EGATe[:STATe] <State>

This command turns gated measurements with the I/Q analyzer on and off.

Before you can use the command you have to turn on the I/Q analyzer and select an external or IF power trigger source.

Parameters:

<State> ON | OFF

Example: TRAC:IQ:EGAT ON

TRACe:IQ:EGATe:GAP <Samples>

This command defines the interval between several gate periods for gated measurements with the I/Q analyzer.

Parameters:

<Samples> <numeric value>

Max = (440 MS * sample rate/200MHz) -1
pretrigger samples defined by `TRACe:IQ:SET`;
sample rate defined by `TRACe:IQ:SRATe`)

Range: 1…Max (samples)
*RST: 1

Example: `TRAC:IQ:EGAT:GAP 2`

TRACe:IQ:EGATe:LENGth <GateLength>

This command defines the gate length for gated measurements with the I/Q analyzer.

Parameters:

<GateLength> <numeric value>

Max = (440 MS * sample rate/200MHz) -1
pretrigger samples defined by `TRACe:IQ:SET`;
sample rate defined by `TRACe:IQ:SRATe`)

Range: 1…Max (samples)
*RST: 100

Example: `TRAC:IQ:EGAT:LENG 2000`

TRACe:IQ:EGATe:NOF <Number>

This command defines the number of gate periods after the trigger signal for gated measurements with the I/Q analyzer.

Parameters:

<Number> Range: 1 to 1023
*RST: 1

Example: `TRAC:IQ:EGAT:NOF 2`

TRACe:IQ:EGATe:TYPE <Type>

This command selects the gate mode for gated measurements with the I/Q analyzer.

Note: The IF power trigger holdoff time is ignored if you are using the "Level" gate mode in combination with an IF Power trigger.

Parameters:

<Type> **LEVel**

EDGE

*RST: EDGE

Example: `TRAC:IQ:EGAT:TYPE LEV`

9.4.5 Configuring Data Acquisition

The following commands are required to capture data in the I/Q Analyzer.

Useful commands for I/Q data acquisition described elsewhere

- `[SENSe:]SWEep:COUNt` on page 156
- `[SENSe:]SWEep[:WINDow<n>]:POINts` on page 156
- `[SENSe:]SWEep:TIME` on page 157

Remote commands exclusive to I/Q data acquisition

[SENSe:]IQ:BANDwidth:MODE <Mode>
[SENSe:]IQ:BWIDth:MODE <Mode>

This command defines how the resolution bandwidth is determined.

Parameters:

<Mode> AUTO | MANual | FFT

AUTO
(Default) The RBW is determined automatically depending on the sample rate and record length.

MANual
The user-defined RBW is used and the (FFT) window length (and possibly the sample rate) are adapted accordingly. The RBW is defined using the `[SENSe:]IQ:BWIDth:RESolution` command.

FFT
The RBW is determined by the FFT parameters.

*RST: AUTO

Example: `IQ:BAND:MODE MAN`
Switches to manual RBW mode.
`IQ:BAND:RES 120000`
Sets the RBW to 120 kHz.

Manual operation: See "RBW" on page 53

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

This command defines the resolution bandwidth manually if `[SENSe:]IQ:BWIDth:MODE` is set to `MAN`.

Defines the resolution bandwidth. The available RBW values depend on the sample rate and record length.

Parameters:

<Bandwidth> refer to data sheet
*RST: RBW: AUTO mode is used
Default unit: HZ

Example: `IQ:BAND:MODE MAN`
Switches to manual RBW mode.
`IQ:BAND:RES 120000`
Sets the RBW to 120 kHz.

Manual operation: See "RBW" on page 53

[SENSe:]IQ:FFT:ALGorithm <Method>

Defines the FFT calculation method.

Parameters:

<Method>
SINGle
One FFT is calculated for the entire record length; if the FFT length is larger than the record length (see `[SENSe:]IQ:FFT:LENGth` and `TRACe:IQ:RLENgth`), zeros are appended to the captured data.

AVERage
Several overlapping FFTs are calculated for each record; the results are averaged to determine the final FFT result for the record.
The user-defined window length and window overlap are used (see `[SENSe:]IQ:FFT:WINDow:LENGth` and `[SENSe:]IQ:FFT:WINDow:OVERlap`).

*RST: AVER

Example: `IQ:FFT:ALG SING`

Manual operation: See "TransformationAlgorithm" on page 54

[SENSe:]IQ:FFT:LENGth <NoOfBins>

Defines the number of frequency points determined by each FFT calculation. The more points are used, the higher the resolution in the spectrum becomes, but the longer the calculation takes.

Parameters:

<NoOfBins> integer value

Range: 3 to 524288
*RST: 4096

Example: `IQ:FFT:LENG 2048`

Manual operation: See "FFT Length" on page 54

[SENSe:]IQ:FFT:WINDow:LENGth <NoOfFFT>

Defines the number of samples to be included in a single FFT window when multiple FFT windows are used.

Parameters:

<NoOfFFT> integer value

Range: 3 to 1001
*RST: 1001

Example: `IQ:FFT:WIND:LENG 500`

Manual operation: See "Window Length" on page 55

[SENSe:]IQ:FFT:WINDow:OVERlap <Rate>

Defines the part of a single FFT window that is re-calculated by the next FFT calculation.

Parameters:

<Rate> double value

Percentage rate

Range: 0 to 1
*RST: 0.75

Example: `IQ:FFT:WIND:OVER 0.5`
Half of each window overlaps the previous window in FFT calculation.

Manual operation: See "Window Overlap" on page 55

[SENSe:]IQ:FFT:WINDow:TYPE <Function>

In the I/Q Analyzer you can select one of several FFT window types.

Parameters:

<Function> **BLACkharris**
Blackman-Harris

FLATtop
Flattop

GAUSsian
Gauss

RECTangular
Rectangular

P5
5-Term

*RST: FLAT

Example: `IQ:FFT:WIND:TYPE GAUS`

Manual operation: See "Window Function" on page 54

[SENSe:]SWAPiq <State>

This command defines whether or not the recorded I/Q pairs should be swapped (I<->Q) before being processed. Swapping I and Q inverts the sideband.

This is useful if the DUT interchanged the I and Q parts of the signal; then the R&S ZNL can do the same to compensate for it.

Parameters:

<State>

ON | 1
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF | 0
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: 0

Manual operation: See "Swap I/Q" on page 53

TRACe:IQ:BWIDth

This command defines or queries the bandwidth of the resampling filter.

The bandwidth of the resampling filter depends on the sample rate.

Parameters:

<Bandwidth>

Default unit: HZ

Manual operation: See "Analysis Bandwidth" on page 52

TRACe:IQ:RLENgth <NoOfSamples>

This command sets the record length for the acquired I/Q data.

Increasing the record length also increases the measurement time.

Note: Alternatively, you can define the measurement time using the `SENS:SWE:TIME` command.

Parameters:

<NoOfSamples> Number of samples to record.

*RST: 1001

Example: `TRAC:IQ:RLEN 256`

Manual operation: See "Record Length" on page 53

TRACe:IQ:SET <NORM>, <0>, <SampleRate>, <TriggerMode>, <TriggerSlope>, <PretriggerSamp>, <NumberSamples>

This command sets up the R&S ZNL for I/Q measurements.

If you do not use this command to set up I/Q measurements, the R&S ZNL will use its current settings for I/Q measurements.

If the I/Q Analyzer has not been turned on previously, the command also switches to the I/Q Analyzer.

Note: If you use the default settings with `TRACe:IQ:DATA`?, the following minimum buffer sizes for the response data are recommended:

ASCII format: 10 kBytes

Binary format: 2 kBytes

Parameters:

Norm This value is always `NORM`.

0 Default unit: HZ
This value is always `0`.

<SampleRate> Sample rate for the data acquisition.

Range: 100 Hz to 10 GHz, continuously adjustable
*RST: 32000000
Default unit: HZ

<TriggerMode> Selection of the trigger source used for the measurement.

IMMediate | EXTernal | EXT2 | EXT3 | IFPower
For IMM mode, gating is automatically deactivated.

*RST: IMM

<TriggerSlope> Used trigger slope.

POSitive | NEGative

*RST: POS

<PretriggerSamp> Defines the trigger offset in terms of pretrigger samples. Negative values correspond to a trigger delay.
This value also defines the interval between the trigger signal and the gate edge in samples.

Range: -1399999999 to 1399999999
*RST: 0

<NumberSamples> Number of measurement values to record (including the pretrigger samples).

*RST: 1001

Example: `TRAC:IQ:SET NORM,0,32MHz,EXT,POS,0,2048`
Reads 2048 I/Q-values starting at the trigger point.
sample rate = 32 MHz
trigger = External
slope = Positive
`TRAC:IQ:SET NORM,0,4 MHz,EXT,POS,1024,512`
Reads 512 I/Q-values from 1024 measurement points before the trigger point.
filter type = NORMAL
sample rate = 4 MHz
trigger = External
slope = Positive

Manual operation: See "Record Length" on page 53

TRACe:IQ:SRATe <SampleRate>

This command sets the final user sample rate for the acquired I/Q data. Thus, the user sample rate can be modified without affecting the actual data capturing settings on the R&S ZNL.

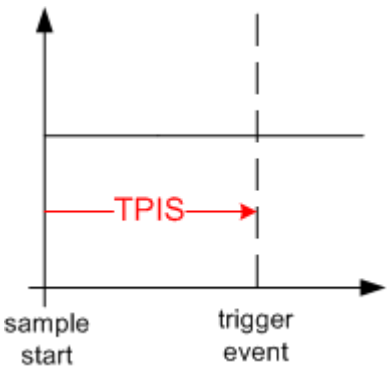
Parameters:
<SampleRate>

*RST: 32 MHz
Default unit: HZ

Manual operation: See "Sample Rate" on page 52

TRACe:IQ:TPISample?

This command queries the time offset between the sample start and the trigger event (trigger point in sample = TPIS). Since the R&S ZNL usually samples with a much higher sample rate than the specific application actually requires, the trigger point determined internally is much more precise than the one determined from the (down-sampled) data in the application. Thus, the TPIS indicates the offset between the sample start and the actual trigger event.



This value can only be determined in triggered measurements using external or IFPower triggers, otherwise the value is 0.

Return values:

<TPIS> numeric value
Default unit: s

Example: `TRAC:IQ:TPIS?`
Result for a sample rate of 1 MHz: between 0 and 1/1 MHz, i.e. between 0 and 1 µs (the duration of 1 sample).

Usage: Query only

Manual operation: See "Trigger Offset" on page 50

9.4.6 Adjusting Settings Automatically

The commands required to adjust settings automatically in a remote environment are described here.

[SENSe:]ADJust:ALL

This command initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Reference level

Example: `ADJ:ALL`

Manual operation: See "Adjusting all Determinable Settings Automatically (Auto All)" on page 58

[SENSe:]ADJust:CONFigure:DURation <Duration>

In order to determine the ideal reference level, the R&S ZNL performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:DURation:MODE` is set to `MANual`.

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Changing the Automatic Measurement Time (MeastimeManual)" on page 59

[SENSe:]ADJust:CONFigure:DURation:MODE <Mode>

In order to determine the ideal reference level, the R&S ZNL performs a measurement on the current input data. This command selects the way the R&S ZNL determines the length of the measurement .

Parameters:

<Mode> **AUTO**
The R&S ZNL determines the measurement length automatically according to the current input data.

MANual
The R&S ZNL uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 142.

*RST: AUTO

Manual operation: See "Resetting the Automatic Measurement Time (MeastimeAuto)" on page 59
See "Changing the Automatic Measurement Time (MeastimeManual)" on page 59

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 144 command, the internal attenuators are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation: See "Lower Level Hysteresis" on page 60

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 144 command, the internal attenuators are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold>
Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual operation: See "Upper Level Hysteresis" on page 60

[SENSe:]ADJust:CONFigure:TRIGger <State>

Defines the behavior of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

Parameters:

<State>
ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

[SENSe:]ADJust:FREQuency

This command sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: `ADJ:FREQ`

Manual operation: See "Adjusting the Center Frequency Automatically (Auto Frequency)" on page 59

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S ZNL or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 43

9.5 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

9.5.1 General Window Commands

The following commands are required to configure general window layout, independent of the application.

Note that the suffix <n> always refers to the window *in the currently selected channel setup* (see `INSTrument[:SELect]` on page 109).

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 149).

Suffix:
<n> Window

Parameters:
<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:SIZE LARG`

9.5.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a channel setup as you do using the SmartGrid in manual operation.

Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected channel setup.

Note that the suffix <n> always refers to the window *in the currently selected channel setup* (see `INSTrument[:SELect]` on page 109).

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

This command adds a window to the display in the active channel setup.

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

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

Query parameters:

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

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

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

Return values:

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

Example:
```
LAY:ADD? '1',LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation: See "Magnitude" on page 13
See "Spectrum" on page 13
See "I/Q-Vector" on page 14
See "Real/Imag (I/Q)" on page 15
See "Marker Table" on page 15
See "Marker Peak List" on page 16

Table 9-3: <WindowType> parameter values for IQ Analyzer application

Parameter value	Window type
FREQ	Spectrum
MAGN	Magnitude
MTABle	Marker table
PEAKlist	Marker peak list
RIMAG	Real/Imag (I/Q)
VECT	I/Q Vector

LAYout:CATalog[:WINDow]?

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

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string
Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active channel setup.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Setting parameters:

<WindowName> String containing the name of an existing window that is to be moved.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel setup, use the `LAYout:CATalog[:WINDow]?` query.

<WindowName> String containing the name of an existing window the selected window is placed next to or replaces.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel setup, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | REPLace

Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active channel.

Setting parameters:

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

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

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

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

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

Setting parameters:

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

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 146 for a list of available window types.

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

Usage: Setting only

LAYout:SPLitter <Index1>, <Index2>, <Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

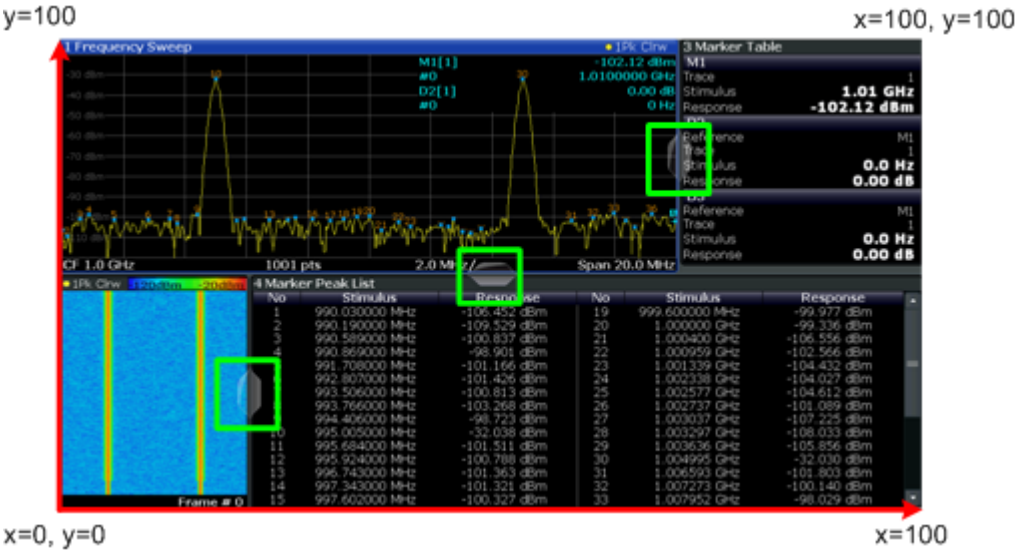


Figure 9-1: SmartGrid coordinates for remote control of the splitters

Setting parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 9-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

Usage: Setting only

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

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

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

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

Suffix:
<n> Window

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 146 for a list of available window types.

Return values:

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

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel setup.

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

Suffix:

<n> Window

Return values:

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

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active channel setup.

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

Suffix:

<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

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

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

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

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 146 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

Usage: Setting only

9.6 Capturing Data and Performing Sweeps

Different measurement procedures

Two different procedures to capture I/Q data remotely are available:

- Measurement and result query with one command (see `TRACe:IQ:DATA` on page 207)
  This method causes the least delay between measurement and output of the result data, but it requires the control computer to wait actively for the response data.
- Setting up the instrument, starting the measurement via `INIT` and querying the result list at the end of the measurement (see `TRACe:IQ:DATA:MEMory?` on page 208)
  With this method, the control computer can be used for other activities during the measurement. However, the additional time needed for synchronization via service request must be taken into account.

ABORt

This command aborts the measurement in the current channel setup and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S ZNL 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 ZNL on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single sweep mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

Suffix:
<n> irrelevant

Example:
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
DISP:WIND:TRAC:MODE AVER
```
Switches on trace averaging.
```
SWE:COUN 20
```
Setting the sweep counter to 20 sweeps.
```
INIT;*WAI
```
Starts the measurement and waits for the end of the 20 sweeps.
```
INIT:CONM;*WAI
```
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.

Manual operation: See "ContinueSingleSweep" on page 57

INITiate<n>:CONTinuous <State>

This command controls the sweep mode for an individual channel setup.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

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

Manual operation: See "Continuous Sweep / Run Cont" on page 56

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

With sweep count or average count > 0, this means a restart of the corresponding number of measurements. With trace mode MAXHold, MINHold and AVERage, the previous results are reset on restarting the measurement.

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

Suffix:
<n> irrelevant

Example:
```
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 operation: See "Single Sweep / Run Single" on page 56

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements.

You can start a new sequence any time using `INITiate:SEQuencer:IMMediate` on page 155.

Usage: Event

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 157).

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

INITiate:SEQuencer:MODE <Mode>

Defines the capture mode for the entire measurement sequence and all measurement groups and channels it contains.

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

Parameters:

<Mode>

SINGle
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence is finished.

CONTinuous
Each measurement group is started one after the other in the order of definition. All measurement channels in a group are started simultaneously and performed once. After *all* measurements are completed, the next group is started. After the last group, the measurement sequence restarts with the first one and continues until it is stopped explicitely.

*RST: CONTinuous

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of sweeps that the application uses to average traces.

In continuous sweep mode, the application calculates the moving average over the average count.

In single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Example:
```
SWE:COUN 64
```
Sets the number of sweeps to 64.
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a sweep and waits for its end.

Manual operation: See "Sweep/Average Count" on page 56

[SENSe:]SWEep:COUNt:CURRent?

This query returns the current number of started sweeps or measurements. This command is only available if a sweep count value is defined and the instrument is in single sweep mode.

Return values:
<CurrentCount>

Example:
```
SWE:COUNt 64
```
Sets sweep count to 64
```
INIT:CONT OFF
```
Switches to single sweep mode
```
INIT
```
Starts a sweep (without waiting for the sweep end!)
```
SWE:COUN:CURR?
```
Queries the number of started sweeps

Usage: Query only

[SENSe:]SWEep[:WINDow<n>]:POINts <SweepPoints>

This command defines the number of sweep points to analyze after a sweep.

Note that the number of sweep points is limited to 10001 when measuring spurious emissions.

Suffix:
<n>

Parameters:
<SweepPoints>
Range: 101 to 100001
*RST: 1001

Example: SWE:POIN 251

Manual operation: See "Sweep Points" on page 55

[SENSe:]SWEep:TIME <Time>

This command defines the sweep time. It automatically decouples the time from any other settings.

Parameters:

<Time> refer to data sheet

*RST: depends on current settings (determined automatically)

Default unit: S

Manual operation: See "Meas Time" on page 53

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 ZNL User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (INIT:SEQ...) are not available.

*RST: 0

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

9.7 I/Q Analysis

General result analysis settings concerning the trace, markers, etc. can be configured using the following commands. They are identical to the analysis functions in the Spectrum application except for the special marker functions.

9.7.1 Configuring Standard Traces

Useful commands for trace configuration described elsewhere

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y:SPACing` on page 127
- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]` on page 125

Remote commands exclusive to trace configuration

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command selects the trace mode. If necessary, the selected trace is also activated.

In case of max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNt`. Note that synchronization to the end of the measurement is possible only in single sweep mode.

Suffix:
<n> Window

<t> Trace

Parameters:

<Mode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

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

MINHold
The minimum value is determined from several measurements and displayed. The R&S ZNL saves the sweep result in the trace memory only if the new value is lower than the previous one.

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

BLANk
Hides the selected trace.

*RST: Trace 1: WRITe, Trace 2-6: BLANk

Example:

```
INIT:CONT OFF
```
Switching to single sweep mode.
```
SWE:COUN 16
```
Sets the number of measurements to 16.
```
DISP:TRAC3:MODE WRIT
```
Selects clear/write mode for trace 3.
```
INIT;*WAI
```
Starts the measurement and waits for the end of the measurement.

Manual operation: See "TraceMode" on page 62

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:MODE:HCONtinuous
<State>

This command turns an automatic reset of a trace on and off after a parameter has changed.

The reset works for trace modes min hold, max hold and average.

Note that the command has no effect if critical parameters like the span have been changed to avoid invalid measurement results

Suffix:

<n> Window

<w> subwindow

<t> Trace

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:WIND:TRAC3:MODE:HCON ON`
Switches off the reset function.

Manual operation: See "Hold" on page 63

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Suffix:

<n> Window

<w> subwindow
Not supported by all applications

<t> Trace

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP:TRAC3 ON`

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4/Trace 5/Trace 6" on page 62
See "Trace 1/ Trace 2/ Trace 3/ Trace 4 (Softkeys)" on page 64

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture <Aperture>

This command defines the degree (aperture) of the trace smoothing, if `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe]TRUE`.

Suffix:

<n> Window

<w> subwindow

<t> Trace

Parameters:

<Aperture> Range: 1 to 50
*RST: 2
Default unit: PCT

Example: `DISP3:TRAC2:SMO:APER 5`
Defines an aperture of 5% for trace 2 in window 3

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing[:STATe] <State>

This command turns trace smoothing for a particular trace on and off.

If enabled, the trace is smoothed by the value specified using `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:SMOothing:APERture` on page 160.

For more information see the R&S ZNL User Manual.

Suffix:

<n> Window

<w> subwindow

<t> Trace

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DISP3:TRAC2:SMO ON`
Turns on trace smoothing for trace 2 in window 3

[SENSe:]AVERage<n>:TYPE <Mode>

This command selects the trace averaging mode.

Suffix:

<n> 1..n
Window

Parameters:

<Mode>

VIDeo
The logarithmic power values are averaged.

LINear
The power values are averaged before they are converted to logarithmic values.

POWer
The power level values are converted into unit Watt prior to averaging. After the averaging, the data is converted back into its original unit.

*RST: VIDeo

Example: `AVER:TYPE LIN`
Switches to linear average calculation.

Manual operation: See "Average Mode" on page 63

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion] <Detector>

Defines the trace detector to be used for trace analysis.

Suffix:
<n> Window

<t> Trace

Parameters:
<Detector>

APEak
Autopeak

NEGative
Negative peak

POSitive
Positive peak

SAMPle
First value detected per trace point

RMS
RMS value

AVERage
Average

*RST: APEak

Example: `DET POS`
Sets the detector to "positive peak".

Manual operation: See "Detector" on page 63

[SENSe:][WINDow<n>:]DETector<t>[:FUNCtion]:AUTO <State>

This command couples and decouples the detector to the trace mode.

Suffix:
<n> Window

<t> Trace

Parameters:
<State> ON | OFF | 0 | 1

*RST: 1

Example: `DET:AUTO OFF`
The selection of the detector is not coupled to the trace mode.

Manual operation: See "Detector" on page 63

TRACe<n>:COPY <TraceNumber>, <TraceNumber>

This command copies data from one trace to another.

Suffix:
<n> Window

Parameters:
<TraceNumber> **TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6**
The first parameter is the destination trace, the second parameter is the source.
(Note the 'e' in the parameter is required!)

Example: `TRAC:COPY TRACE1,TRACE2`
Copies the data from trace 2 to trace 1.

Manual operation: See "Copy Trace" on page 64

[SENSe:]AVERage<n>:COUNt <AverageCount>
TRACe:IQ:AVERage:COUNt <NumberSets>

This command defines the number of I/Q data sets that the averaging is based on.

Parameters:
<NumberSets> Range: 0 to 32767
*RST: 0

Example: `TRAC:IQ ON`
Switches on acquisition of I/Q data.
`TRAC:IQ:AVER ON`
Enables averaging of the I/Q measurement data
`TRAC:IQ:AVER:COUN 10`
Selects averaging over 10 data sets
`TRAC:IQ:DATA?`
Starts the measurement and reads out the averaged data.

[SENSe:]AVERage<n>[:STATe<t>] <State>
TRACe:IQ:AVERage[:STATe] <State>

This command turns averaging of the I/Q data on and off.

Before you can use the command you have to turn the I/Q data acquisition on with `TRACe:IQ[:STATe]`.

If averaging is on, the maximum amount of I/Q data that can be recorded is 512kS (524288 samples).

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:

```
TRAC:IQ ON
```
Switches on acquisition of I/Q data.
```
TRAC:IQ:AVER ON
```
Enables averaging of the I/Q measurement data.
```
TRAC:IQ:AVER:COUN 10
```
Selects averaging over 10 data sets.
```
TRAC:IQ:DATA?
```
Starts the measurement and reads out the averaged data.

9.7.2 Configuring Spectrograms

In addition to the standard "level versus frequency" or "level versus time" spectrum traces, the R&S ZNL also provides a spectrogram display of the measured data. A spectrogram shows how the spectral density of a signal varies over time. The x-axis shows the frequency, the y-axis shows the time. The commands required to configure spectrograms in a remote environment are described here. For details and manual operation see Chapter 6.2, "Spectrogram Settings", on page 65.

When configuring spectrograms, the window suffix is irrelevant. The settings are always applied to the spectrogram window, or to all spectrogram windows, if several are active for the same channel setup.

For commands to set markers in spectrograms, see Chapter 9.7.3.4, "Marker Search (Spectrograms)", on page 183.

9.7.2.1 Configuring a Spectrogram Measurement

CALCulate<n>:SGRam:CLEar[:IMMediate]
CALCulate<n>:SPECtrogram:CLEar[:IMMediate]

This command resets the spectrogram and clears the history buffer.

Suffix:
<n> Window

Example: //Reset the result display and clear the memory
`CALC:SGR:CLE`

Manual operation: See "Clear Spectrogram" on page 68

CALCulate<n>:SGRam:CONTinuous <State>
CALCulate<n>:SPECtrogram:CONTinuous <State>

This command determines whether the results of the last measurement are deleted before starting a new measurement in single sweep mode.

This setting applies to all spectrograms in the channel setup.

Suffix:
<n> Window

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `INIT:CONT OFF`
Selects single sweep mode.
`INIT;*WAI`
Starts the sweep and waits for the end of the sweep.
`CALC:SGR:CONT ON`
Repeats the single sweep measurement without deleting the results of the last measurement.

CALCulate<n>:SGRam:FRAMe:COUNt <Frames>
CALCulate<n>:SPECtrogram:FRAMe:COUNt <Frames>

This command defines the number of frames to be recorded in a single sweep.

This value applies to all spectrograms in the channel setup.

Suffix:
<n> Window

Parameters:

<Frames> The maximum number of frames depends on the history depth.

Range: 1 to history depth
Increment: 1
*RST: 1

Example: //Select single sweep mode
```
INIT:CONT OFF
```
//Set the number of frames to 200
```
CALC:SGR:FRAM:COUN 200
```

CALCulate<n>:SGRam:FRAMe:SELect <Frame> | <Time>
CALCulate<n>:SPECtrogram:FRAMe:SELect <Frame> | <Time>

This command selects a specific frame for further analysis.

The command is available if no measurement is running or after a single sweep has ended.

Suffix:

<n> Window

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.

Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Example:
```
INIT:CONT OFF
```
Stop the continuous sweep.
```
CALC:SGR:FRAM:SEL -25
```
Selects frame number -25.

Manual operation: See "Select Frame" on page 67

CALCulate<n>:SGRam:HDEPth <History>
CALCulate<n>:SPECtrogram:HDEPth <History>

This command defines the number of frames to be stored in the R&S ZNL memory.

Suffix:

<n> Window

Parameters:

<History> The maximum number of frames depends on the number of sweep points.

Range: 781 to 20000
Increment: 1
*RST: 3000

Example: //Set the history depth to 1500
`CALC:SGR:SPEC 1500`

Manual operation: See "History Depth" on page 67

CALCulate<n>:SGRam:LAYout <State>
CALCulate<n>:SPECtrogram:LAYout <State>

This command selects the state and size of spectrograms.

The command is available for result displays that support spectrograms.

Suffix:
<n> Window

Parameters:
<State>

ON
Spectrogram and trace diagram share a window.

OFF
Only the trace diagram is displayed, the spectrogram is not.

*RST: OFF

Example: `CALC4:SPEC:LAY FULL`
Shows the spectrogram in window 4. The corresponding trace diagram is hidden.

Manual operation: See "State" on page 66

CALCulate<n>:SGRam[:STATe] <State>
CALCulate<n>:SPECtrogram[:STATe] <State>

This command turns the spectrogram on and off.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:SGR ON`
Activates the Spectrogram result display.

CALCulate<n>:SGRam:THReedim[:STATe] <State>
CALCulate<n>:SPECtrogram:THReedim[:STATe] <State>

Activates or deactivates a 3-dimensional spectrogram for the selected result display.

Suffix:
<n> Window

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CALC:SPEC:THR:STAT ON`

Manual operation: See "3D Spectrogram State" on page 66

CALCulate<n>:SGRam:TRACe <Trace>
CALCulate<n>:SPECtrogram:TRACe <Trace>

This command determines the trace in the result display the Spectrogram is based on.

Suffix:
<n> Window

Parameters:
<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

How many traces are available depends on the selected result display.

Example: `CALC2:SPEC:TRAC TRACE3`

CALCulate<n>:SGRam:TSTamp:DATA? <Frames>
CALCulate<n>:SPECtrogram:TSTamp:DATA? <Frames>

This command queries the starting time of the frames.

The return values consist of four values for each frame. If the Spectrogram is empty, the command returns '0,0,0,0'. The times are given as delta values, which simplifies evaluating relative results; however, you can also calculate the absolute date and time as displayed on the screen.

The frame results themselves are returned with `TRAC:DATA? SGR`

Suffix:
<n> Window

Query parameters:
<Frames>

CURRent
Returns the starting time of the current frame.

ALL
Returns the starting time for all frames. The results are sorted in descending order, beginning with the current frame.

Return values:
<Seconds> Number of seconds that have passed since 01.01.1970 till the frame start

<Nanoseconds> Number of nanoseconds that have passed *in addition to the <Seconds>* since 01.01.1970 till the frame start.

<Reserved> The third value is reserved for future uses.

<Reserved> The fourth value is reserved for future uses.

Example:
```
CALC:SGR:TST ON
```
Activates the time stamp.
```
CALC:SGR:TST:DATA? ALL
```
Returns the starting times of all frames sorted in a descending order.

Usage: Query only

Manual operation: See "Time Stamp" on page 67

CALCulate<n>:SGRam:TSTamp[:STATe] <State>
CALCulate<n>:SPECtrogram:TSTamp[:STATe] <State>

This command activates and deactivates the time stamp.

If the time stamp is active, some commands do not address frames as numbers, but as (relative) time values:

- `CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe` on page 189
- `CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe` on page 184
- `CALCulate<n>:SPECtrogram:FRAMe:SELect` on page 166

Suffix:
<n> 1..n
Window

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: //Activates the time stamp
```
CALC:SGR:TST ON
```

Manual operation: See "Time Stamp" on page 67

9.7.2.2 Configuring the Color Map

DISPlay[:WINDow<n>]:SGRam:COLor:DEFault
DISPlay[:WINDow<n>]:SPECtrogram:COLor:DEFault

This command restores the original color map.

Suffix:
<n> Window

Manual operation: See "Set to Default" on page 70

DISPlay[:WINDow<n>]:SGRam:COLor:LOWer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:LOWer <Percentage>

This command defines the starting point of the color map.

Suffix:
<n> Window

Parameters:
<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:LOW 10`
Sets the start of the color map to 10%.

Manual operation: See "Start / Stop" on page 69

DISPlay[:WINDow<n>]:SGRam:COLor:SHAPe <Shape>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:SHAPe <Shape>

This command defines the shape and focus of the color curve for the spectrogram result display.

Suffix:
<n> Window

Parameters:
<Shape> Shape of the color curve.

Range: -1 to 1
*RST: 0

Manual operation: See "Shape" on page 69

DISPlay[:WINDow<n>]:SGRam:COLor:UPPer <Percentage>
DISPlay[:WINDow<n>]:SPECtrogram:COLor:UPPer <Percentage>

This command defines the end point of the color map.

Suffix:
<n> Window

Parameters:
<Percentage> Statistical frequency percentage.

Range: 0 to 66
*RST: 0
Default unit: %

Example: `DISP:WIND:SGR:COL:UPP 95`
Sets the start of the color map to 95%.

Manual operation: See "Start / Stop" on page 69

DISPlay[:WINDow<n>]:SGRam:COLor[:STYLe] <ColorScheme>
DISPlay[:WINDow<n>]:SPECtrogram:COLor[:STYLe] <ColorScheme>

This command selects the color scheme.

Parameters:
<ColorScheme>

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

COLD
Uses a color range from red to blue. Red colors indicate low levels, blue colors indicate high ones.

RADar
Uses a color range from black over green to light turquoise with shades of green in between.

GRAYscale
Shows the results in shades of gray.

*RST: HOT

Example: `DISP:WIND:SPEC:COL GRAY`
Changes the color scheme of the spectrogram to black and white.

Manual operation: See "Hot/Cold/Radar/Grayscale" on page 70

9.7.3 Using Markers

The following commands are available for marker settings and functions in the I/Q Analyzer application.

For "I/Q Vector" displays markers are not available.

9.7.3.1 Setting Up Individual Markers

The following commands define the position of markers in the diagram.

CALCulate<n>:DELTamarker<m>:AOFF

This command turns off *all* delta markers.

Suffix:
<n> Window

<m> irrelevant

Example: `CALC:DELT:AOFF`
Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

This command links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Tip: to link any marker to a different marker than marker 1, use the `CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>` or `CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>` commands.

Suffix:
<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2:LINK ON`

Manual operation: See "Linking to Another Marker" on page 75

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

This command links delta marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, delta marker <m1> changes its horizontal position to the same value.

Suffix:

<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See "Linking to Another Marker" on page 75

CALCulate<n>:DELTamarker<m>:MODE <Mode>

This command defines whether the position of a delta marker is provided as an absolute value or relative to a reference marker.

Note that when the position of a delta marker is *queried*, the result is always an absolute value (see `CALCulate<n>:DELTamarker<m>:X` on page 175)!

Suffix:

<n> Window

<m> irrelevant

Parameters:

<Mode> **ABSolute**
Delta marker position in absolute terms.

RELative
Delta marker position in relation to a reference marker.

*RST: RELative

Example: `CALC:DELT:MODE ABS`
Absolute delta marker position.

CALCulate<n>:DELTamarker<m>:MREFerence <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.

Suffix:
<n> Window

<m> Marker

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.

Manual operation: See "Reference Marker" on page 75

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 74
See "Marker Type" on page 75
See "Select Marker" on page 76

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window

<m> Marker

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:
<n> Window

<m> Marker

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker Position X-value" on page 75

CALCulate<n>:MARKer<m>:AOFF

This command turns off all markers.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Manual operation: See "All Markers Off" on page 76

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

This command links normal marker <m1> to any active normal marker <m2>.

If you change the horizontal position of marker <m2>, marker <m1> changes its horizontal position to the same value.

Suffix:

<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See "Linking to Another Marker" on page 75

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 74
See "Marker Type" on page 75
See "Select Marker" on page 76

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window

<m> Marker

Parameters:
<Trace>

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See "Assigning the Marker to a Trace" on page 76

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:
<n> Window

<m> Marker

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 15
See "Marker Peak List" on page 16
See "Marker Position X-value" on page 75

9.7.3.2 General Marker Settings

The following commands control general marker functionality.

Remote commands exclusive to general marker functionality

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

This command turns the marker table on and off.

Suffix:
<n> irrelevant

Parameters:
<DisplayMode>
ON | 1
Turns on the marker table.
OFF | 0
Turns off the marker table.
AUTO
Turns on the marker table if 3 or more markers are active.
*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 77

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

This command turns the marker information in all diagrams on and off.

Suffix:
<n> irrelevant

Parameters:
<State>
ON | 1
Displays the marker information in the diagrams.
OFF | 0
Hides the marker information in the diagrams.
*RST: 1

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Marker Info" on page 77

CALCulate<n>:MARKer<m>:X:SSIZe <StepSize>

This command selects the marker step size mode for *all* markers in *all* windows.

The step size defines the distance the marker moves when you move it with the rotary knob.

It therefore takes effect in manual operation only.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<StepSize> **STANdard**
the marker moves from one pixel to the next
POINts
the marker moves from one sweep point to the next
*RST: POINts

Example: `CALC:MARK:X:SSIZ STAN`
Sets the marker step size to one pixel.

Manual operation: See "Marker Stepsize" on page 78

9.7.3.3 Configuring and Performing a Marker Search

The following commands control the marker search.

CALCulate<n>:MARKer<m>:LOEXclude <State>

This command turns the suppression of the local oscillator during automatic marker positioning on and off (for *all* markers in *all* windows).

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `CALC:MARK:LOEX ON`

Manual operation: See "Exclude LO" on page 80

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

This command defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Application/Result display	Unit
Spectrum	dB

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<Excursion> The excursion is the distance to a trace maximum that must be attained before a new maximum is recognized, or the distance to a trace minimum that must be attained before a new minimum is recognized

*RST: 6 dB in the Spectrum application and RF displays
Default unit: DB

Example: `CALC:MARK:PEXC 10dB`
Defines peak excursion as 10 dB.

Manual operation: See "Peak Excursion" on page 80

CALCulate<n>:MARKer<m>:SEARch <MarkRealImag>

This command selects the trace type a marker search is performed on.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<MarkRealImag> **REAL**
Marker search functions are performed on the real trace of the "I/Q" measurement.

IMAG
Marker search functions are performed on the imaginary trace of the "I/Q" measurement.

MAGN
Marker search functions are performed on the magnitude of the I and Q data.

*RST: REAL

Example: `CALC4:MARK:SEAR IMAG`

Manual operation: See "Branch for Peaksearch" on page 81

CALCulate<n>:MARKer<m>:X:SLIMits[:STATe] <State>

This command turns marker search limits on and off for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:X:SLIM ON`
Switches on search limitation.

Manual operation: See "Search Limits (Left / Right)" on page 80
See "Deactivating All Search Limits" on page 81

CALCulate<n>:MARKer<m>:X:SLIMits:LEFT <SearchLimit>

This command defines the left limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<SearchLimit> The value range depends on the frequency range or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: left diagram border
Default unit: HZ

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:LEFT 10MHz`
Sets the left limit of the search range to 10 MHz.

Manual operation: See "Search Limits (Left / Right)" on page 80

CALCulate<n>:MARKer<m>:X:SLIMits:RIGHt <SearchLimit>

This command defines the right limit of the marker search range for *all* markers in *all* windows.

If you perform a measurement in the time domain, this command limits the range of the trace to be analyzed.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<Limit> The value range depends on the frequency range or sweep time.
The unit is Hz for frequency domain measurements and s for time domain measurements.

*RST: right diagram border
Default unit: HZ

Example: `CALC:MARK:X:SLIM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Search Limits (Left / Right)" on page 80

CALCulate<n>:MARKer<m>:X:SLIMits:ZOOM[:STATe] <State>

This command adjusts the marker search range to the zoom area for *all* markers in *all* windows.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:X:SLIM:ZOOM ON`
Switches the search limit function on.
`CALC:MARK:X:SLIM:RIGH 20MHz`
Sets the right limit of the search range to 20 MHz.

Manual operation: See "Use Zoom Limits" on page 81

CALCulate<n>:THReshold <Level>

This command defines a threshold level for the marker peak search (for *all* markers in *all* windows).

Suffix:
<n> irrelevant

Parameters:
<Level> Numeric value. The value range and unit are variable.
*RST: -120 dBm
Default unit: DBM

Example: `CALC:THR -82DBM`
Sets the threshold value to -82 dBm.

Manual operation: See "Search Threshold" on page 81

CALCulate<n>:THReshold:STATe <State>

This command turns a threshold for the marker peak search on and off (for *all* markers in *all* windows).

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: `CALC:THR:STAT ON`
Switches on the threshold line.

Manual operation: See "Deactivating All Search Limits" on page 81

9.7.3.4 Marker Search (Spectrograms)

The following commands automatically define the marker and delta marker position in the spectrogram.

Using Markers

The following commands control spectrogram markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the markers.

- `CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 193
- `CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 194

- CALCulate<n>:MARKer<m>:MAXimum[:PEAK] on page 194
- CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 194
- CALCulate<n>:MARKer<m>:MINimum:LEFT on page 195
- CALCulate<n>:MARKer<m>:MINimum:NEXT on page 195
- CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 196
- CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 196

Remote commands exclusive to spectrogram markers

CALCulate<n>:MARKer<m>:SGRam:FRAMe <Frame>
CALCulate<n>:MARKer<m>:SPECtrogram:FRAMe <Frame> | <Time>

This command positions a marker on a particular frame.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame directly by the frame number. Valid if the time stamp is off.
The range depends on the history depth.
Default unit: S

<Time> Selects a frame via its time stamp. Valid if the time stamp is on. The number is the (negative) distance to frame 0 in seconds. The range depends on the history depth.

Example: `CALC:MARK:SGR:FRAM -20`
Sets the marker on the 20th frame before the present.
`CALC:MARK2:SGR:FRAM -2s`
Sets second marker on the frame 2 seconds ago.

Manual operation: See "Frame (Spectrogram only)" on page 75

CALCulate<n>:MARKer<m>:SGRam:SAREa <SearchArea>
CALCulate<n>:MARKer<m>:SPECtrogram:SAREa <SearchArea>

This command defines the marker search area for all spectrogram markers in the channel setup.

Suffix:
<n> irrelevant

<m> irrelevant

Parameters:
<SearchArea> **VISible**
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "Marker Search Area" on page 83

CALCulate<n>:MARKer<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram.

Suffix:
<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a marker to the minimum level of the spectrogram.

Suffix:
<n> Window

<m> Marker

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a marker vertically to the next lower peak level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:MARKer<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:
<n> Window
<m> Marker

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:BELow

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a marker vertically to the next higher minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:MARKer<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:MARKer<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level for all frequencies and moves the marker vertically to the minimum level.

Suffix:
<n> Window

<m> Marker

Using Delta Markers

The following commands control spectrogram delta markers.

Useful commands for spectrogram markers described elsewhere

The following commands define the horizontal position of the delta markers.

- `CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 196
- `CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 197
- `CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 197
- `CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 197
- `CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 198
- `CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 198
- `CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 198
- `CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 198

Remote commands exclusive to spectrogram markers

CALCulate<n>:DELTamarker<m>:SGRam:FRAMe <Frame>
CALCulate<n>:DELTamarker<m>:SPECtrogram:FRAMe <Frame>

This command positions a delta marker on a particular frame. The frame is relative to the position of marker 1.

The command is available for the spectrogram.

Suffix:

<n> Window

<m> Marker

Parameters:

<Frame> Selects a frame either by its frame number or time stamp.
The frame number is available if the time stamp is off. The range depends on the history depth.
The time stamp is available if the time stamp is on. The number is the distance to frame 0 in seconds. The range depends on the history depth.

Default unit: S

Example:

```
CALC:DELT4:SGR:FRAM -20
```

Sets fourth deltamarker 20 frames below marker 1.

```
CALC:DELT4:SGR:FRAM 2 s
```

Sets fourth deltamarker 2 seconds above the position of marker 1.

Manual operation: See "Frame (Spectrogram only)" on page 75

CALCulate<n>:DELTamarker<m>:SGRam:SARea <SearchArea>
CALCulate<n>:DELTamarker<m>:SPECtrogram:SARea <SearchArea>

This command defines the marker search area for *all* spectrogram markers in the channel setup.

Suffix:

<n> irrelevant

<m> irrelevant

Parameters:

<SearchArea> **VISible**
Performs a search within the visible frames.
Note that the command does not work if the spectrogram is not visible for any reason (e.g. if the display update is off).

MEMory
Performs a search within all frames in the memory.

*RST: VISible

Manual operation: See "Marker Search Area" on page 83

CALCulate<n>:DELTamarker<m>:SGRam:XY:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MAXimum[:PEAK]

This command moves a marker to the highest level of the spectrogram over all frequencies.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:DELTamarker<m>:SGRam:XY:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:XY:MINimum[:PEAK]

This command moves a delta marker to the minimum level of the spectrogram over all frequencies.

Suffix:

<n> Window

<m> Marker

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:ABOVe

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:BELow

This command moves a marker vertically to the next higher level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum:NEXT

This command moves a delta marker vertically to the next higher level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:DELTamarker<m>:SGRam:Y:MAXimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MAXimum[:PEAK]

This command moves a delta marker vertically to the highest level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command looks for the peak level in the whole spectrogram.

Suffix:
<n> Window

<m> Marker

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:ABOVe
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:ABOVe

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames above the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:BELow
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:BELow

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes only frames below the current marker position. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum:NEXT
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum:NEXT

This command moves a delta marker vertically to the next minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Mode for Next Peak in Y-Direction" on page 82

CALCulate<n>:DELTamarker<m>:SGRam:Y:MINimum[:PEAK]
CALCulate<n>:DELTamarker<m>:SPECtrogram:Y:MINimum[:PEAK]

This command moves a delta marker vertically to the minimum level for the current frequency.

The search includes all frames. It does not change the horizontal position of the marker.

If the marker hasn't been active yet, the command first looks for the peak level in the whole spectrogram and moves the marker vertically to the minimum level.

Suffix:
<n> Window

<m> Marker

9.7.3.5 Positioning the Marker

This chapter contains remote commands necessary to position the marker on a trace.

Positioning Normal Markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:MAXimum:AUTO <State>

This command turns an automatic marker peak search for a trace maximum on and off. The R&S ZNL performs the peak search after each sweep.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:MAX:AUTO ON`
Activates the automatic peak search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Max Peak Search / Auto Min Peak Search" on page 80

CALCulate<n>:MARKer<m>:MAXimum:LEFT

This command moves a marker to the next lower peak.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 85

CALCulate<n>:MARKer<m>:MAXimum:NEXT

This command moves a marker to the next lower peak.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 85

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Peak Search" on page 85

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

This command moves a marker to the next lower peak.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 85

CALCulate<n>:MARKer<m>:MINimum:AUTO <State>

This command turns an automatic marker peak search for a trace minimum on and off. The R&S ZNL performs the peak search after each sweep.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK:MIN:AUTO ON`
Activates the automatic minimum value search function for marker 1 at the end of each particular sweep.

Manual operation: See "Auto Max Peak Search / Auto Min Peak Search" on page 80

CALCulate<n>:MARKer<m>:MINimum:LEFT

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 85

CALCulate<n>:MARKer<m>:MINimum:NEXT

This command moves a marker to the next minimum value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 85

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 85

CALCulate<n>:MARKer<m>:MINimum:RIGHt

This command moves a marker to the next minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 85

Positioning Delta Markers

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

This command moves a delta marker to the next higher value.

The search includes only measurement values to the left of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Peak" on page 85

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

This command moves a marker to the next higher value.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> 1..n
Window
<m> 1..n
Marker

Manual operation: See "Search Next Peak" on page 85

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Peak Search" on page 85

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

This command moves a delta marker to the next higher value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the maximum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Peak" on page 85

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 85

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

This command moves a marker to the next higher minimum value.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 85

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 85

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

This command moves a delta marker to the next higher minimum value.

The search includes only measurement values to the right of the current marker position.

In the spectrogram, the command moves a marker horizontally to the minimum level in the currently selected frame. The vertical marker position remains the same.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 85

9.7.3.6 Band Power Marker

The following commands control the marker for band power measurements.

Using Markers

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:AOFF

Removes all band power markers in the specified window.

Suffix:
<n> Window

<m> irrelevant

Example: `CALC:MARK:FUNC:BPOW:AOFF`

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power marker are displayed.

(Note: relative power results are only availabe for delta markers,
see .`CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE` on page 201

Suffix:
<n> Window

<m> Marker

Parameters:
<Mode>

POWer
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

DENSity
Result is displayed as a density in dBm/Hz.

*RST: POWer

Example: CALC:MARK4:FUNC:BPOW:MODE DENS
Configures marker 4 to show the measurement results in dBm/Hz.

Manual operation: See "Power Mode" on page 91

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Suffix:
<n> Window

<m> Marker

Return values:
<Power> Signal power over the marker bandwidth.

Example: Activate the band power marker:
CALC:MARK:FUNC:BPOW:STAT ON
Select the density mode for the result:
CALC:MARK:FUNC:BPOW:MODE DENS
Query the result:
CALC:MARK:FUNC:BPOW:RES?
Response:
20dBm/Hz

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the marker position.

Suffix:
<n> Window

<m> Marker

Parameters:
<Span> Frequency. The maximum span depends on the marker position and R&S ZNL model.
*RST: 5% of current span
Default unit: Hz

Example: CALC:MARK:FUNC:BPOW:SPAN 2MHz
Measures the band power over 2 MHz around the marker.

Manual operation: See "Span" on page 91

CALCulate<n>:MARKer<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns markers for band power measurements on and off.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:FUNC:BPOW:STAT ON`
Activates or turns marker 4 into a band power marker.

Manual operation: See "Band Power Measurement State" on page 91
See "Switching All Band Power Measurements Off" on page 92

Using Delta Markers

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:MODE <Mode>

This command selects the way the results for a band power delta marker are displayed.

Suffix:
<n> Window

<m> Marker

Parameters:
<Mode>

POWer
Result is displayed as an absolute power. The power unit depends on the `CALCulate<n>:UNIT:POWer` setting.

DENSity
Result is displayed as a density in dBm/Hz.

RPOWer
This setting is only available for a delta band power marker. The result is the difference between the absolute power in the band around the delta marker and the absolute power for the reference marker. The powers are subtracted logarithmically, so the result is a dB value.
[Relative band power (Delta2) in dB] = [absolute band power (Delta2) in dBm] - [absolute (band) power of reference marker in dBm]
For details see "Relative band power markers" on page 89.

*RST: POWer

Manual operation: See "Power Mode" on page 91

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:RESult?

This command queries the results of the band power measurement.

Suffix:
<n> Window

<m> Marker

Return values:
<Power> Signal power over the delta marker bandwidth.

Usage: Query only

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer:SPAN <Span>

This command defines the bandwidth around the delta marker position.

Suffix:
<n> Window

<m> Marker

Parameters:
<Span> Frequency. The maximum span depends on the marker position and R&S ZNL model.

*RST: 5% of current span
Default unit: Hz

Manual operation: See "Span" on page 91

CALCulate<n>:DELTamarker<m>:FUNCtion:BPOWer[:STATe] <State>

This command turns delta markers for band power measurements on and off.

If neccessary, the command also turns on a reference marker.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Manual operation: See "Band Power Measurement State" on page 91
See "Switching All Band Power Measurements Off" on page 92

9.7.3.7 Marker Peak Lists

Useful commands for peak lists described elsewhere

- `CALCulate<n>:MARKer<m>:PEXCursion` on page 179
- `MMEMory:STORe<n>:PEAK` on page 206

Remote commands exclusive to peak lists

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:ANNotation:LABel[:STATe]
<State>

This command turns labels for peaks found during a peak search on and off.

The labels correspond to the marker number in the marker peak list.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `CALC:MARK:FUNC:FPE:ANN:LAB:STAT OFF`
Removes the peak labels from the diagram

Manual operation: See "Display MarkerNumbers" on page 95

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:COUNt?

This command queries the number of peaks that have been found during a peak search.

The actual number of peaks that have been found may differ from the number of peaks you have set to be found because of the peak excursion.

Suffix:
<n> irrelevant

<m> irrelevant

Return values:
<NumberOfPeaks>

Example: `CALC:MARK:FUNC:FPE:COUN?`
Queries the number of peaks.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks[:IMMediate] <Peaks>

This command initiates a peak search.

Suffix:
<n> Window

<m> Marker

Parameters:
<Peaks> This parameter defines the number of peaks to find during the search.
Note that the actual number of peaks found during the search also depends on the peak excursion you have set with `CALCulate<n>:MARKer<m>:PEXCursion`.

Range: 1 to 200

Example: `CALC:MARK:PEXC 5`
Defines a peak excursion of 5 dB, i.e. peaks must be at least 5 dB apart to be detected as a peak.
`CALC:MARK:FUNC:FPE 10`
Initiates a search for 10 peaks on the current trace.

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:LIST:SIZE <MaxNoPeaks>

This command defines the maximum number of peaks that the R&S ZNL looks for during a peak search.

Suffix:
<n> Window

<m> Marker

Parameters:
<MaxNoPeaks> Maximum number of peaks to be determined.

Range: 1 to 200
*RST: 50

Example: `CALC:MARK:FUNC:FPE:LIST:SIZE 10`
The marker peak list will contain a maximum of 10 peaks.

Manual operation: See "Maximum Numberof Peaks" on page 95

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT <SortMode>

This command selects the order in which the results of a peak search are returned.

Suffix:
<n> Window

<m> Marker

Parameters:
<SortMode> **X**
Sorts the peaks according to increasing position on the x-axis.
Y
Sorts the peaks according to decreasing position on the y-axis.
*RST: X

Example: `CALC:MARK:FUNC:FPE:SORT Y`
Sets the sort mode to decreasing y values

Manual operation: See "Sort Mode" on page 94

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:STATe <State>

This command turns a peak search on and off.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on

Example: `CALC:MARK:FUNC:FPE:STAT ON`
Activates marker peak search

Manual operation: See "Peak List State" on page 94

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X?

This command queries the position of the peaks on the x-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Suffix:
<n> irrelevant

<m> irrelevant

Return values:
<PeakPosition> Position of the peaks on the x-axis. The unit depends on the measurement.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y?

This command queries the position of the peaks on the y-axis.

The order depends on the sort order that has been set with `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:SORT`.

Suffix:
<n> irrelevant

<m> irrelevant

Return values:
<PeakPosition> Position of the peaks on the y-axis. The unit depends on the measurement.

Usage: Query only

MMEMory:STORe<n>:PEAK <FileName>

This command exports the marker peak list to a file.

Suffix:
<n> Window

Parameters:
<FileName> String containing the path,name and extension of the target file.

Example: `MMEM:STOR:PEAK 'test.dat'`
Saves the current marker peak list in the file `test.dat`.

Manual operation: See "Export Peak List" on page 95

9.8 Retrieving Results

The following commands can be used to retrieve the results of the I/Q Analyzer measurement.

Storing large amounts of I/Q data

When storing large amounts of I/Q data to a file, consider the following tips to improve performance:

- If capturing and storing the I/Q data is the main goal of the measurement and evaluation functions are not required, use the basic I/Q data acquisition mode (see `TRACe:IQ[:STATe]` on page 110).
- Use a HiSlip or raw socket connection to export the data from the R&S ZNL to a PC.
- Export the data in binary format rather than ASCII format (see Chapter A, "Formats for Returned Values: ASCII Format and Binary Format", on page 222).
- Use the "Compatible" or "IQPair" data mode (see Chapter B, "Reference: Format Description for I/Q Data Files", on page 223).
- If only an extract of the available data is relevant, use the `TRACe<n>[:DATA]:MEMory?` command to store only the required section of data.

9.8.1 Retrieving Captured I/Q Data

The raw captured I/Q data is output in the form of a list.

TRACe:IQ:DATA

This command initiates a measurement with the current settings and returns the captured data from I/Q measurements.

This command corresponds to:

```
INIT:IMM;*WAI;:TRACe:IQ:DATA:MEMory?
```

However, the `TRACe:IQ:DATA?` command is quicker in comparison.

Note: Using the command with the *RST values for the `TRACe:IQ:SET` command, the following minimum buffer sizes for the response data are recommended: ASCII format 10 kBytes, binary format: 2 kBytes

Return values:

<Results> Measured voltage for I and Q component for each sample that has been captured during the measurement.
The number of samples depends on `TRACe:IQ:SET`. In ASCII format, the number of results is 2* the number of samples.
The data format depends on `TRACe:IQ:DATA:FORMat` on page 208.
Default unit: V

Example:

```
TRAC:IQ:STAT ON
```
Enables acquisition of I/Q data
```
TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096
```
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 0
Number of Samples = 4096
```
FORMat REAL,32
```
Selects format of response data
```
TRAC:IQ:DATA?
```
Starts measurement and reads results

TRACe:IQ:DATA:FORMat <Format>

This command selects the order of the I/Q data.

For details see Chapter B, "Reference: Format Description for I/Q Data Files", on page 223.

Parameters:

<Format> COMPatible | IQBLock | IQPair

COMPatible
I and Q values are separated and collected in blocks: A block (512k) of I values is followed by a block (512k) of Q values, followed by a block of I values, followed by a block of Q values etc. (I,I,I,I,Q,Q,Q,Q,I,I,I,I,Q,Q,Q,Q...)

IQBLock
First all I-values are listed, then the Q-values (I,I,I,I,I,I,...Q,Q,Q,Q,Q,Q)

IQPair
One pair of I/Q values after the other is listed (I,Q,I,Q,I,Q...).

*RST: IQBL

TRACe:IQ:DATA:MEMory? [<OffsetSamples>,<NoOfSamples>]

This command queries the I/Q data currently stored in the capture buffer of the R&S ZNL.

By default, the command returns all I/Q data in the memory. You can, however, narrow down the amount of data that the command returns using the optional parameters.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command returns the same results as `TRACe:IQ:DATA`. (Note, however, that the `TRAC:IQ:DATA?` command initiates a new measurement before returning the captured values, rather than returning the existing data in the memory.)

The command returns a comma-separated list of the measured values in floating point format (comma-separated values = CSV). The number of values returned is 2 * the number of complex samples.

The total number of complex samples is displayed in the channel bar in manual operation and can be calculated as:

<SampleRate> * <CaptureTime>

(See `TRACe:IQ:SET`, `TRACe:IQ:SRATe` on page 141 and `[SENSe:]SWEep:TIME` on page 157)

Query parameters:

<OffsetSamples> Selects an offset at which the output of data should start in relation to the first data. If omitted, all captured samples are output, starting with the first sample.

Range: 0 to <# of samples> – 1, with <# of samples> being the maximum number of captured values
*RST: 0

<NoOfSamples> Number of samples you want to query, beginning at the offset you have defined. If omitted, all captured samples (starting at offset) are output.

Range: 1 to <# of samples> - <offset samples> with <# of samples> maximum number of captured values
*RST: <# of samples>

Return values:

<IQData> Measured value pair (I,Q) for each sample that has been recorded.
By default, the first half of the list contains the I values, the second half the Q values. The order can be configured using `TRACe:IQ:DATA:FORMat`.
The data format of the individual values depends on `FORMat[:DATA]` on page 210.

Default unit: V

Example:
```
TRAC:IQ:STAT ON
```
Enables acquisition of I/Q data
```
TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,100,4096
```
Measurement configuration:
Sample Rate = 32 MHz
Trigger Source = External
Trigger Slope = Positive
Pretrigger Samples = 100
Number of Samples = 4096
```
INIT;*WAI
```
Starts measurement and wait for sync
```
FORMat REAL,32
```
Determines output format
To read the results:
```
TRAC:IQ:DATA:MEM?
```
Reads all 4096 I/Q data
```
TRAC:IQ:DATA:MEM? 0,2048
```
Reads 2048 I/Q data starting at the beginning of data acquisition
```
TRAC:IQ:DATA:MEM? 2048,1024
```
Reads 1024 I/Q data from half of the recorded data
```
TRAC:IQ:DATA:MEM? 100,512
```
Reads 512 I/Q data starting at the trigger point (<Pretrigger Samples> was 100)

Example:
```
// Perform a single I/Q capture.
INIT;*WAI
// Determine output format (binary float32)
FORMat REAL,32
// Read 1024 I/Q samples starting at sample 2048.
TRAC:IQ:DATA:MEM? 2048,1024
```

Usage: Query only

9.8.2 Retrieving I/Q Trace Data

In addition to the raw captured I/Q data, the results from I/Q analysis as shown in the result displays can also be retrieved.

FORMat[:DATA] <Format>[, <BitLength>]

This command selects the data format that is used for transmission of trace data from the R&S ZNL to the controlling computer.

Note that the command has no effect for data that you send to the R&S ZNL. The R&S ZNL automatically recognizes the data it receives, regardless of the format.

Parameters:

<Format> ASCii | REAL | UINT | MATLab

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
Floating-point numbers (according to IEEE 754) in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.

<BitLength> 16 | 32 | 64

Length in bits for floating-point results

32
32-bit floating-point numbers
For I/Q data, 8 bytes per sample are returned for this format setting.

Example: `FORM REAL,32`

TRACe<n>[:DATA]? <ResultType>

This command queries current trace data and measurement results.

If you use it as a setting command, it transfers trace data from an external source to the R&S ZNL.

The data format depends on `FORMat[:DATA]` on page 210.

Suffix:

<n> Window

Query parameters:

<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6
Returns the trace data for the corresponding trace.
For details see Table 9-4.

LIST
Returns the results of the peak list evaluation for Spurious Emission and Spectrum Emission Mask measurements.
For SEM measurements, one peak per range is returned.
For details see Table 9-5.

SPURious
Returns the peak list of Spurious Emission measurements.

SPECtrogram | SGRam
Returns the results of the spectrogram result display.
For details see Table 9-6.

Return values:

<TraceData> Returns the sweep point values as shown in the result display.
If you are measuring with the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.)
For the Magnitude and Spectrum result displays in the I/Q Analyzer application, this command returns the magnitude of the I and Q values (I+jQ) for each sweep point (=1001 values).
For the Real/Imag (I/Q) result display, the command returns first the real parts for each trace point, then the imaginary parts (I_1,...,I_{1001}, Q_1,...,Q_{1001}).
For the I/Q Vector result display, the I and Q values for each trace point are returned (1001 pairs of I and Q values).

Example: `TRAC? TRACE3`
Queries the data of trace 3.

Manual operation: See "Magnitude" on page 13
See "Spectrum" on page 13
See "I/Q-Vector" on page 14
See "Real/Imag (I/Q)" on page 15

Table 9-4: Return values for TRACE1 to TRACE6 parameter

The trace data consists of a list of power levels that have been measured. The number of power levels in the list depends on the currently selected number of sweep points. The unit depends on the measurement and on the unit you have currently set. If you are measuring with the auto peak detector, the command returns positive peak values only. (To retrieve negative peak values, define a second trace with a negative peak detector.)

Table 9-5: Return values for LIST parameter

For each peak, the command returns 11 values in the following order: <No>,<StartFreq>,<StopFreq>,<RBW>,<PeakFreq>,<PowerAbs>,<PowerRel>,<PowerDelta>,<LimitCheck>,<Unused1>,<Unused2> • <No>: range number • <StartFreq>,<StopFreq>: start and stop frequency of the range • <RBW>: resolution bandwidth • <PeakFreq>: frequency of the peak in a range • <PowerAbs>: absolute power of the peak in dBm • <PowerRel>: power of the peak in relation to the channel power in dBc • <PowerDelta>: distance from the peak to the limit line in dB, positive values indicate a failed limit check • <LimitCheck>: state of the limit check (0 = PASS, 1 = FAIL) • <Unused1>,<Unused2>: reserved (0.0)

Table 9-6: Return values for SPECtrogram parameter

For every frame in the spectrogram, the command returns the power levels that have been measured, one for each sweep point. The number of frames depends on the size of the history depth. The power level depends on the unit you have currently set.

TRACe<n>[:DATA]:MEMory? <Trace>,<OffsSwPoint>,<NoOfSwPoints>

This command queries the previously captured trace data for the specified trace from the memory. As an offset and number of sweep points to be retrieved can be specified, the trace data can be retrieved in smaller portions, making the command faster than the `TRAC:DATA?` command. This is useful if only specific parts of the trace data are of interest.

If no parameters are specified with the command, the entire trace data is retrieved; in this case, the command returns the same results as `TRAC:DATA? TRACE1`.

Suffix:
<n> Window

Query parameters:
<Trace> TRACE1 | TRACE2 | TRACE3 | TRACE4 | TRACE5 | TRACE6

<OffsSwPoint> The offset in sweep points related to the start of the measurement at which data retrieval is to start.

<NoOfSwPoints> Number of sweep points to be retrieved from the trace.

Return values:
<SweepPointValues>

Example: `TRAC:DATA:MEM? TRACE1,25,100`
Retrieves 100 sweep points from trace 1, starting at sweep point 25.

Usage: Query only

TRACe<n>[:DATA]:X? <TraceNumber>

This command queries the horizontal trace data for each sweep point in the specified window, for example the frequency in frequency domain or the time in time domain measurements.

This is especially useful for traces with non-equidistant x-values.

Suffix:
<n> Window

Query parameters:
<TraceNumber> Trace number.
TRACE1 | ... | TRACE6

Example: `TRAC3:X? TRACE1`
Returns the x-values for trace 1 in window 3.

Usage: Query only

9.8.3 Exporting Traces and Data

The following commands are required to export traces and spectrograms.

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 32
See "Export Peak List" on page 95

FORMat:DEXPort:FORMat <FileFormat>

Determines the format of the ASCII file to be imported or exported. Depending on the external program in which the data file was created or will be evaluated, a comma-separated list (CSV) or a plain data format (DAT) file may be required.

Parameters:

<FileFormat> CSV | DAT

*RST: DAT

Example: `FORM:DEXP:FORM CSV`

Manual operation: See "File Type" on page 32

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Manual operation: See "Include Instrument & Measurement Settings" on page 71

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 215).

Parameters:

<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Manual operation: See "Export all Traces and all Table Results" on page 71

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

Suffix:

<n> Window

Parameters:

<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

Manual operation: See "Export Trace to ASCII File" on page 31

9.8.4 Retrieving Marker Results

The following commands are required to retrieve the results of markers.

Useful commands for retrieving marker results described elsewhere:

- `CALCulate<n>:DELTamarker<m>:X` on page 175
- `CALCulate<n>:MARKer<m>:X` on page 177
- `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:X?` on page 205
- `CALCulate<n>:MARKer<m>:FUNCtion:FPEaks:Y?` on page 206

Remote commands exclusive to retrieving marker results:

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:

<n> Window

<m> Marker

Return values:

<Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

CALCulate<n>:DELTamarker<m>:Y

Queries the result at the position of the specified delta marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.
Default unit: DBM

CALCulate<n>:MARKer<m>:Y

Queries the result at the position of the specified marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Default unit: DBM

Manual operation: See "Marker Table" on page 15
See "Marker Peak List" on page 16

MMEMory:STORe<n>:LIST <FileName>

This command exports the SEM and spurious emission list evaluation to a file.

The file format is *.dat.

Suffix:
<n> Window

Parameters:
<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:LIST 'test'`
Stores the current list evaluation results in the `test.dat` file.

9.9 Importing and Exporting I/Q Data and Results

Alternatively to capturing I/Q data by the I/Q Analyzer itself, stored I/Q data from previous measurements or other applications can be imported to the I/Q Analyzer. Furthermore, I/Q data processed in the I/Q Analyzer can be stored to a file for further evaluation in other applications.

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

MMEMory:STORe<n>:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

Suffix:
<n> irrelevant

Parameters:
<Comment> String containing the comment.

Example: `MMEM:STOR:IQ:COMM 'Device test 1b'`
Creates a description for the export file.
`MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores I/Q data and the comment to the specified file.

Manual operation: See "I/Q Export" on page 33

MMEMory:STORe<n>:IQ:FORMat <Format>,<DataFormat>

This command sets or queries the format of the I/Q data to be stored.

Suffix:
<n> irrelevant

Parameters:
<Format> **FLOat32**
32-bit floating point format.
INT32
32-bit integer format.
*RST: FLOat32

<DataFormat> **COMPlex**
Exports complex data.
REAL
Exports real data.
*RST: COMPlex

Example:
```
MMEM:STOR:IQ:FORM INT32,REAL
```

MMEMory:STORe<n>:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Suffix:
<n> 1..n

Parameters:
<FileName> String containing the path and name of the target file.

Example:
```
MMEM:STOR:IQ:STAT 1, 'C:
\R_S\Instr\user\data.iq.tar'
```
Stores the captured I/Q data to the specified file.

Manual operation: See "I/Q Export" on page 33

9.10 Programming Examples

The following programming examples demonstrate how to capture I/Q data and perform I/Q data analysis using the I/Q Analyzer in a remote environment.

9.10.1 I/Q Analysis with Graphical Evaluation

This example demonstrates how to configure and perform a basic I/Q data acquisition and analyze the data using the I/Q Analyzer in a remote environment.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument
INST:CRE IQ,'IQANALYZER'
//Creates a new measurement channel named 'IQANALYZER'.
INIT:CONT OFF
//Switches to single sweep mode

//--------------Configuring Data Acquisition-------------
TRAC:IQ:SRAT 32MHZ
//Defines the sample rate.
TRAC:IQ:RLEN 1000
//Sets the record length (number of samples to capture) to 1000 samples.
TRAC:IQ:BWID?
//Queries the bandwidth of the resampling filter, determined by the sample rate
FORM:DATA REAL,32
//Formats the data as 32-byte real values.
TRAC:IQ:DATA:FORM IQBL
//Lists all I values first, then all Q values in the trace results.

//--------------Configuring the Trace--------------------
TRAC:IQ:AVER ON
//Defines averaging for the I/Q trace.
TRAC:IQ:AVER:COUN 10
//Defines an average over 10 sweeps.

DISP:TRAC1:MODE WRIT
DISP:TRAC2:MODE MAXH
DISP:TRAC3:MODE MINH
//Changes the trace modes.

//--------------Performing the Measurement---------------------
INIT;*WAI
//Initiates a new measurement and waits until the sweep has finished.

//---------------Retrieving Results----------------------------

TRAC:DATA? TRACE1
TRAC:DATA? TRACE2
TRAC:DATA? TRACE3
//Returns the magnitude for each sweep point

LAY:REPL:WIND '1',RIMAG
//Changes the result display to Real/Imag (I/Q)

CALC:MARK:SEAR MAGN
//Configures searches to search both I and Q branches.
CALC:MARK:Y?
//Queries the result of the peak search on both branches.
```

```
TRAC:IQ:DATA:MEM? 0,500
//Returns the first 500 samples of the stored I/Q data for the measurement.
//For each sample, first the I-value, then the Q-value is listed.

TRAC:IQ:DATA:MEM? 500,500
//Returns the second half of the 1000 captured sample values.
```

9.10.2 Basic I/Q Analysis with Improved Performance

This example demonstrates how to configure and perform a basic I/Q data acquisition and analyze the data using the I/Q Analyzer in a remote environment.

```
//--------------Activating the I/Q Analyzer application ---------------------
*RST
//Reset the instrument

INIT:CONT OFF
//Switches to single sweep mode
TRACE:IQ ON
//Switches the operating mode of the current measurement channel to I/Q Analyzer
//while retaining the relevant parameters from the Spectrum mode.

//--------------Configuring Data Acquisition-------------
TRACE:IQ:SET NORM,0,32000000,IQP,POS,0,1000
//Configures the sample rate as 32 MHz, IQP trigger, positive trigger slope,
//no pretrigger samples, 1000 samples to capture
FORM REAL,32
//The data is formatted as real values.

//--------------Configuring I/Q Gating--------------------------
TRAC:IQ:EGAT ON
//Turns on gated measurement.
TRAC:IQ:EGAT:TYPE LEV
//Select the level gate type.
TRAC:IQ:EGAT:LENG 20
//Sets the gate length to 20 samples.
TRAC:IQ:EGAT:GAP 20
//Sets the interval between gate periods to 20 samples.
TRAC:IQ:EGAT:NOF 2
//Sets the number of gate periods after the trigger signal to 2.
TRIG:SOUR IQP
//Defines the magnitude of the sampled I/Q data to be used as a trigger.
TRIG:LEV:IQP -30dbm
//Sets the trigger level.

//---------------Performing the Measurement and Retrieving Results--------------
TRAC:IQ:DATA?; *WAI;
//Performs a measurement and returns the RF input voltage at each sample point
```

```
//(first 1000 I-values, then 1000 Q-values).

TRAC:IQ:DATA:MEM? 0,500
//Returns the first 500 samples of the stored trace data for the measurement.
//For each sample, first the I-value, then the Q-value is listed.

TRAC:IQ:DATA:MEM? 500,500
//Returns the second half of the 1000 captured sample values.
```

Annex

A Formats for Returned Values: ASCII Format and Binary Format

When trace data is retrieved using the `TRAC:DATA` or `TRAC:IQ:DATA` command, the data is returned in the format defined using the `FORMat[:DATA]` on page 210. The possible formats are described here.

- ASCII Format (FORMat ASCII):
  The data is stored as a list of comma-separated values (CSV) of the measured values in floating point format.
- Binary Format (FORMat REAL,32):
  The data is stored as binary data (Definite Length Block Data according to IEEE 488.2), each measurement value being formatted in 32-Bit IEEE 754 Floating-Point-Format.
  The schema of the result string is as follows:
  `#41024<value1><value2>…<value n>` with

#4	Number of digits (= 4 in the example) of the following number of data bytes
1024	Number of following data bytes (= 1024 in the example)
<Value>	4-byte floating point value

Reading out data in binary format is quicker than in ASCII format. Thus, binary format is recommended for large amounts of data.

B Reference: Format Description for I/Q Data Files

This section describes how I/Q data is transferred to the memory during remote control (see `TRACe:IQ:DATA:FORMat` command).

For details on the format of the individual values, see Chapter A, "Formats for Returned Values: ASCII Format and Binary Format", on page 222.

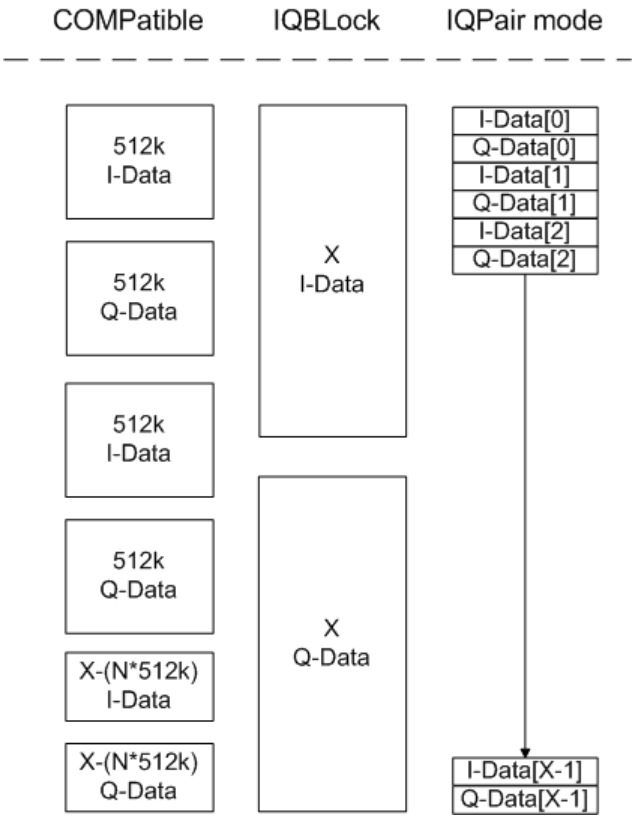


Figure B-1: I/Q data formats

Note: 512k corresponds to 524288 samples

For maximum performance, the formats "Compatible" or "IQPair" should be used. Furthermore, for large amounts of data, the data should be in binary format to improve performance.

In binary format, the number of I- and Q-data can be calculated as follows:

$$\#\,of\ I-Data\ =\ \#\,of\ Q-Data\ =\ \frac{\#\,of\ DataBytes}{8}$$

For the format "QBLock", the offset of Q-data in the output buffer can be calculated as follows:

$$Q - Data - Offset = \frac{(\#\ of\ DataBytes)}{2} + LengthIndicatorDigits$$

with "LengthIndicatorDigits" being the number of digits of the length indicator including the #. In the example above (#41024…), this results in a value of 6 for "LengthIndicatorDigits" and the offset for the Q-data results in 512 + 6 = 518.

C I/Q Data File Format (iq-tar)

I/Q data is packed in a file with the extension `.iq.tar`. An iq-tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the iq-tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include user-specific data.

The iq-tar container packs several files into a single `.tar` archive file. Files in `.tar` format can be unpacked using standard archive tools (see http://en.wikipedia.org/wiki/Comparison_of_file_archivers) available for most operating systems. The advantage of `.tar` files is that the archived files inside the `.tar` file are not changed (not compressed) and thus it is possible to read the I/Q data directly within the archive without the need to unpack (untar) the `.tar` file first.

An application note on converting Rohde & Schwarz I/Q data files is available from the Rohde & Schwarz website:

1EF85: Converting R&S I/Q data files

Contained files

An iq-tar file must contain the following files:

- **I/Q parameter XML file**, e.g. `xyz.xml`
  Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an iq-tar file.
- **I/Q data binary file**, e.g. `xyz.complex.float32`
  Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an iq-tar file.

Optionally, an iq-tar file can contain the following file:

- **I/Q preview XSLT file**, e.g. `open_IqTar_xml_file_in_web_browser.xslt`
  Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.
  A sample stylesheet is available at http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt.

C.1 I/Q Parameter XML File Specification

The content of the I/Q parameter XML file must comply with the XML schema `RsIqTar.xsd` available at: http://www.rohde-schwarz.com/file/RsIqTar.xsd.

In particular, the order of the XML elements must be respected, i.e. iq-tar uses an "ordered XML schema". For your own implementation of the iq-tar file format make sure to validate your XML file against the given schema.

The following example shows an I/Q parameter XML file. The XML elements and attributes are explained in the following sections.

Sample I/Q parameter XML file: xyz.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl"
href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1"
xsi:noNamespaceSchemaLocation="RsIqTar.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Name>R&S ZNL</Name>
  <Comment>Here is a comment</Comment>
  <DateTime>2011-01-24T14:02:49</DateTime>
  <Samples>68751</Samples>
  <Clock unit="Hz">6.5e+006</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
<DataFilename>xyz.complex.float32</DataFilename>
<UserData>
  <UserDefinedElement>Example</UserDefinedElement>
</UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>
```

Element	Description
RS_IQ_TAR_File-Format	The root element of the XML file. It must contain the attribute `fileFormatVersion` that contains the number of the file format definition. Currently, `fileFormatVersion` "2" is used.
Name	Optional: describes the device or application that created the file.
Comment	Optional: contains text that further describes the contents of the file.
DateTime	Contains the date and time of the creation of the file. Its type is `xs:dateTime` (see `RsIqTar.xsd`).

Element	Description
Samples	Contains the number of samples of the I/Q data. For multi-channel signals all channels have the same number of samples. One sample can be: • A complex number represented as a pair of I and Q values • A complex number represented as a pair of magnitude and phase values • A real number represented as a single real value See also `Format` element.
Clock	Contains the clock frequency in Hz, i.e. the sample rate of the I/Q data. A signal generator typically outputs the I/Q data at a rate that equals the clock frequency. If the I/Q data was captured with a signal analyzer, the signal analyzer used the clock frequency as the sample rate. The attribute `unit` must be set to "Hz".
Format	Specifies how the binary data is saved in the I/Q data binary file (see `DataFilename` element). Every sample must be in the same format. The format can be one of the following: • `complex`: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless • `real`: Real number (unitless) • `polar`: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires `DataType` = `float32` or `float64`
DataType	Specifies the binary format used for samples in the I/Q data binary file (see `DataFilename` element and Chapter C.2, "I/Q Data Binary File", on page 229). The following data types are allowed: • `int8`: 8 bit signed integer data • `int16`: 16 bit signed integer data • `int32`: 32 bit signed integer data • `float32`: 32 bit floating point data (IEEE 754) • `float64`: 64 bit floating point data (IEEE 754)
ScalingFactor	Optional: describes how the binary data can be transformed into values in the unit Volt. The binary I/Q data itself has no unit. To get an I/Q sample in the unit Volt the saved samples have to be multiplied by the value of the `ScalingFactor`. For polar data only the magnitude value has to be multiplied. For multi-channel signals the `ScalingFactor` must be applied to all channels. The attribute `unit` must be set to "`V`". The `ScalingFactor` must be > 0. If the `ScalingFactor` element is not defined, a value of 1 V is assumed.
NumberOfChannels	Optional: specifies the number of channels, e.g. of a MIMO signal, contained in the I/Q data binary file. For multi-channels, the I/Q samples of the channels are expected to be interleaved within the I/Q data file (see Chapter C.2, "I/Q Data Binary File", on page 229). If the `NumberOfChannels` element is not defined, one channel is assumed.
DataFilename	Contains the filename of the I/Q data binary file that is part of the iq-tar file. It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> • <xyz> = a valid Windows file name • <Format> = complex, polar or real (see `Format` element) • <Channels> = Number of channels (see `NumberOfChannels` element) • <Type> = float32, float64, int8, int16, int32 or int64 (see `DataType` element) Examples: • xyz.complex.1ch.float32 • xyz.polar.1ch.float64 • xyz.real.1ch.int16 • xyz.complex.16ch.int8

Element	Description
UserData	Optional: contains user, application or device-specific XML data which is not part of the iq-tar specification. This element can be used to store additional information, e.g. the hardware configuration. User data must be valid XML content.
PreviewData	Optional: contains further XML elements that provide a preview of the I/Q data. The preview data is determined by the routine that saves an iq-tar file (e.g. R&S ZNL). For the definition of this element refer to the `RsIqTar.xsd` schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet `open_IqTar_xml_file_in_web_browser.xslt` is available.

Example: ScalingFactor

Data stored as `int16` and a desired full scale voltage of 1 V

`ScalingFactor` = 1 V / maximum int16 value = 1 V / 2^{15} = 3.0517578125e-5 V

Scaling Factor	Numerical value	Numerical value x ScalingFactor
Minimum (negative) int16 value	- 2^{15} = - 32768	-1 V
Maximum (positive) int16 value	2^{15}-1= 32767	0.999969482421875 V

Example: PreviewData in XML

```
<PreviewData>
    <ArrayOfChannel length="1">
      <Channel>
        <PowerVsTime>
          <Min>
            <ArrayOfFloat length="256">
              <float>-134</float>
              <float>-142</float>
              ...
              <float>-140</float>
            </ArrayOfFloat>
          </Min>
          <Max>
            <ArrayOfFloat length="256">
              <float>-70</float>
              <float>-71</float>
              ...
              <float>-69</float>
            </ArrayOfFloat>
          </Max>
        </PowerVsTime>
        <Spectrum>
          <Min>
            <ArrayOfFloat length="256">
              <float>-133</float>
              <float>-111</float>
              ...
```

```
            <float>-111</float>
          </ArrayOfFloat>
        </Min>
        <Max>
          <ArrayOfFloat length="256">
            <float>-67</float>
            <float>-69</float>
            ...
            <float>-70</float>
            <float>-69</float>
          </ArrayOfFloat>
        </Max>
      </Spectrum>
      <IQ>
        <Histogram width="64" height="64">0123456789...0</Histogram>
      </IQ>
    </Channel>
  </ArrayOfChannel>
</PreviewData>
```

C.2 I/Q Data Binary File

The I/Q data is saved in binary format according to the format and data type specified in the XML file (see `Format` element and `DataType` element). To allow reading and writing of streamed I/Q data, all data is interleaved, i.e. complex values are interleaved pairs of I and Q values and multi-channel signals contain interleaved (complex) samples for channel 0, channel 1, channel 2 etc. If the `NumberOfChannels` element is not defined, one channel is presumed.

Example: Element order for real data (1 channel)

```
I[0],                       // Real sample 0
I[1],                       // Real sample 1
I[2],                       // Real sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

```
I[0], Q[0],                 // Real and imaginary part of complex sample 0
I[1], Q[1],                 // Real and imaginary part of complex sample 1
I[2], Q[2],                 // Real and imaginary part of complex sample 2
...
```

Example: Element order for complex polar data (1 channel)

```
Mag[0], Phi[0],             // Magnitude and phase part of complex sample 0
Mag[1], Phi[1],             // Magnitude and phase part of complex sample 1
Mag[2], Phi[2],             // Magnitude and phase part of complex sample 2
...
```

Example: Element order for complex cartesian data (3 channels)

Complex data: I[channel no][time index], Q[channel no][time index]

```
I[0][0], Q[0][0],            // Channel 0, Complex sample 0
I[1][0], Q[1][0],            // Channel 1, Complex sample 0
I[2][0], Q[2][0],            // Channel 2, Complex sample 0

I[0][1], Q[0][1],            // Channel 0, Complex sample 1
I[1][1], Q[1][1],            // Channel 1, Complex sample 1
I[2][1], Q[2][1],            // Channel 2, Complex sample 1

I[0][2], Q[0][2],            // Channel 0, Complex sample 2
I[1][2], Q[1][2],            // Channel 1, Complex sample 2
I[2][2], Q[2][2],            // Channel 2, Complex sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

This example demonstrates how to store complex cartesian data in float32 format using MATLAB®.

```
% Save vector of complex cartesian I/Q data, i.e. iqiqiq...
N = 100
iq = randn(1,N)+1j*randn(1,N)
fid = fopen('xyz.complex.float32','w');
for k=1:length(iq)
  fwrite(fid,single(real(iq(k))),'float32');
  fwrite(fid,single(imag(iq(k))),'float32');
end
fclose(fid)
```

List of Commands

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