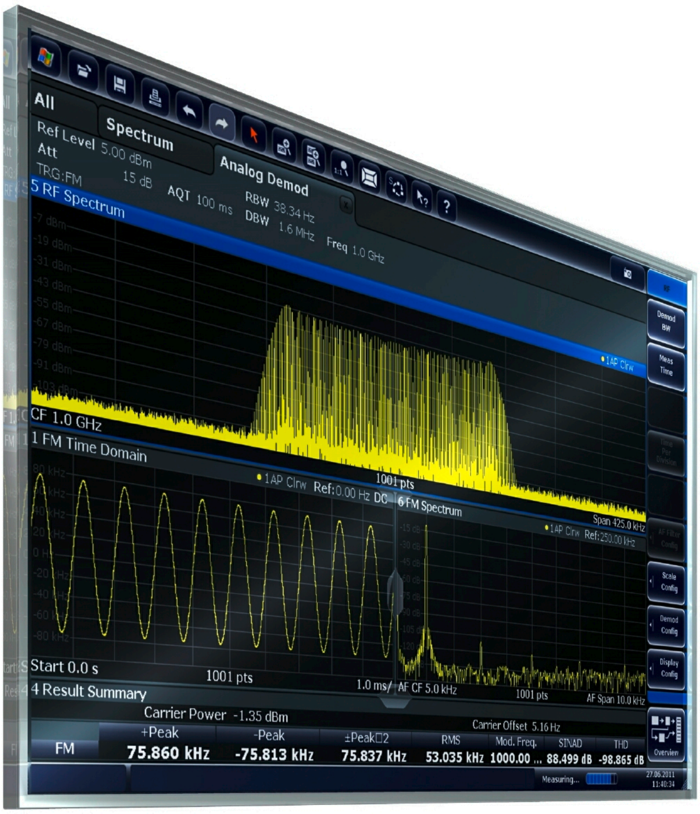
R&S®FSWP-K7
Analog Demodulation
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following R&S®FSWP models with firmware version 1.11 or higher:

- R&S®FSWP8 (1322.8003K08)
- R&S®FSWP26 (1322.8003K26)
- R&S®FSWP50 (1322.8003K50)

The following firmware options are described:

- R&S FSWP-K7 (1325.4238.02) (requires R&S FSWP-B1)

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The following abbreviations are used throughout this manual: R&S®FSWP is abbreviated as R&S FSWP. R&S MultiView is abbreviated as MultiView. Products of the R&S®SMW family, e.g. R&S®SMW200A, are abbreviated as R&S SMW.

Contents

1 Welcome to the Analog Demodulation Application

The R&S FSWP-K7 AM/FM/PM measurement demodulator option converts the R&S FSWP into an analog modulation analyzer for amplitude-, frequency- or phase-modulated signals. It measures not only characteristics of the useful modulation, but also factors such as residual FM or synchronous modulation.

The R&S FSWP Analog Demodulation application features:

- AM, FM, and PM demodulation, with various result displays:
  - Modulation signal versus time
  - Spectrum of the modulation signal (FFT)
  - RF signal power versus time
  - Spectrum of the RF signal
- Determining maximum, minimum and average or current values in parallel over a selected number of measurements
- Maximum accuracy and temperature stability due to sampling (digitization) already at the IF and digital down-conversion to the baseband (I/Q)
- Error-free AM to FM conversion and vice versa, without deviation errors, frequency response or frequency drift at DC coupling
- Relative demodulation, in relation to a user-defined or measured reference value

Availability of the Analog Demodulation application

Using the Analog Demodulation application requires the optional Spectrum Analyzer hardware (R&S FSWP-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 FSWP User Manual. The latest version is available for download at the product homepage

(http://www2.rohde-schwarz.com/product/FSWP.html).

Installation

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

1.1 Starting the Analog Demodulation Application

Analog Demodulation is a separate application on the R&S FSWP.

To activate the Analog Demodulation application

1. Select the MODE key.

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

2. Select the "Analog Demodulation" item.

   The R&S FSWP opens a new measurement channel for the Analog Demodulation application.

The measurement is started immediately with the default settings. It can be configured in the Analog Demodulation Configuration Overview dialog box, which is displayed when you select the "Overview" softkey from any menu.

Multiple Measurement Channels and Sequencer Function

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

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

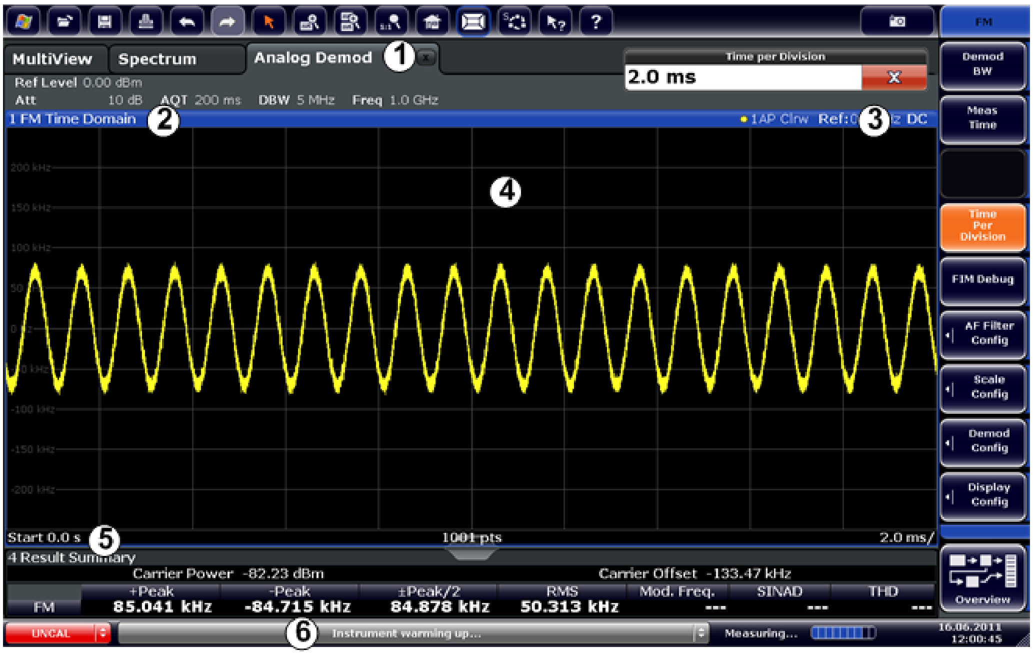
Only one measurement can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

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

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

1.2 Understanding the Display Information

The following figure shows a measurement diagram during an Analog Demodulation measurement. All different information areas are labeled. They are explained in more detail in the following sections.



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

MSRA operating mode

In MSRA operating mode, additional tabs and elements are available. A colored background of the screen behind the measurement channel tabs indicates that you are in MSRA operating mode.

For details on the MSRA operating mode see the R&S FSWP MSRA User Manual.

Channel bar information

In the Analog Demodulation application, the R&S FSWP shows the following settings:

Table 1-1: Information displayed in the channel bar in the Analog Demodulation application

Ref Level	Reference level
m.+el.Att	Mechanical and electronic RF attenuation
Offset	Reference level offset
AQT	Measurement time for data acquisition.
RBW	Resolution bandwidth
DBW	Demodulation bandwidth
Freq	Center frequency for the RF signal

Window title bar information

For each diagram, the header provides the following information:

Figure 1-1: Window title bar information in the Analog Demodulation application

1 = Window number
2 = Modulation type
3 = Trace color
4 = Trace number
5 = Detector
6 = Trace mode
7 = Reference value (at the defined reference position)
8 = AF coupling (AC/DC), only in AF time domains, if applicable
9 = Results are selected for demodulation output

Diagram footer information

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

RF Spectrum		
CF: Center frequency of input signal	Sweep points	Span: measured span

RF Time domain		
CF: Center frequency of input signal	Sweep points	Time per division

AF Spectrum		
AF CF: center frequency of demodulated signal	Sweep points	AF Span: evaluated span

AF Time domain		
CF: Center frequency of input signal	Sweep points	Time per division

For most modes, the number of sweep points shown in the display are indicated in the diagram footer. In zoom mode, the (rounded) number of currently displayed points are indicated.

Status bar information

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

2 Measurements and Result Displays

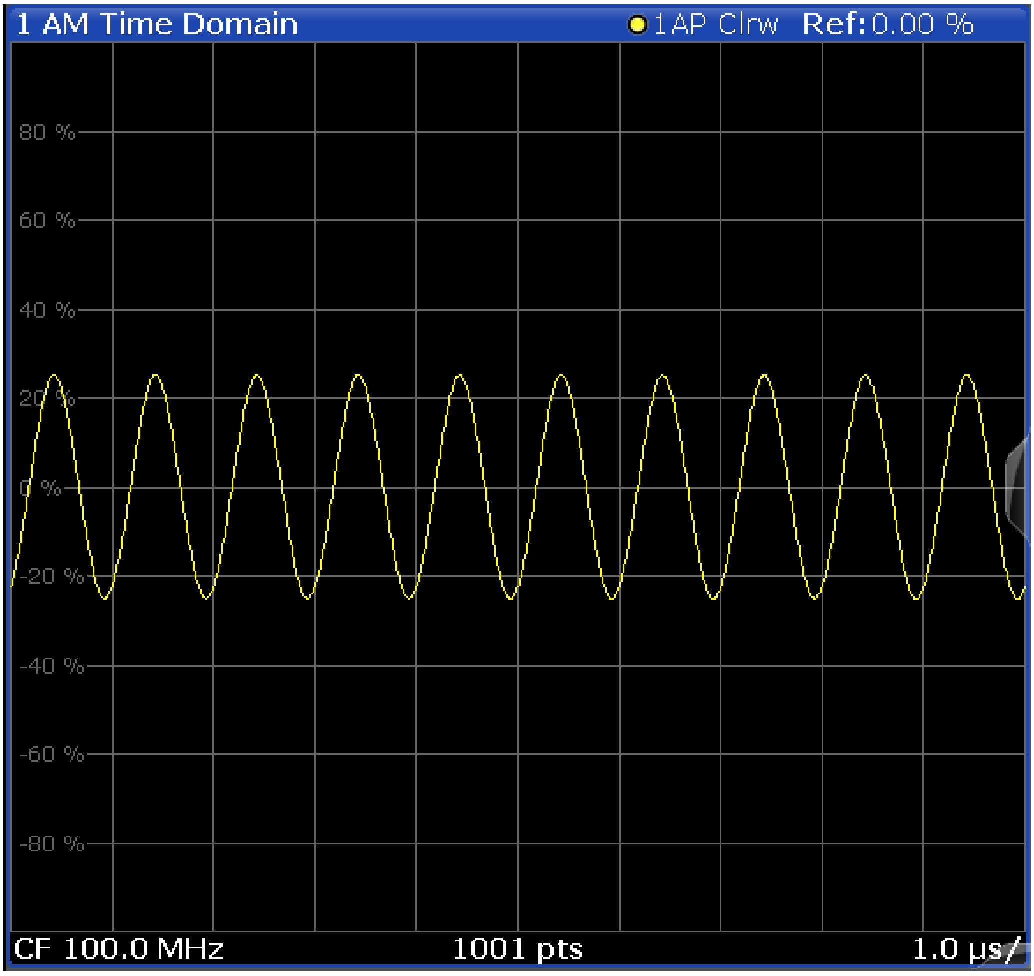
The data that was measured by the R&S FSWP can be evaluated using various different methods. In the Analog Demodulation application, up to six evaluation methods can be displayed simultaneously in separate windows. The results can be displayed as absolute deviations or relative to a reference value or level.

The abbreviation "AF" (for Audio Frequency) refers to the demodulated AM, FM or PM signal.

Basis for evaluation

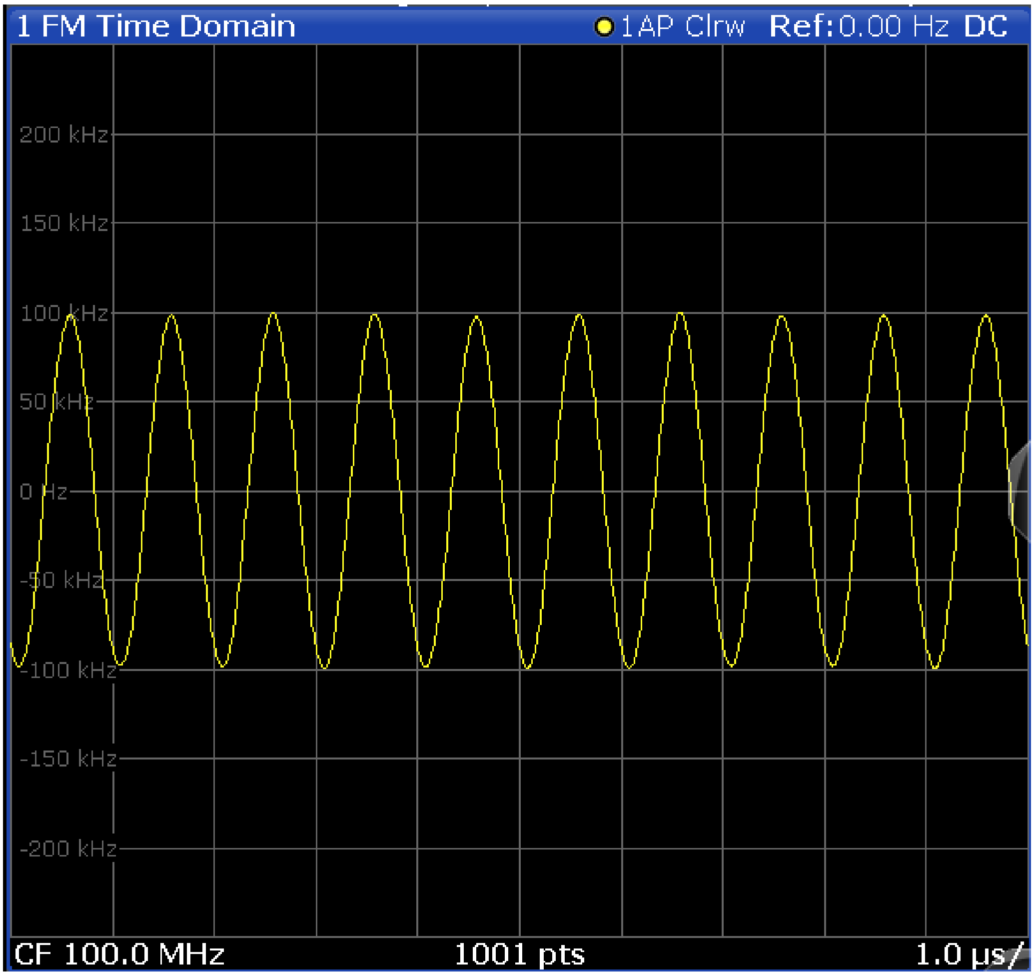
All evaluations are based on the I/Q data set acquired during the measurement. The spectrum of the modulated signal to be evaluated is determined by the demodulation bandwidth. However, it can be restricted to a limited span ("AF Span") if only part of the signal is of interest. Furthermore, the time base for evaluations in the time domain can be restricted to analyze a smaller extract in more detail, see Chapter 3.6, "Time Domain Zoom", on page 24.

AM Time Domain
Displays the modulation depth of the demodulated AM signal (in %) versus time.



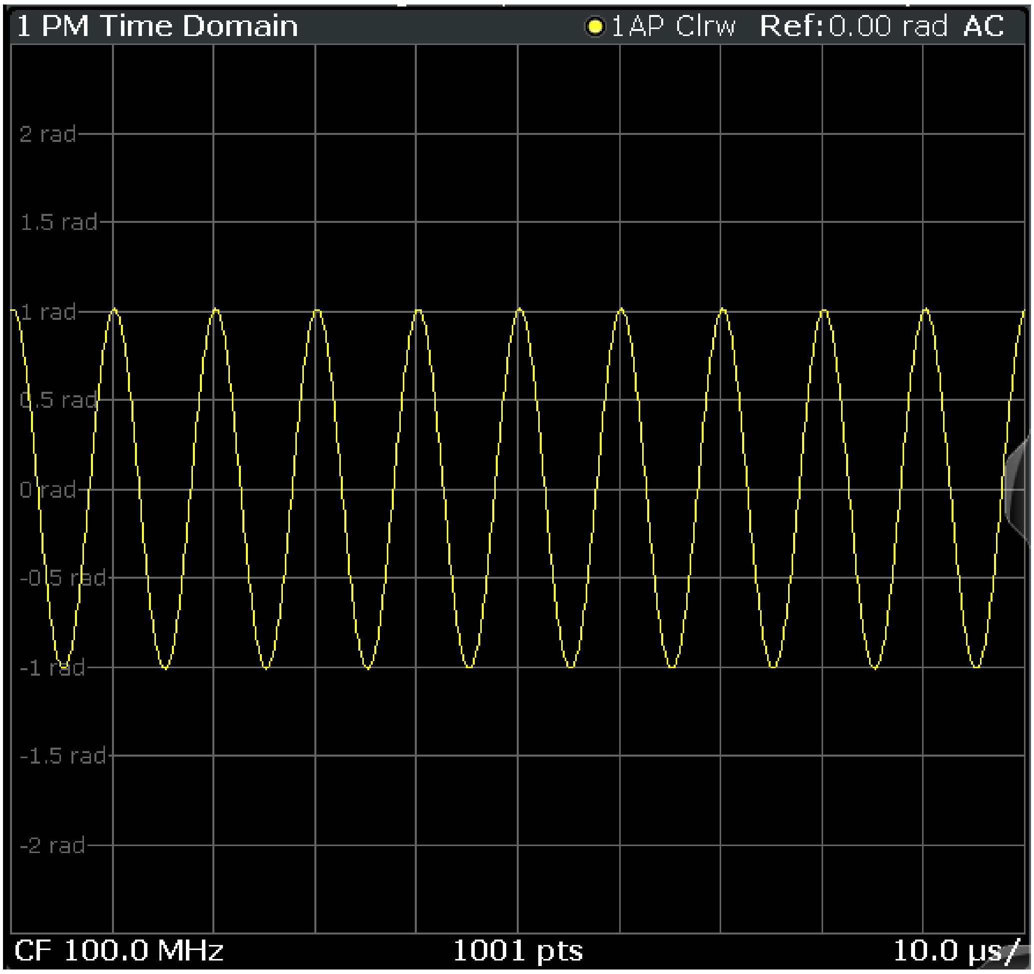
Remote command:
`LAY:ADD? '1',RIGH,'XTIM:AM:REL'`
(See `LAYout:ADD[:WINDow]?` on page 134)

FM Time Domain
Displays the frequency spectrum of the demodulated FM signal versus time.



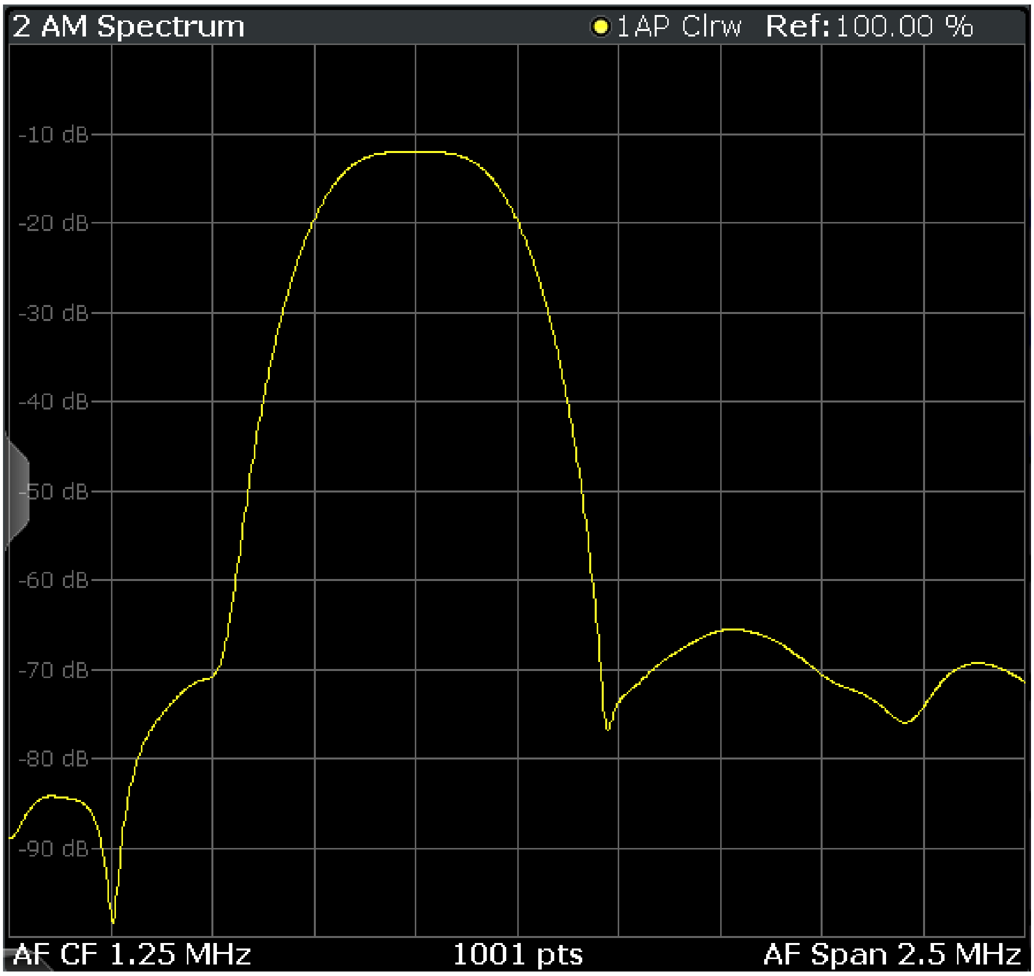
Remote command:
`LAY:ADD? '1',RIGH,'XTIM:FM'`
(See `LAYout:ADD[:WINDow]?` on page 134)

PM Time Domain
Displays the phase deviations of the demodulated PM signal (in rad or °) versus time.



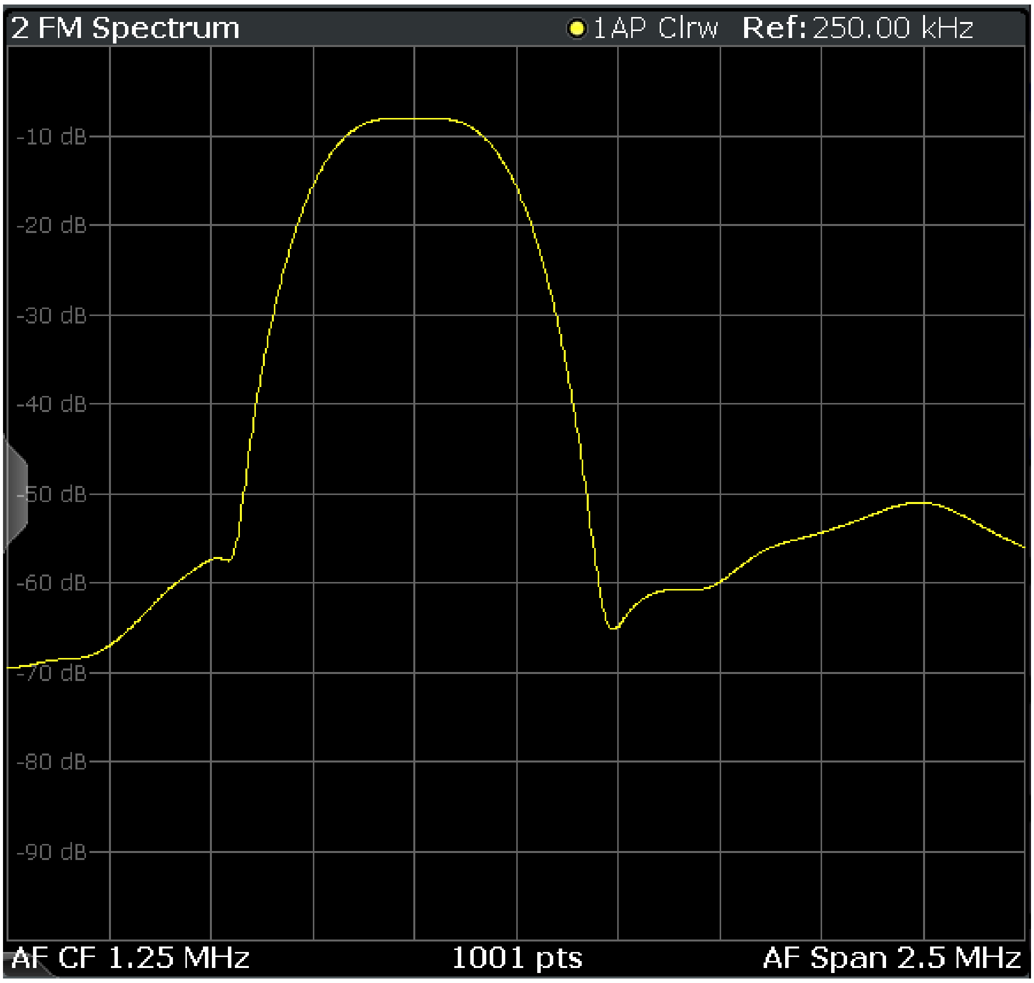
Remote command:
`LAY:ADD? '1',RIGH,'XTIM:PM'`
(See `LAYout:ADD[:WINDow]?` on page 134)

AM Spectrum
Displays the modulation depth of the demodulated AM signal (in % or dB) versus AF span. The spectrum is calculated from the demodulated AM signal in the time domain via FFT.



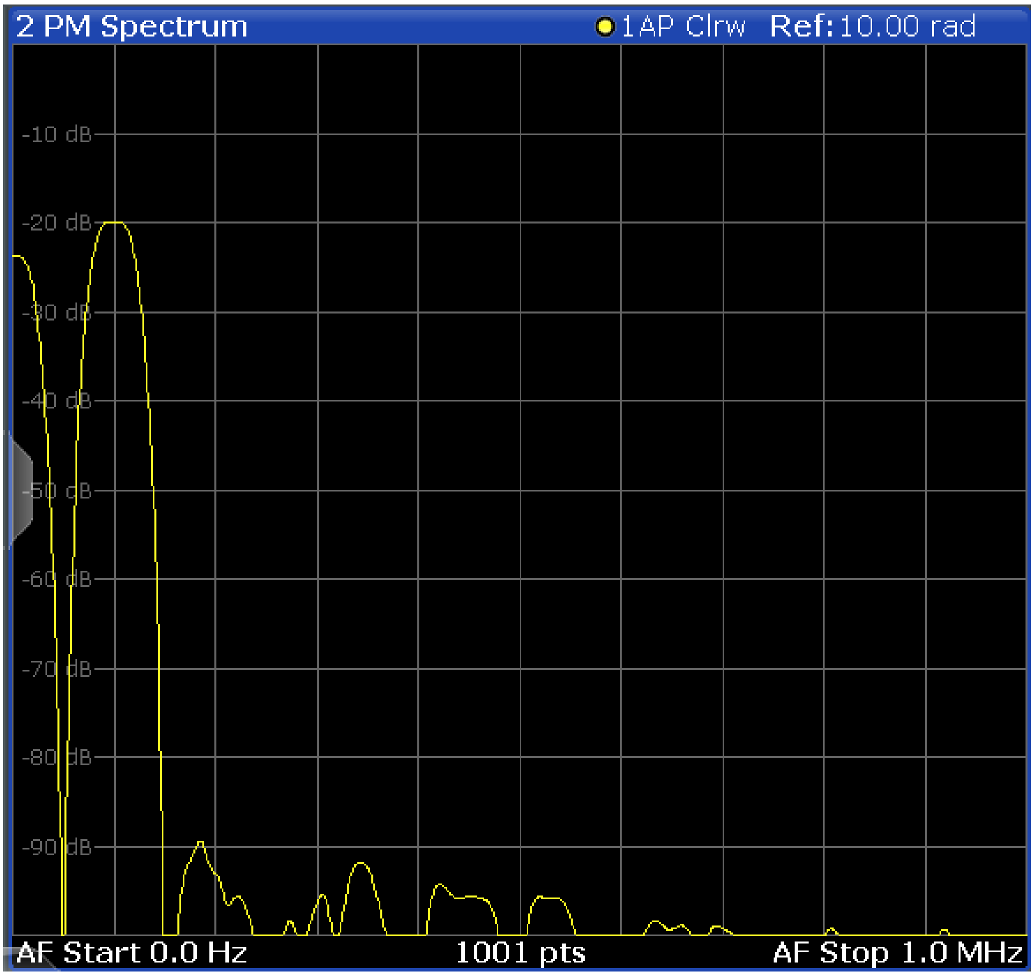
Remote command:
`LAY:ADD? '1',RIGH,'XTIMe:AM:REL:AFSPectrum1'`
(see `LAYout:ADD[:WINDow]?` on page 134)

FM Spectrum
Displays the frequency deviations of the demodulated FM signal (in Hz or dB) versus AF span. The spectrum is calculated from the demodulated AM signal in the time domain via FFT.



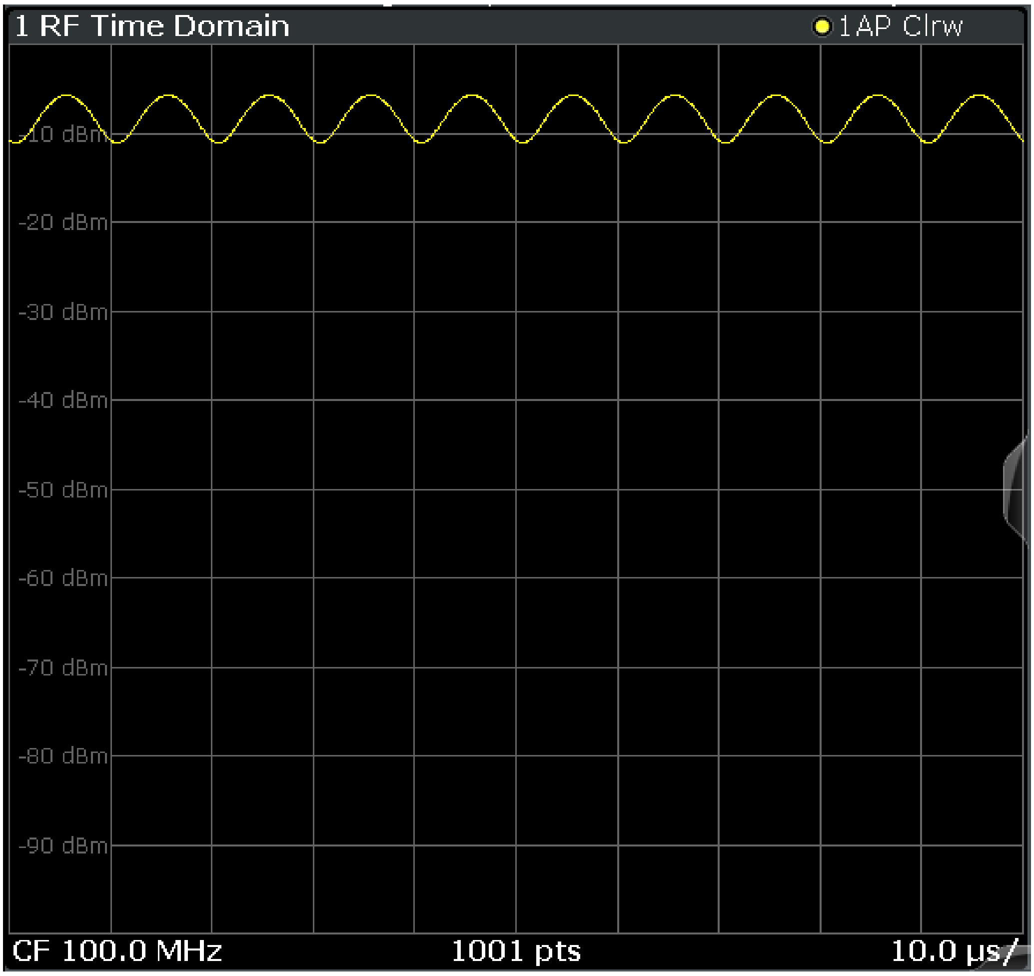
Remote command:
`LAY:ADD? '1',RIGH,'XTIMe:FM:AFSPectrum1'`
(see `LAYout:ADD[:WINDow]?` on page 134)

PM Spectrum
Displays the phase deviations of the demodulated PM signal (in rad, ° or dB) versus AF span. The spectrum is calculated from the demodulated AM signal in the time domain via FFT.



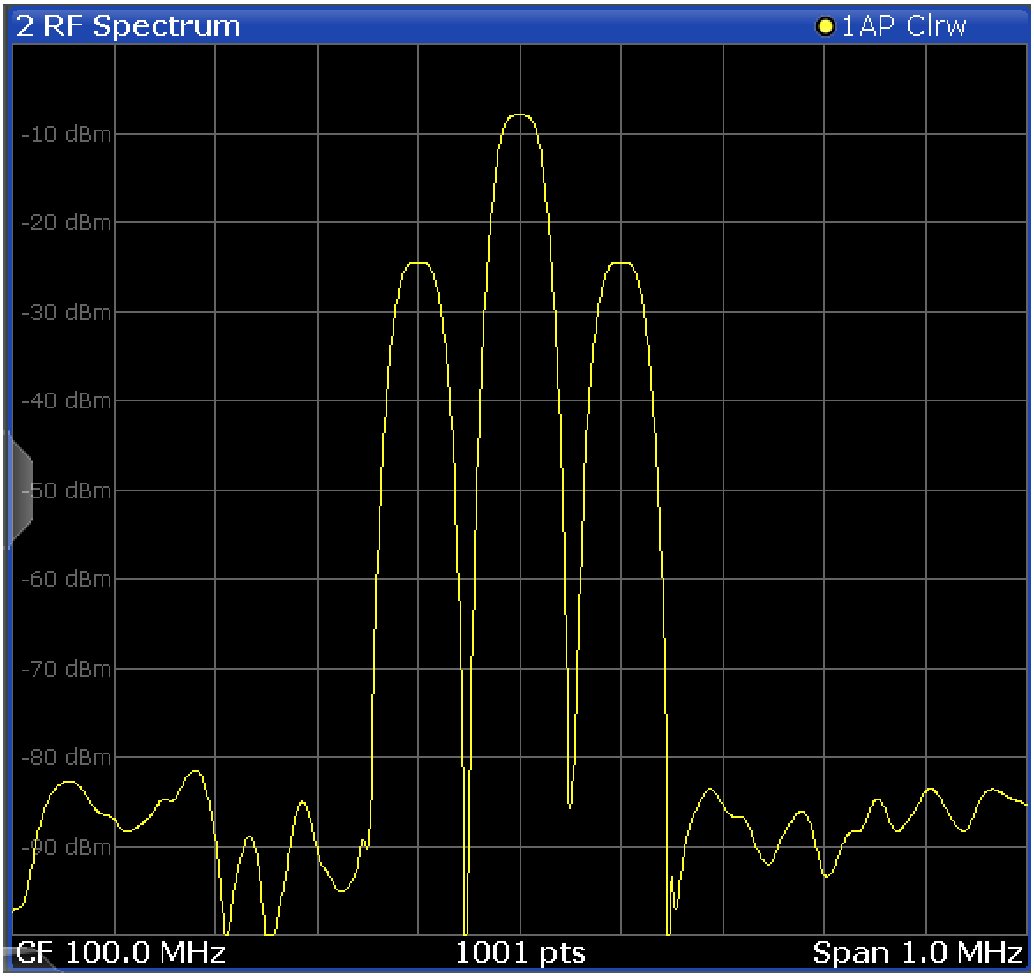
Remote command:
`LAY:ADD? '1',RIGH,'XTIMe:PM:AFSPectrum1'`
(see `LAYout:ADD[:WINDow]?` on page 134)

RF Time Domain
Displays the RF power of the input signal versus time. The level values represent the magnitude of the I/Q data set.



Remote command:
`LAY:ADD? '1',RIGH,'XTIM:AM'`
(see `LAYout:ADD[:WINDow]?` on page 134)

RF Spectrum
Displays the spectrum of the input signal. In contrast to the Spectrum application, the frequency values are determined using FFT from the recorded I/Q data set.



Remote command:

`LAY:ADD? '1',RIGH,'XTIM:SPECTRUM'`

(see `LAYout:ADD[:WINDow]?` on page 134)

Result Summary

The result summary displays the results of the demodulation functions for all windows in a table.

For each demodulation, the following information is provided:

Table 2-1: Result summary description

Label	Description
+Peak	Positive peak (maximum)
-Peak	Negative peak (minimum)
+/-Peak/2	Average of positive and negative peaks
RMS	Root Mean Square value

Label	Description
Mod Freq	Modulation frequency
SINAD	Signal-to-noise-and-distortion (Calculated only if AF Spectrum is displayed) Measures the ratio of the total power to the power of noise and harmonic distortions. The noise and harmonic power is calculated inside the AF spectrum span. The DC offset is removed before the calculation. $SINAD[dB] = 20 \cdot \log\left[\frac{\text{total power}}{\text{noise} + \text{distortion power}}\right]$
THD	Total harmonic distortion The ratio of the harmonics to the fundamental and harmonics. All harmonics inside the AF spectrum span are considered up to the tenth harmonic. (Calculated only if AF Spectrum is displayed) $THD[dB] = 20 \cdot \log\left[\frac{\sqrt{\sum_{i=2}^{\infty} U_i^2}}{\sqrt{\sum_{i=1}^{\infty} U_i^2}}\right]$

Note: Relative demodulation results. Optionally, the demodulation results in relation to user-defined or measured reference values are determined. See Chapter 4.8.6, "Result Table Settings", on page 61.

In addition, the following general information for the input signal is provided:

- Carrier Power: the power of the carrier without modulation
- Carrier Offset: the deviation of the calculated carrier frequency to the ideal carrier frequency
- Modulation Depth (AM or RF Time Domain only): the difference in amplitude the carrier signal is modulated with

Remote command:
`LAY:ADD? '1',RIGH,RSUM`, see `LAYout:ADD[:WINDow]?` on page 134
Results:
`CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:PM[:RESult<t>]?` on page 145
`CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:PM[:RESult<t>]:RELative?` on page 145

Marker Table

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

This table may be displayed automatically if configured accordingly.

Type	Shows the marker type and number ("M" for a normal marker, "D" for a delta marker).
Ref	Shows the reference marker a delta marker refers to.

Trace	Shows the trace the marker is positioned on.
X- / Y-Value	Shows the marker coordinates (usually frequency and level).

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 134
Results:
`CALCulate<n>:MARKer<m>:X` on page 148
`CALCulate<n>:MARKer<m>:Y?` on page 149

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.

2 Marker Peak List

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

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

Remote command:
`LAY:ADD? '1',RIGH, PEAK`, see `LAYout:ADD[:WINDow]?` on page 134
Results:
`CALCulate<n>:MARKer<m>:X` on page 148
`CALCulate<n>:MARKer<m>:Y?` on page 149

3 Measurement Basics

Some background knowledge on basic terms and principles used in Analog Demodulation measurements is provided here for a better understanding of the required configuration settings.

3.1 Demodulation Process

The demodulation process is shown in Figure 3-1. All calculations are performed simultaneously with the same I/Q data set. Magnitude (= amplitude) and phase of the complex I/Q pairs are determined. The frequency result is obtained from the differential phase.

For details on general I/Q data processing in the R&S FSWP, refer to the reference part of the I/Q Analysis remote control description in the R&S FSWP User Manual.

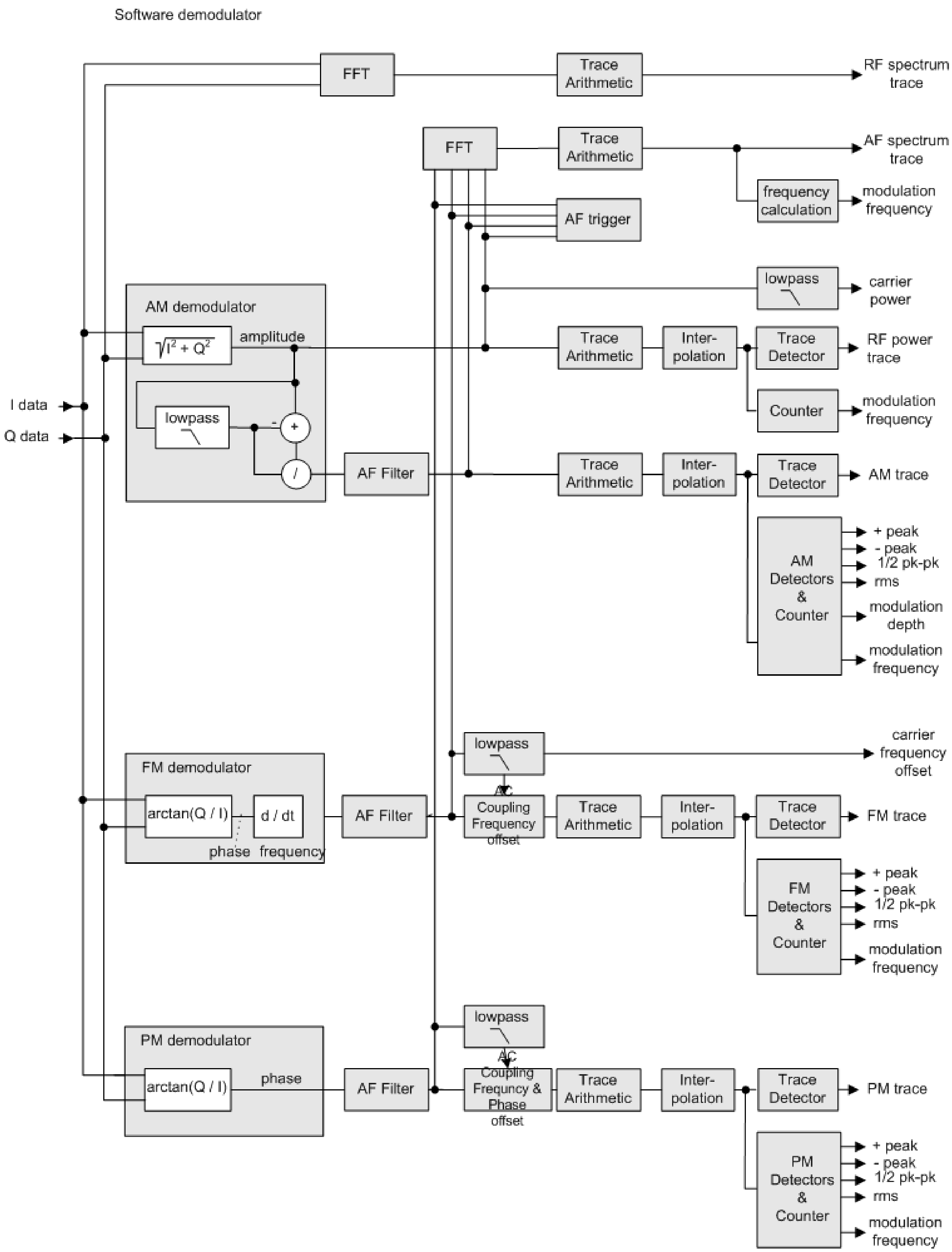


Figure 3-1: Block diagram of software demodulator

The AM DC, FM DC and PM DC raw data of the demodulators is fed into the "Trace Arithmetic" block that combines consecutive data sets. Possible trace modes are: Clear Write, Max Hold, Min Hold and Average. The output data of the "Trace Arithmetic" block can be read via remote control (`[SENS:]ADEM:<evaluation>:RES?`, see `[SENSe:]ADEMod:AM[:ABSolute][:TDOMain]:RESult?` on page 142.

The collected measured values are evaluated by the selected detector. The result is displayed on the screen and can be read out via remote control.

In addition, important parameters are calculated:

- A counter determines the modulation frequency for AM, FM, and PM.
- average power = carrier power (RF power)
- average frequency = carrier frequency offset (FM)
- The modulation depth or the frequency or phase deviation; the deviations are determined from the trace data

AC coupling is possible with FM and PM display.

3.2 Demodulation Bandwidth

The demodulation bandwidth determines the span of the signal that is demodulated. It is not the 3 dB bandwidth of the filter but the useful bandwidth which is distortion-free with regard to phase and amplitude.

Therefore the following formulas apply:

- AM: demodulation bandwidth ≥ 2 x modulation frequency
- FM: demodulation bandwidth ≥ 2 x (frequency deviation + modulation frequency)
- PM: demodulation bandwidth ≥ 2 x modulation frequency x (1 + phase deviation)

If the center frequency of the analyzer is not set exactly to the signal frequency, the demodulation bandwidth must be increased by the carrier offset, in addition to the requirement described above. This also applies if FM or PM AC coupling has been selected.

In general, the demodulation bandwidth should be as narrow as possible to improve the S/N ratio. The residual FM caused by noise floor and phase noise increases dramatically with the bandwidth, especially with FM.

For help on determining the adequate demodulation bandwidth see "Determining the demodulation bandwidth" on page 80.

A practical example is described in Chapter 8, "Measurement Example: Demodulating an FM Signal", on page 74.

3.3 Sample Rate and Demodulation Bandwidth

The maximum demodulation bandwidths that can be obtained during the measurement, depending on the sample rate, are listed in the tables below for different demodulation filter types. The allowed value range of the measurement time and trigger offset depends on the selected demodulation bandwidth and demodulation filter. If the AF filter or the AF trigger are not active, the measurement time increases by 20 %.

A maximum of 24 million samples can be captured, assuming sufficient memory is available; thus the maximum measurement time can be determined according to the following formula:

$Meas.time_{max} = Sample\ count_{max} / sample\ rate$

The minimum trigger offset is ($-Meas.time_{max}$)

Large numbers of samples

Principally, the R&S FSWP can handle up to 1.6 million samples. However, when 480001 samples are exceeded, all traces that are not currently being displayed in a window are deactivated to improve performance. The traces can only be activated again when the samples are reduced.

Effects of measurement time on the stability of measurement results

Despite amplitude and frequency modulation, the display of carrier power and carrier frequency offset is stable.

This is achieved by a digital filter which sufficiently suppresses the modulation, provided, however, that the measurement time is ≥ 3 x 1 / modulation frequency, i.e. that at least three periods of the AF signal are recorded.

The mean carrier power for calculating the AM is also calculated with a digital filter that returns stable results after a measurement time of ≥ 3 x 1 / modulation frequency, i.e. at least three cycles of the AF signal must be recorded before a stable AM can be shown.

3.4 AF Triggers

The Analog Demodulation application allows triggering to the demodulated signal. The display is stable if a minimum of five modulation periods are within the recording time.

Triggering is always DC-coupled. Therefore triggering is possible directly to the point where a specific carrier level, phase or frequency is exceeded or not attained.

3.5 AF Filters

Additional filters applied after demodulation help filter out unwanted signals, or correct pre-emphasized input signals. A CCITT filter allows you to evaluate the signal by simulating the characteristics of human hearing.

3.6 Time Domain Zoom

For evaluations in the time domain, the demodulated data for a particular time span can be extracted and displayed in more detail using the "Time Domain Zoom" function. This is useful if the measurement time is very large and thus each sweep point represents a large time span. The time domain zoom function distributes the available sweep points only among the time span defined by the zoom area length. The time span displayed per division of the diagram is decreased. Thus, the display of the extracted time span becomes more precise.

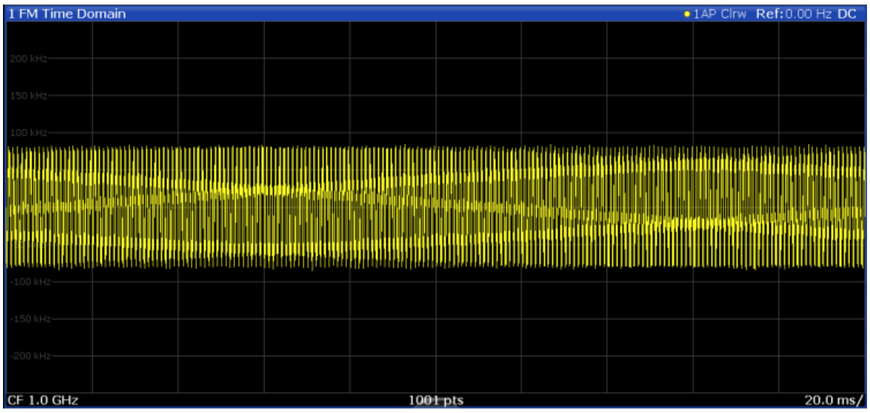


Figure 3-2: FM time domain measurement with a very long measurement time (200 ms)

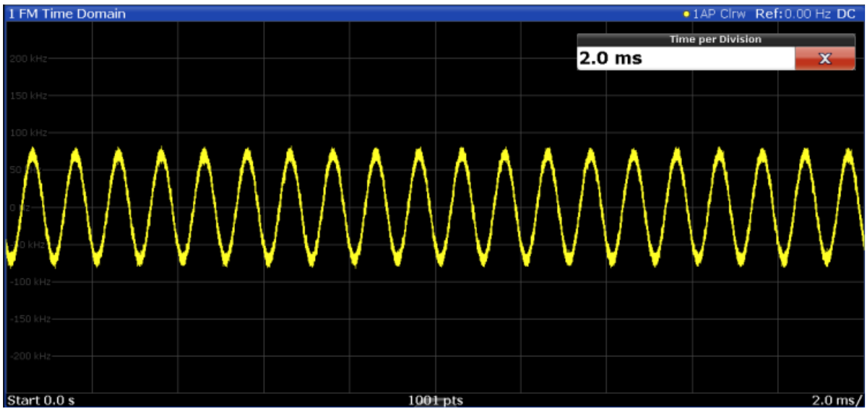
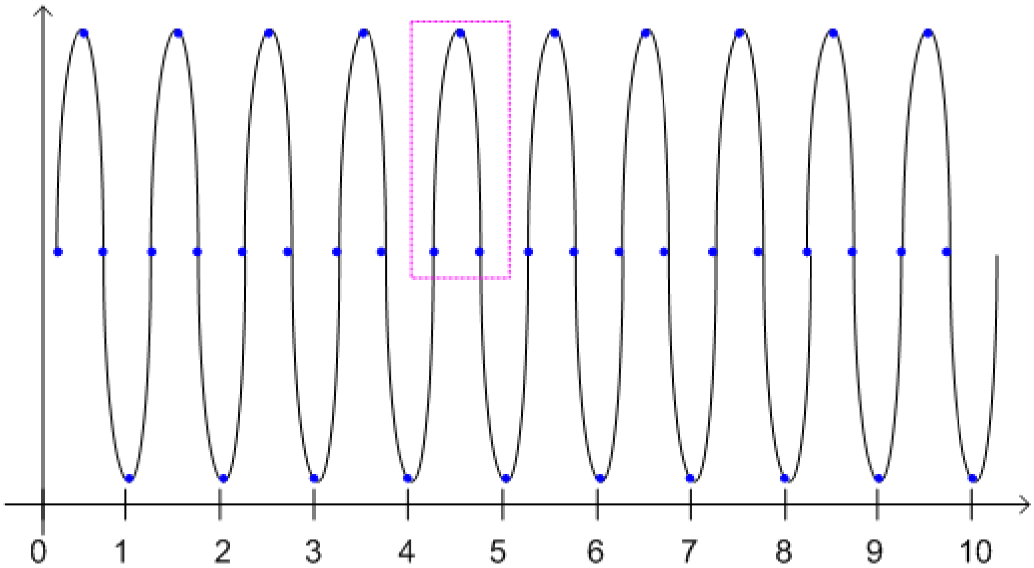
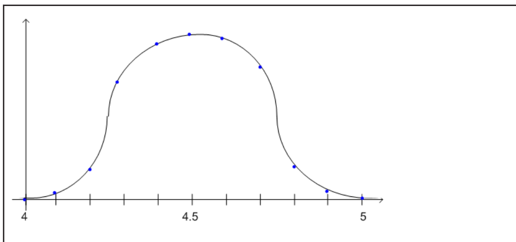
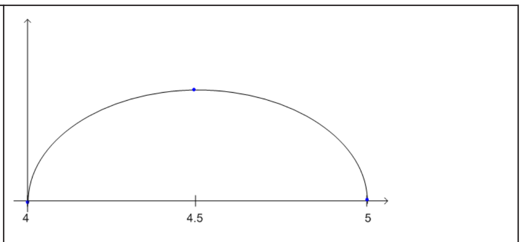


Figure 3-3: FM time domain measurement with time domain zoom (2.0 ms per division)

The time domain zoom area affects not only the diagram display, but the entire evaluation for the current window.

In contrast to the time domain zoom, the graphical zoom is available for all diagram evaluations. However, the graphical zoom is useful only if more measured values than trace points are available. The (time) span represented by each measurement point remains the same.



	
Time domain zoom	Graphical zoom

3.7 Analog Demodulation in MSRA Operating Mode

The Analog Demodulation application can also be used to analyze data in MSRA operating mode.

In MSRA operating mode, only the MSRA Master actually captures data; the data acquisition settings for an Analog Demodulation application channel in MSRA mode configure the **analysis interval**, not an actual data capture from the input signal.

In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval for Analog Demodulation.

The currently used analysis interval (in seconds, related to measurement start) is indicated in the window header for each result display.

Analysis line

A frequent question when analyzing multi-standard signals is how each data channel is correlated (in time) to others. Thus, an analysis line has been introduced. The analysis line is a common time marker for all MSRA applications. It can be positioned in any MSRA application or the MSRA Master and is then adjusted in all other applications. Thus, you can easily analyze the results at a specific time in the measurement in all applications and determine correlations.

If the marked point in time is contained in the analysis interval of the application, the line is indicated in all time-based result displays, such as time, symbol, slot or bit diagrams. By default, the analysis line is displayed, however, it can be hidden from view manually. In all result displays, the "AL" label in the window title bar indicates whether or not the analysis line lies within the analysis interval or not:

- **orange "AL"**: the line lies within the interval
- **white "AL"**: the line lies within the interval, but is not displayed (hidden)
- **no "AL"**: the line lies outside the interval

For details on the MSRA operating mode see the R&S FSWP MSRA User Manual.

4 Configuration

The optional application for analog demodulation measurements is an application, which you activate using the MODE key on the front panel. The Analog Demodulation application requires the optional Spectrum application.

When you activate the Analog Demodulation application, a Analog Demodulation measurement for the input signal is started automatically with the default configuration. It can be configured in the Analog Demodulation "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu.

The main configuration settings and dialog boxes are also available via the "Analog Demod" menu which is displayed when you press the MEAS CONFIG key.

Predefined settings

For commonly performed measurements, standard setup files are provided for quick and easy configuration. Simply load an existing standard settings file and, if necessary, adapt the measurement settings to your specific requirements.

For an overview of predefined standards and settings see Chapter A.1, "Predefined Standards and Settings", on page 156.

4.1 Configuration According to Digital Standards

Various predefined settings files for common digital standards are provided for use with the Analog Demodulation application. In addition, you can create your own settings files for user-specific measurements.

For details on which settings are defined and an overview of predefined standards see Chapter A.1, "Predefined Standards and Settings", on page 156.

Digital standard settings are available via the "Digital Standards" softkey in the MEAS menu or the "Overview".

Setup Standard

Opens a file selection dialog box to select a predefined setup file. The predefined settings are configured in the R&S FSWP Analog Demodulation application. This allows for quick and easy configuration for commonly performed measurements.

Selecting the Storage Location - Drive/ Path/ Files ← Setup Standard

Select the storage location of the settings file on the instrument or an external drive.

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

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

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

The default storage location for the settings files is:
`C:\R_S\Instr\user\predefined\AdemodPredefined`.

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

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

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

File Name ← Setup Standard

Contains the name of the data file without the path or extension.

For details on the file name and location see the "Data Management" topic in the R&S FSWP User Manual.

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

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

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

Load Standard ← Setup Standard

Loads the selected measurement settings file.

Remote command:
[SENSe:]ADEMod<n>:PRESet[:STANdard] on page 84

Save Standard ← Setup Standard
Saves the current measurement settings for a specific standard as a file with the defined name.

Remote command:
[SENSe:]ADEMod<n>:PRESet:STORe on page 85

Delete Standard ← Setup Standard
Deletes the selected standard. Standards predefined by Rohde & Schwarz can also be deleted. A confirmation query is displayed to avoid unintentional deletion of the standard.

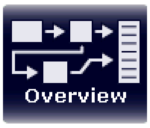
Note: Restoring predefined standard files. The standards predefined by Rohde & Schwarz available at the time of delivery can be restored using the "Restore Standards" function (see "Restore Standard Files" on page 29).

Restore Standard Files ← Setup Standard
Restores the standards predefined by Rohde & Schwarz available at the time of delivery.

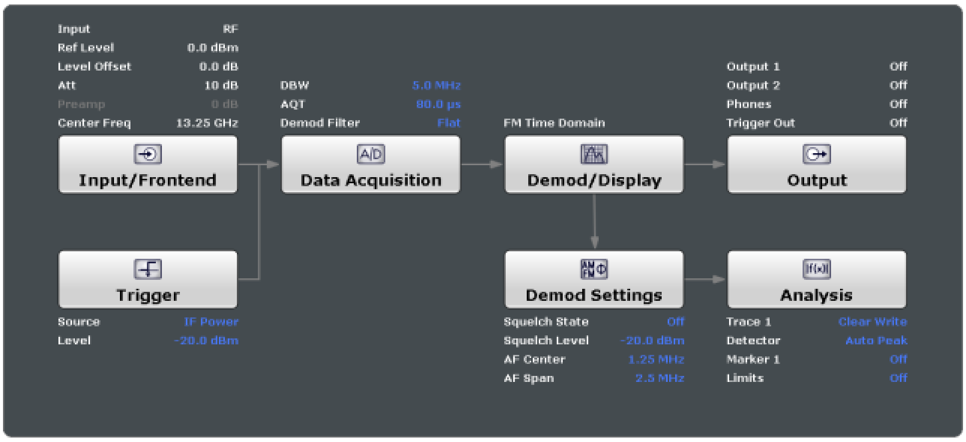
Note that this function will overwrite customized standards that have the same name as predefined standards.

Remote command:
[SENSe:]ADEMod<n>:PRESet:RESTore on page 85

4.2 Configuration Overview



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



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. Thus, you can easily configure an entire Analog

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

To configure settings

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

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 84

Setup Standard
Opens a file selection dialog box to select a predefined setup file. See "Setup Standard" on page 28.

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

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

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

4.3 Data Input and Output

The R&S FSWP can analyze signals from different input sources and provide various types of output (such as video or trigger signals).

4.3.1 RF Input

The default input source for the R&S FSWP is "Radio Frequency", i.e. the signal at the RF INPUT connector on the front panel of the R&S FSWP.

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

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

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

Remote command:
`INPut:COUPling` on page 86

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

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

This value also affects the unit conversion.

Remote command:
`INPut:IMPedance` on page 87

YIG-Preselector
Activates or deactivates the YIG-preselector, if available on the R&S FSWP.

An internal YIG-preselector at the input of the R&S FSWP ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. In order to use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FSWP, which may lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 87

High-Pass Filter 1...3 GHz
Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer in order to measure the harmonics for a DUT, for example.

This function requires an additional hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 86

4.3.2 Power Sensors

Controlling external generators is available with the optional External Generator Control.

For more information about using external generators, refer to the User Manual of the optional R&S FSWP Spectrum application.

4.3.3 External Generators

Controlling external generators is available with the optional External Generator Control.

For more information about using external generators, refer to the User Manual of the R&S FSWP.

4.3.4 Configuring Additional Outputs

The R&S FSWP provides additional outputs that you can use for various tasks.

The remote commands required to configure the outputs are described in Chapter 10.2.2.3, "Configuring Outputs", on page 87.

IF/Video Output

Defines the type of signal available at the IF/VIDEO/DEMOD on the rear panel of the R&S FSWP.

"IF" The measured IF value is available at the IF/VIDEO/DEMOD output connector.

"VIDEO" The displayed video signal (i.e. the filtered and detected IF signal) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output.

Remote command:
`OUTPut:IF[:SOURce]` on page 89

IF (Wide) Out Frequency

Defines or indicates the frequency at which the IF signal level is provided at the IF/VIDEO/DEMOD connector if IF/Video Output is set to "IF".

Note: The IF output frequency of the **IF WIDE OUTPUT** connector cannot be defined manually, but is determined automatically depending on the center frequency. It is indicated in this field when the IF WIDE OUTPUT connector is used. For details on the used frequencies see the data sheet.

Remote command:
`OUTPut:IF:IFFRequency` on page 89

Noise Source

Switches the supply voltage for an external noise source on or off.

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

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 88

Trigger 1/2

Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 1": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

Note: Providing trigger signals as output is described in detail in the R&S FSWP User Manual.

"Input" The signal at the connector is used as an external trigger source by the R&S FSWP. Trigger input parameters are available in the "Trigger" dialog box.

"Output" The R&S FSWP sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Note: For offline AF or RF triggers, no output signal is provided.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 90
`OUTPut:TRIGger<port>:DIRection` on page 90

Output Type ← Trigger 1/2
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSWP triggers.

"Trigger Armed" Sends a (high level) trigger when the R&S FSWP is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when user selects "Send Trigger" button.
In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 90

Level ← Output Type ← Trigger 1/2
Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 90

Pulse Length ← Output Type ← Trigger 1/2
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 91

Send Trigger ← Output Type ← Trigger 1/2
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 91

4.3.5 Analog Demodulation Output Settings

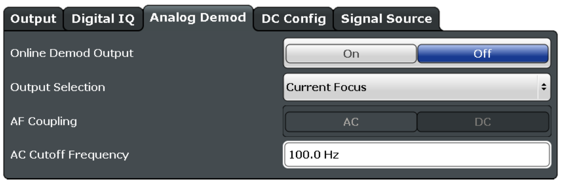
Access: "Overview" ≥ "Output" > "Analog Demod"

The demodulated signal in time domain results can be output to the IF/VIDEO/DEMOD output connector on the R&S FSWP.

The following settings and functions are available to configure the output in the Analog Demodulation application.

Note that the audio frequency (AF) filter settings used for demodulation also apply to the online output. However, a maximum of two high pass, low pass or deemphasis filters can be active at the same time if analog demodulation output is active.

(See Chapter 4.8.3, "AF Filter", on page 54)



Online Demodulation Output State

Enables or disables online demodulation output. If enabled, the demodulated audio frequencies are output to the IF/VIDEO/DEMOD output connector on the rear panel of the R&S FSWP.

Remote command:
`OUTPut:ADEMod[:ONLine][:STATe]` on page 89

Output Selection

Selects the result display whose results are output. Only time domain results can be selected. All currently active time domain result displays are listed.

"Current Focus" dynamically switches to the currently selected window. Thus you can easily change the output signal simply by selecting the windows in the display. If a window is selected that does not contain a time-domain result display, the selection is ignored and the previous setting is maintained.

The result display currently used for output is indicated by a "Demod Out" label in the window title bar.

Remote command:
`OUTPut:ADEMod[:ONLine]:SOURce` on page 88

AF Coupling

Controls the automatic correction of the frequency offset and phase offset of the input signal:

This function is only available for FM or PM time domain evaluations.

- FM time evaluation
  If DC is selected, the absolute frequency is displayed, i.e. an input signal with an offset relative to the center frequency is not displayed symmetrically with respect to the zero line.
  If AC is selected, the frequency offset is automatically corrected, i.e. the trace is always symmetric with respect to the zero line.
- PM time evaluation
  If DC is selected, the phase runs according to the existing frequency offset. In addition, the DC signal contains a phase offset of ± π.

If AC is selected, the frequency offset and phase offset are automatically corrected, i.e. the trace is always symmetric with respect to the zero line.

Remote command:
`[SENSe:]ADEMod<n>:AF:COUPling` on page 116

AC Cutoff Frequency
Defines the cutoff frequency for the AC highpass filter (for AC coupling only, see AF Coupling).

Note that the audio frequency (AF) filter settings used for demodulation also apply to the online output.

(See Chapter 4.8.3, "AF Filter", on page 54)

Remote command:
`OUTPut:ADEMod[:ONLine]:AF[:CFRequency]` on page 88

4.3.6 DC Power Output

The configuration of the DC Power supply is the same as in the Phase Noise application.

For a comprehensive description, please refer to the R&S FSWP User Manual.

4.3.7 Signal Source Output

The configuration of the optional Signal Source is the same as in the Phase Noise application.

For a comprehensive description, please refer to the R&S FSWP User Manual.

4.4 Amplitude

The amplitude is configured in the "Amplitude" tab of the "Input" dialog box.

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

► To display this dialog box, do one of the following:
  - Select the "Input/Frontend" button in the Analog Demodulation "Overview" and switch to the "Amplitude" tab.
  - Select the AMPT key and then the "Amplitude Config" softkey.

The remote commands required to define these settings are described in Chapter 10.2.3, "Configuring Level Characteristics", on page 91.

Functions to configure level characteristics described elsewhere:
- "Input Coupling" on page 31
- "Impedance" on page 31

Reference Level

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

The reference level is also 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 FSWP is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level to ensure an optimum measurement (no compression, good signal-to-noise ratio).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 92

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 FSWP so the application shows correct power results. All displayed power level results will be shifted by this value.

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

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

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 92

Unit ← Reference Level

The R&S FSWP measures the signal voltage at the RF input.

In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input impedance (50 Ω or 75 Ω, see "Impedance" on page 31), conversion to other units is possible.

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

Remote command:
INPut:IMPedance on page 87
CALCulate<n>:UNIT:POWer on page 92

Setting the Reference Level Automatically (Auto Level) ← Reference Level
Automatically determines a reference level which ensures that no overload occurs at the R&S FSWP 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 FSWP.

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

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meastime Manual)" on page 65).

Remote command:
[SENSe:]ADJust:LEVel on page 94

Attenuation Mode / Value
The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). This ensures that the optimum RF attenuation is always used. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1 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:ATTenuation on page 93
INPut:ATTenuation:AUTO on page 93

Preamplifier
If the (optional) Preamplifier hardware is installed, a preamplifier can be activated for the RF input signal.

You can use a preamplifier to analyze signals from DUTs with low input power.

For R&S FSWP26 or higher models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSWP8, the following settings are available:

"Off"	Deactivates the preamplifier.
"15 dB"	The RF input signal is amplified by about 15 dB.
"30 dB"	The RF input signal is amplified by about 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 94
`INPut:GAIN[:VALue]` on page 93

4.5 Frequency

The center frequency of the input signal is configured in the "Frequency" tab of the "Input/Frontend" dialog box.

► To display this dialog box, do one of the following:
- Select the "Input/Frontend" button in the Analog Demodulation "Overview" and switch to the "Frequency" tab.
- Select the FREQ key and then the "Frequency Config" softkey.

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 95

Center Frequency Stepsize
Defines the step size of the center frequency. The step size can be coupled to the demodulation bandwidth, or it can be manually set to a fixed value.

"0.1 * Demod BW"	Sets the step size for the center frequency to 10 % of the demodulation bandwidth. This is the default setting.
"0.5 * Demod BW"	Sets the step size for the center frequency to 50 % of the demodulation bandwidth.
"X * Demod BW"	Sets the step size for the center frequency to a manually defined factor of the demodulation bandwidth. The "X-Factor" defines the percentage of the demodulation bandwidth. Values between 1 and 100 % in steps of 1 % are allowed. The default setting is 10 %.
"= Center"	Sets the step size to the value of the center frequency and removes the coupling of the step size to the demodulation bandwidth. 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:LINK` on page 95
`[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor` on page 96
`[SENSe:]FREQuency:CENTer:STEP` on page 95

4.6 Trigger Configuration

Triggering means to capture the interesting part of the signal. Choosing the right trigger type and configuring all trigger settings correctly allows you to detect various incidents in your demodulated signals.

Optionally, the trigger signal used by the R&S FSWP can be output to a connected device, and an external trigger signal from a connected device can be used by the R&S FSWP.

For more information, please refer to the description of the documentation of the optional Spectrum application.

4.6.1 Trigger Source Settings

The trigger source settings are configured in the "Trigger Source" tab of the "Trigger" dialog box.

Trigger Source

In the Analog Demodulation application, the next measurement can be triggered if the selected input signal exceeds the threshold specified using the "Trigger Level" setting (see "Trigger Level" on page 42). Thus, a periodic signal modulated onto the carrier frequency can be displayed. It is recommended that the measurement time covers at least five periods of the audio signal.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 101

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

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

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 101

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

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

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

"External Trigger 1"
Trigger signal from the TRIGGER 1 INPUT / OUTPUT connector.
(front panel)

"External Trigger 2"
Trigger signal from the TRIGGER 2 INPUT / OUTPUT connector.
(rear panel)
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 1/2" on page 33).

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
See `TRIGger[:SEQuence]:SOURce` on page 101

I/Q Power ← Trigger Source
Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

The trigger bandwidth corresponds to the resolution bandwidth setting for data acquisition (see "Resolution Bandwidth" on page 46).

Remote command:
`TRIG:SOUR IQP`, see `TRIGger[:SEQuence]:SOURce` on page 101

IF Power ← Trigger Source
The R&S FSWP 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.

The available trigger levels depend on the RF attenuation and preamplification. A reference level offset, if defined, is also considered.

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

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 101

FM / AM / PM / RF (Offline) ← Trigger Source
Triggers when the demodulated input signal exceeds the trigger level.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 101

Time ← Trigger Source
Triggers in a specified repetition interval.

Remote command:
`TRIG:SOUR TIME`, see `TRIGger[:SEQuence]:SOURce` on page 101

RF Power ← Trigger Source
Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose the instrument uses a level detector at the first intermediate frequency.

The input signal must be in the frequency range between 500 MHz and 8 GHz.

The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels see the instrument's data sheet.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement may be aborted and a message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 101

Trigger Level
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 100
`TRIGger[:SEQuence]:LEVel:IQPower` on page 100
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 99
`TRIGger[:SEQuence]:LEVel:RFPower` on page 100
`TRIGger[:SEQuence]:LEVel:AM:RELative` on page 99
`TRIGger[:SEQuence]:LEVel:AM[:ABSolute]` on page 98
`TRIGger[:SEQuence]:LEVel:FM` on page 99
`TRIGger[:SEQuence]:LEVel:PM` on page 100

Trigger Offset

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

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

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 98

Hysteresis

Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Settting 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 98

Drop-Out Time

Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 97

Slope

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.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 101

Trigger Holdoff

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 97

4.6.2 Trigger Input and Output Settings

The trigger input and output settings are configured in the "Trigger In/Out" tab of the "Trigger" dialog box, or in the "Outputs" configuration dialog box (via the INPUT/ OUTPUT key).

Trigger 1/2
Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 1": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

Note: Providing trigger signals as output is described in detail in the R&S FSWP User Manual.

"Input"	The signal at the connector is used as an external trigger source by the R&S FSWP. Trigger input parameters are available in the "Trigger" dialog box.
"Output"	The R&S FSWP sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector. **Note:** For offline AF or RF triggers, no output signal is provided.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 90
`OUTPut:TRIGger<port>:DIRection` on page 90

Output Type ← Trigger 1/2
Type of signal to be sent to the output

"Device Triggered"	(Default) Sends a trigger when the R&S FSWP triggers.
"Trigger Armed"	Sends a (high level) trigger when the R&S FSWP is in "Ready for trigger" state. This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low level signal at the AUX port (pin 9).
"User Defined"	Sends a trigger when user selects "Send Trigger" button. In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 90

Level ← Output Type ← Trigger 1/2
Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 90

Pulse Length ← Output Type ← Trigger 1/2
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 91

Send Trigger ← Output Type ← Trigger 1/2
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 91

4.7 Data Acquisition

How data is to be acquired and then demodulated is configured in the "Data Acquisition" dialog box.

MSRA operating mode

In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. The data acquisition settings for the Analog Demodulation application in MSRA mode define the analysis interval.

For details on the MSRA operating mode see the R&S FSWP MSRA User Manual.

4.7.1 Bandwidth Settings

The bandwidth settings define which parts of the input signal are acquired and then demodulated. They are configured via the BW key or in the "Bandwidth" tab of the "Data Acquisition" dialog box.

► To display this dialog box, do one of the following:
  - Select the "Data Acquisition" button in the Analog Demodulation "Overview"
  - Select the BW key and then the "Bandwidth Config" softkey.

Demodulation Bandwidth

Defines the demodulation bandwidth of the measurement. The demodulation bandwidth determines the sample rate with which the input signal is captured and analyzed.

For recommendations on finding the correct demodulation bandwidth see Chapter 3.2, "Demodulation Bandwidth", on page 22.

For details on the relation between demodulation bandwidth and sample rate refer to Chapter 3.3, "Sample Rate and Demodulation Bandwidth", on page 23.

Remote command:
`[SENSe:]BANDwidth|BWIDth:DEMod` on page 113

Demodulation Filter
Defines the filter to be used for demodulation.

For details on sample rates, measurement times and trigger offsets for various demodulation bandwidths when using a Gaussian filter, see Chapter 3.3, "Sample Rate and Demodulation Bandwidth", on page 23.

"Flat"	Default
"Gauss"	Optimizes the settling behaviour of the filter

Remote command:
`[SENSe:]BANDwidth|BWIDth:DEMod:TYPE` on page 113

Measurement Time (AQT)
Defines how long data is acquired for demodulatation.

Remote command:
`[SENSe:]ADEMod<n>:MTIMe` on page 110

Capture Offset
This setting is only available for applications in **MSRA operating mode**. It has a similar effect as the trigger offset in other measurements: it defines the time offset between the capture buffer start and the start of the extracted application data.

In MSRA mode, the offset must be a positive value, as the capture buffer starts at the trigger time = 0.

For details on the MSRA operating mode see the R&S FSWP MSRA User Manual.

Remote command:
`[SENSe:]MSRA:CAPTure:OFFSet` on page 113

Resolution Bandwidth
Defines the resolution bandwidth for data acquisition. The available range is specified in the data sheet.

Remote command:
`[SENSe:]BANDwidth[:RESolution]` on page 113

4.7.2 Sweep Settings

The sweep settings define how often data from the input signal is acquired and then demodulated. They are configured via the SWEEP key or in the "Sweep" tab of the "Data Acquisition" dialog box.

► To display this dialog box, do one of the following:
- Select the "Data Acquisition" button in the Analog Demodulation "Overview" and switch to the "Sweep" tab.
- Select the SWEEP key and then the "Sweep Config" softkey.

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

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

Remote command:
`INITiate<n>:CONTinuous` on page 107

Single Sweep/ RUN SINGLE

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

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

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

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

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

Remote command:
`INITiate<n>[:IMMediate]` on page 110

Continue Single Sweep

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

Remote command:
`INITiate<n>:CONMeas` on page 107

Measurement Time (AQT)
Defines how long data is acquired for demodulatation.

Remote command:
`[SENSe:]ADEMod<n>:MTIMe` on page 110

Sweep Points
Defines the number of measured values to be collected during one sweep.

All values from 101 to 100001 can be set. The default value is 1001 sweep points.

Remote command:
`[SENSe:]SWEep:POINts` on page 114

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

The sweep count is applied to all the traces in all 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 measurements. For sweep count =1, no averaging, maxhold or minhold operations are performed.

Remote command:
`[SENSe:]SWEep:COUNt` on page 114

4.8 Demodulation

Access: "Overview" > "Demod Settings"

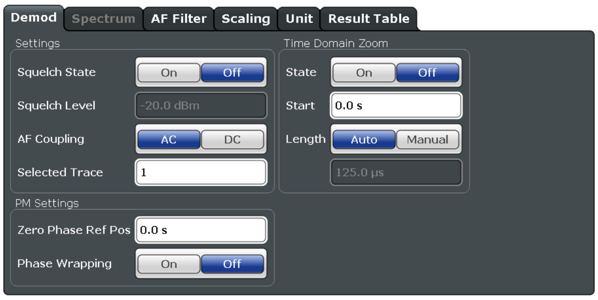
or: "Meas Setup" > "Demod"

4.8.1 Basic Demodulation Measurement Parameters (Demod)

Access: "Overview" > "Demod Settings" > "Demod"

or: "Meas Setup" > "Demod" > "Demod" tab

The basic demodulation measurement parameters define how the measurement is performed.



Squelch State
Activates the squelch function, i.e. if the signal falls below a defined threshold, the demodulated data is automatically set to 0. This is useful, for example, to avoid demodulation noise during transmission breaks.

Remote command:
`[SENSe:]ADEMod<n>:SQUelch[:STATe]` on page 116

Squelch Level
Defines the level threshold below which the demodulated data is set to 0 if squelching is enabled. The squelch level is an absolute value.

Remote command:
`[SENSe:]ADEMod<n>:SQUelch:LEVel` on page 117

AF Coupling
Controls the automatic correction of the frequency offset and phase offset of the input signal:

This function is only available for FM or PM time domain evaluations.

- FM time evaluation

If DC is selected, the absolute frequency is displayed, i.e. an input signal with an offset relative to the center frequency is not displayed symmetrically with respect to the zero line.
If AC is selected, the frequency offset is automatically corrected, i.e. the trace is always symmetric with respect to the zero line.
- PM time evaluation
If DC is selected, the phase runs according to the existing frequency offset. In addition, the DC signal contains a phase offset of ± π.
If AC is selected, the frequency offset and phase offset are automatically corrected, i.e. the trace is always symmetric with respect to the zero line.

Remote command:
`[SENSe:]ADEMod<n>:AF:COUPling` on page 116

Selected Trace
Defines the trace used to determine the results in the Result Summary.

Time Domain Zoom
Using the time domain zoom, the demodulated data for a particular time span is extracted and displayed in more detail. This is useful if the measurement time is very large and thus each sweep point represents a large time span. The time domain zoom function distributes the available sweep points only among the time span defined by the zoom area length. The time span displayed per division of the diagram is decreased. Thus, the display of the extracted time span becomes more precise. Note that the time domain zoom area affects not only the diagram display, but the entire evaluation for the current window.

This function is only available for evaluations in the time domain.

Tip: In addition to the Time Domain Zoom, a graphical zoom is available for all diagram evaluations. However, the graphical zoom is useful only if more measured values than trace points are available. The (time) span represented by each measurement point remains the same.

State ← Time Domain Zoom
Activates or deactivates the time domain zoom mode.

"ON" Activates the time domain zoom.

"OFF" Deactivates the time domain zoom and restores the original display. If more measured values than measurement points are available, several measured values are combined in one measurement point according to the method of the selected trace detector.

Remote command:
`[SENSe:]ADEMod<n>:ZOOM[:STATe]` on page 118

Start ← Time Domain Zoom
Defines the start time for the time domain zoom area. For spectrum evaluations the start time is always 0.

Remote command:
[SENSe:]ADEMod<n>:ZOOM:STARt on page 118

Length ← Time Domain Zoom
Defines the length of the time domain zoom area. Enter the length as a time value manually, or use the "Auto" setting to set the length to the current number of sweep points automatically.

Remote command:
[SENSe:]ADEMod<n>:ZOOM:LENGth on page 117
[SENSe:]ADEMod<n>:ZOOM:LENGth:MODE on page 118

Time per Division ← Time Domain Zoom
Enables the "Time Domain Zoom" function and defines the zoom area length in one step. The width of the zoom display is divided into 10 divisions; thus, by entering the time that is displayed in each division, you indirectly define the zoom area length ("Time per Division" * 10). The starting point of the zoom area is determined automatically. To specify the starting point manually, use the Start setting.

The "Time per Division" softkey is available from the main "Analog Demodulation" menu.

Zero Phase Reference Position (PM Time Domain only)
Defines the position at which the phase of the PM-demodulated signal is set to 0 rad. The entry is made with respect to time. In the default setting, the first measured value is set to 0 rad.

This setting is only available for PM time domain displays with DC coupling.

Remote command:
[SENSe:]ADEMod<n>:PM:RPOint[:X] on page 116

Phase Wrap On/Off (PM Time Domain only)
Activates/deactivates the phase wrap.

On	The phase is displayed in the range ±180° (± Π). For example, if the phase exceeds +180°, 360° is subtracted from the phase value, with the display thus showing >-180°.
Off	The phase is not wrapped.

This setting is only available for PM time domain displays with DC coupling.

4.8.2 Demodulation Spectrum

Access: "Overview" > "Demod Settings" > "Spectrum"

or: "Meas Setup" > "Demod" > "Spectrum" tab

The demodulation spectrum defines which span of the demodulated data is evaluated.

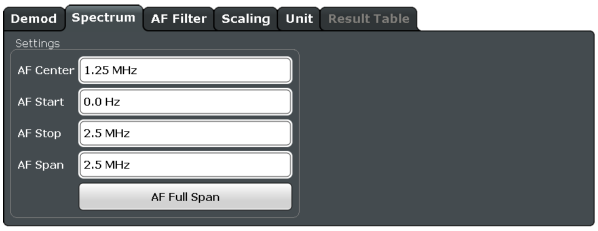
Depending on the evaluation (AF or RF display), the settings vary.

4.8.2.1 AF Evaluation

Access: "Overview" > "Demod Settings" > "Spectrum"

or: "Meas Setup" > "Demod" > "Spectrum" tab

These settings are only available for AF Spectrum evaluations, not in the time domain.



AF Center
Defines the center frequency of the demodulated data to evaluate.

Remote command:
`[SENSe:]ADEMod<n>:AF:CENTer` on page 120

AF Start
Defines the start frequency of the demodulated data to evaluate.

Remote command:
`[SENSe:]ADEMod<n>:AF:STARt` on page 121

AF Stop
Defines the stop frequency of the demodulated data to evaluate.

The maximum AF stop frequency corresponds to half the demodulation bandwidth.

Remote command:
`[SENSe:]ADEMod<n>:AF:STOP` on page 121

AF Span
Defines the span (around the center frequency) of the demodulated data to evaluate. The maximum span is DBW/2.

Remote command:
`[SENSe:]ADEMod<n>:AF:SPAN` on page 121

AF Full Span
Sets the span (around the center frequency) of the demodulated data to the maximum of DBW/2.

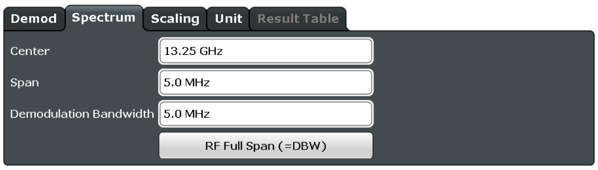
Remote command:
[SENSe:]ADEMod<n>:AF:SPAN:FULL on page 121

4.8.2.2 RF Evaluation

Access: "Overview" > "Demod Settings" > "Spectrum"

or: "Meas Setup" > "Demod" > "Spectrum" tab

These settings are only available for RF evaluation, both in time and frequency domain. Note that for RF data the center frequency and demodulation bandwidth correspond to the settings defined in the "Input" and "Data Acquisition" configuration.



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 95

Span

Defines the frequency span. The center frequency is kept constant. The following range is allowed:

span = 0: 0 Hz

span >0:

$span_{min} \leq f_{span} \leq f_{max}$

and f_{max}=DBW/2

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

Remote command:
[SENSe:]ADEMod<n>:SPECtrum:SPAN[:MAXimum] on page 122
[SENSe:]ADEMod<n>:SPEC:SPAN:ZOOM on page 122

Demodulation Bandwidth

Defines the demodulation bandwidth of the measurement. The demodulation bandwidth determines the sample rate with which the input signal is captured and analyzed.

For recommendations on finding the correct demodulation bandwidth see Chapter 3.2, "Demodulation Bandwidth", on page 22.

For details on the relation between demodulation bandwidth and sample rate refer to Chapter 3.3, "Sample Rate and Demodulation Bandwidth", on page 23.

Remote command:
[SENSe:]BANDwidth|BWIDth:DEMod on page 113

RF Full Span
Sets the span (around the center frequency) of the RF data to be evaluated to the demodulation bandwidth.

Remote command:
[SENSe:]ADEMod<n>:SPECtrum:SPAN[:MAXimum] on page 122

4.8.3 AF Filter

Access: "Overview" > "Demod Settings" > "AF Filter"

or: "Meas Setup" > "Demod" > "AF Filter" tab

The AF filter reduces the evaluated bandwidth of the demodulated signal and can define a weighting function.

AF filters are only available for AF time domain evaluations.

High Pass
Defines a high pass filter with the given limit to separate the DC component. The filters are indicated by the 3 dB cutoff frequency. The 50 Hz and 300 Hz filters are designed as 2nd-order Butterworth filter (12 dB/octave). The 20 Hz filter is designed as 3rd-order Butterworth filter (18 dB/octave).

The high pass filters are active in the following demodulation bandwidth range:

None	No AF Filter used (default)
20 Hz	100 Hz ≤ demodulation bandwidth ≤ 1.6 MHz
50 Hz:	200 Hz ≤ demodulation bandwidth ≤ 3 MHz

300 Hz:	800 Hz ≤ demodulation bandwidth ≤ 8 MHz
Manual:	A high pass filter with the manually defined frequency is used.

Remote command:
[SENSe:]FILTer<n>:HPASs[:STATe] on page 126
[SENSe:]FILTer<n>:HPASs:FREQuency[:ABSolute] on page 125
[SENSe:]FILTer<n>:HPASs:FREQuency:MANual on page 125

Low Pass

Defines a low pass filter type. Relative and absolute low pass filter are available.

- Absolute low pass filters:
  Absolute filters are indicated by the 3 dB cutoff frequency. The 3 kHz, 15 kHz and 23 kHz filters are designed as 5th-order Butterworth filters (30 dB/octave). The 150 kHz filter is designed as 8th-order Butterworth filter (48 dB/octave).
  The absolute low pass filters are active in the following demodulation bandwidth range:

Filter type	Demodulation bandwidth
3 kHz:	6.4 kHz ≤ demodulation bandwidth ≤ 3 MHz
15 kHz:	50 kHz ≤ demodulation bandwidth ≤ 8 MHz
23 kHz	50 kHz ≤ demodulation bandwidth ≤ 18 MHz
150 kHz:	400 kHz ≤ demodulation bandwidth ≤ 8 MHz
Manual:	A low pass filter with the manually defined frequency is used.

- Relative low pass filters:
  Relative filters (3 dB) can be selected in % of the demodulation bandwidth. The filters are designed as 5th-order Butterworth filter (30 dB/octave) and active for all demodulation bandwidths.
- "None" deactivates the AF low pass filter (default).

Remote command:
[SENSe:]FILTer<n>:LPASs[:STATe] on page 127
[SENSe:]FILTer<n>:LPASs:FREQuency[:ABSolute] on page 126
[SENSe:]FILTer<n>:LPASs:FREQuency:RELative on page 126
[SENSe:]FILTer<n>:LPASs:FREQuency:MANual on page 126

Weighting

Selects a weighting AF filter. By default, no weighting filter is active.

"A weighted" Switches on the A weighted filter. The weighting filter is active in the following demodulation bandwidth range:
100 kHz ≤ demodulation bandwidth ≤ 800 kHz

"CCITT" Switches on a CCITT P.53 weighting filter. The weighting filter is active in the following demodulation bandwidth range:
20 kHz ≤ demodulation bandwidth ≤ 3 MHz

"CCIR weighted"	Switches on the CCIR weighted filter. The weighting filter is active in the following demodulation bandwidth range: 100 kHz ≤ demodulation bandwidth ≤ 3.0 MHz
"CCIR unweighted"	Switches on the CCIR unweighted filter, which is the combination of the 20 Hz highpass and 23 kHz low pass filter. The weighting filter is active in the following demodulation bandwidth range: 50 kHz ≤ demodulation bandwidth ≤ 1.6 MHz

Remote command:
[SENSe:]FILTer<n>:CCIT on page 124
[SENSe:]FILTer<n>:CCIR:[:UNWeighted][:STATe] on page 124
[SENSe:]FILTer<n>:CCIR:WEIGhted[:STATe] on page 123
[SENSe:]FILTer<n>:AWEighted[:STATe] on page 123

Deemphasis

Activates a deemphasis filter with the given time constant.

Sometimes a modulated signal is extorted by a pre-emphasis filter before transmission, for example to eliminate frequencies that are more prone to interferences. In this case, the emphasis function must be reversed after demodulation. This is done by the deemphasis filter.

The deemphasis filter is active in the following demodulation bandwidth range:

25 µs:	25 kHz ≤ demodulation bandwidth ≤ 40 MHz
50 µs:	6.4 kHz ≤ demodulation bandwidth ≤ 18 MHz
75 µs:	6.4 kHz ≤ demodulation bandwidth ≤ 18 MHz
750 µs:	800 Hz ≤ demodulation bandwidth ≤ 3 MHz

Depending on the deemphasis filter, a minimum demodulation bandwidth is required for an error less than 0.5 dB, up to a maximum AF frequency. The following table shows the dependencies.

Deemphasis [us]	25 µs	50 µs	75 µs	750 µs
Max. AF frequency	25 kHz	12 kHz	8 kHz	800 Hz
Required demodulation bandwidth	≥ 200 kHz	≥ 100 kHz	≥ 50 kHz	≥ 6.4 kHz

For higher AF frequencies the demodulation bandwidth must be increased.

Remote command:
[SENSe:]FILTer<n>:DEMPhasis[:STATe] on page 125
[SENSe:]FILTer<n>:DEMPhasis:TCONstant on page 124

Deactivating all AF Filters

The "All Filter Off" button deactivates all AF filters for the selected evaluation.

Remote command:
[SENSe:]FILTer<n>:AOFF on page 123

4.8.4 Scaling

Access: "Overview" > "Demod Settings" > "Scaling"

or: "Meas Setup" > "Demod" > "Scaling" tab

The scaling parameters define the range of the demodulated data to be displayed.

4.8.4.1 AF Evaluation

Access: "Overview" > "Demod Settings" > "Scaling"

or: "Meas Setup" > "Demod" > "Scaling" tab

These settings are only available for AF evaluations.

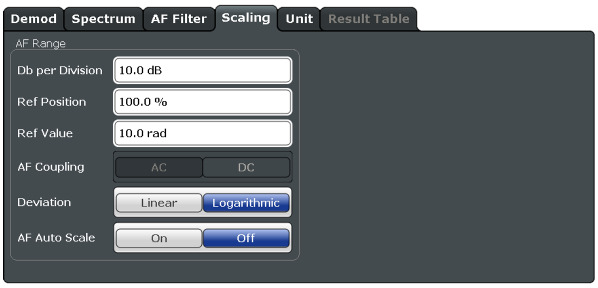


Figure 4-1: Dialog contents in case of FM Time Domain measurements. Contents for other measurements are different.

Dev per Division/ Db per Division

Defines the modulation depth or the phase deviation or frequency deviation per division (logarithmic: 0.1 to 20 dB):

AM display:	0.0001 % to 1000 %
FM display:	1 Hz/div to 100 MHz/div
PM display:	0.0001 rad/div to 1000 rad/div

Note: The value defined per division refers to the default display of 10 divisions on the y-axis. If fewer divisions are displayed (e.g. because the window is reduced in height), the range per division is increased in order to display the same result range in the smaller window. In this case, the per division value does not correspond to the actual display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision` on page 119

Reference Value Position
Determines the position of the reference value for the modulation depth or the phase deviation or frequency deviation on the y-axis of the diagram.

The position is entered as a percentage of the diagram height with 100 % corresponding to the upper diagram border. The default setting is 50 % (diagram center) for the AF time evaluations and 100 % (upper diagram border) for the AF spectrum evaluations.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 119

Reference Value
Determines the modulation depth or the phase deviation or the frequency deviation at the reference line of the y-axis. The reference value can be set specifically for each evaluation.

- AF time display
  The trace display takes individual frequency/phase offsets into account (in contrast, the AF Coupling setting permits automatic correction by the average frequency/phase offset of the signal, and can therefore not be activated simultaneously).
- AF spectrum display
  In the default setting, the reference value defines the modulation depth or the FM/PM deviation at the upper diagram border.

Possible values:
- AM: 0 and ± 10000 %
- FM: 0 and ± 10 MHz
- PM: 0 and ± 10000 rad

Note: The reference value for the AF range in the **window title bar** is displayed with respect to the defined reference *position*. The position may vary for different windows. For time domain and frequency domain windows, for example, a different reference value may be displayed, although the same reference is actually used (but the positions vary).

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 127

AF Coupling
Controls the automatic correction of the frequency offset and phase offset of the input signal:

This function is only available for FM or PM time domain evaluations.

- FM time evaluation
  If DC is selected, the absolute frequency is displayed, i.e. an input signal with an offset relative to the center frequency is not displayed symmetrically with respect to the zero line.

If AC is selected, the frequency offset is automatically corrected, i.e. the trace is always symmetric with respect to the zero line.

- PM time evaluation
  If DC is selected, the phase runs according to the existing frequency offset. In addition, the DC signal contains a phase offset of ± π.
  If AC is selected, the frequency offset and phase offset are automatically corrected, i.e. the trace is always symmetric with respect to the zero line.

Remote command:
`[SENSe:]ADEMod<n>:AF:COUPling` on page 116

Deviation
Switches between logarithmic and linear display of the modulation depth or the phase deviation or the frequency deviation.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 120

AF Auto Scale
Activates automatic scaling of the y-axis for AF measurements. RF power and RF spectrum measurements are not affected by the auto-scaling.

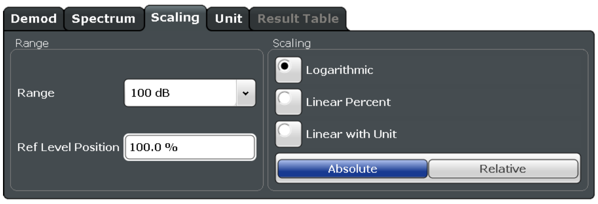
Remote command:
`[SENSe:]ADJust:SCALe:Y:AUTO[:CONTinuous]` on page 106

4.8.4.2 RF Evaluation

Access: "Overview" > "Demod Settings" > "Scaling"

or: "Meas Setup" > "Demod" > "Scaling" tab

These settings are only available for RF evaluations and the result summary.



Range
Defines the displayed y-axis range in dB.

The default value is 100 dB.

For Analog Demodulation measurements, time domain scaling is defined in Hz (default: 500 kHz).

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] on page 128

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

Only available for RF measurements.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition on page 119

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

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

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE on page 128

Scaling
Defines the scaling method for the y-axis.

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

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing on page 120
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE on page 128

4.8.5 Units

Access: "Overview" > "Demod Settings" > "Unit"

or: "Meas Setup" > "Demod" > "Unit" tab

The units define how the demodulated data is displayed.

Figure 4-2: Dialog contents in case of PM Spectrum measurements. Contents for other measurements are different.

Phase Unit (Rad/Deg)

Sets the phase unit to rad or deg for displaying PM signals.

Remote command:
`UNIT<n>:ANGLe` on page 129

THD Unit (% / DB)

Sets the unit to percent or DB for the calculation of the THD (in the Result Summary).

Remote command:
`UNIT<n>:THD` on page 129

Relative Unit

Defines the unit for relative demodulation results (see Chapter 4.8.6, "Result Table Settings", on page 61).

Remote command:
`CONFigure:ADEMod:RESults:UNIT` on page 132

4.8.6 Result Table Settings

Access: "Overview" > "Demod Settings" > "Result Table"

or: "Meas Setup" > "Demod" > "Result Table" tab

The demodulation results are displayed in the Result Summary table (see also "Result Summary" on page 17). The detectors used to determine the results can be configured.

In addition to common absolute demodulation, the R&S FSWP Analog Demodulation application also provides demodulation results relative to user-defined or measured reference values in the Result Summary.

The settings for the Result Summary can be defined individually for the different modulation types (FM, AM, PM). For each modulation, a separate tab is provided in the dialog box.

Detector

Detector type for demodulation results

"+ Peak"	Positive peak
"- Peak"	Negative peak
"+/- Peak"	Autopeak
"RMS"	Root mean square

Remote command:
The detector is specified by the `DETector<det>` suffix in `CONFigure:RELative:AM|FM|PM:DETector<det>...` commands.

Mode

Defines the mode with which the demodulation result is determined.

"Clear Write"	Overwrite mode: the detector value is overwritten by each sweep. This is the default setting.
"Max Hold"	The maximum value is determined over several sweeps and displayed. The R&S FSWP saves each result only if the new value is greater than the previous one.
"Average"	The average result is determined over all sweeps.

Remote command:
`CONFigure:ADEMod:RESults:AM:DETector<det>:MODE` on page 131
`CONFigure:ADEMod:RESults:FM:DETector<det>:MODE` on page 131
`CONFigure:ADEMod:RESults:PM:DETector<det>:MODE` on page 131

State

Activates relative demodulation for the selected detector. If activated, the demodulated result is set in relation to the Reference Value.

Remote command:
`CONFigure:ADEMod:RESults:AM:DETector<det>:STATe` on page 130
`CONFigure:ADEMod:RESults:FM:DETector<det>:STATe` on page 130
`CONFigure:ADEMod:RESults:PM:DETector<det>:STATe` on page 130

Reference Value

Defines the reference value to be used for relative demodulation results and recalculates the results. If necessary, the detector is activated.

Note: A reference value *0* would provide infinite results and is thus automatically corrected to *0.1*.

Remote command:
CONFigure:ADEMod:RESults:AM:DETector<det>:REFerence on page 130
CONFigure:ADEMod:RESults:FM:DETector<det>:REFerence on page 130
CONFigure:ADEMod:RESults:PM:DETector<det>:REFerence on page 130

Meas -> Reference
Sets the Reference Value to be used for relative demodulation results to the currently measured value *for all relative detectors*.

Note: A reference value *0* would provide infinite results and is thus automatically corrected to *0.1*.

If necessary, the detectors are activated.

Remote command:
CONFigure:ADEMod:RESults:AM:DETector<det>:REFerence:MEAStoref on page 131
CONFigure:ADEMod:RESults:FM:DETector<det>:REFerence:MEAStoref on page 131
CONFigure:ADEMod:RESults:PM:DETector<det>:REFerence:MEAStoref on page 131

4.9 Demodulation Display

The demodulated signal can be displayed using various evaluation methods. All evaluation methods available for the Analog Demodulation application are displayed in the evaluation bar in SmartGrid mode when you do one of the following:

- Select the "SmartGrid" icon from the toolbar.
- Select the "Demod/Display" button in the "Overview".
- Press the MEAS key.
- Select the "Display Config" softkey in the main "Analog Demod" menu.

Up to six evaluation methods can be displayed simultaneously in separate windows. The Analog Demodulation evaluation methods are described in Chapter 2, "Measurements and Result Displays", on page 9.

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

4.10 Automatic Settings

Some settings can be adjusted by the R&S FSWP automatically according to the current measurement settings.

To activate the automatic adjustment of a setting, select the corresponding function in the AUTO SET menu or in the configuration dialog box for the setting, where available.

Adjusting all Determinable Settings Automatically (Auto All)
Activates all automatic adjustment functions for the current measurement settings.

This includes:

- Auto Frequency
- Auto Level
- "AF Auto Scale" on page 59

Note: MSRA operating modes. In MSRA operating mode this function is only available for the MSRA Master, not the applications.

Remote command:
`[SENSe:]ADJust:ALL` on page 103

Adjusting the Center Frequency Automatically (Auto Freq)
The R&S FSWP 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 105

Setting the Reference Level Automatically (Auto Level)
Automatically determines a reference level which ensures that no overload occurs at the R&S FSWP 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 FSWP.

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

You can change the measurement time for the level measurement if necessary (see "Changing the Automatic Measurement Time (Meastime Manual)" on page 65).

Remote command:
`[SENSe:]ADJust:LEVel` on page 94

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

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 104

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

Remote command:
[SENSe:]ADJust:CONFigure:DURation:MODE on page 104
[SENSe:]ADJust:CONFigure:DURation on page 103

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

Remote command:
[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer on page 105

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

Remote command:
[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer on page 104

AF Auto Scale
Activates automatic scaling of the y-axis for AF measurements. RF power and RF spectrum measurements are not affected by the auto-scaling.

Remote command:
[SENSe:]ADJust:SCALe:Y:AUTO[:CONTinuous] on page 106

5 Analysis

General result analysis settings concerning the trace, markers, lines etc. can be configured via the "Analysis" button in the "Overview". They are identical to the analysis functions in the Spectrum application except for the special marker functions (the Spectrum application supports more marker functions).

For more information, refer to the User Manual of the R&S FSWP Spectrum application.

6 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 FSWP later
- Capturing and saving I/Q signals with an RF or baseband signal analyzer to analyze them with the R&S FSWP or an external software tool later

For example, you can capture I/Q data using the I/Q Analyzer application, if available, and then analyze that data later using the R&S FSWP Analog Demodulation application.

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`.

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

Export only in MSRA mode

In MSRA mode, I/Q data can only be exported to other applications; I/Q data cannot be imported to the MSRA Master or any MSRA applications.

6.1 Import/Export Functions

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

These functions are only available if no measurement is running. In particular, if Continuous Sweep/RUN CONT is active, the import/export functions are not available.

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

Import
Provides functions to import data.

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

Note that the I/Q data must have a specific format as described in the R&S FSWP I/Q Analyzer and I/Q Input User Manual.

I/Q import is not available in MSRA mode.

Remote command:
`MMEMory:LOAD:IQ:STATe` on page 153

Export
Opens a submenu to configure data export.

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

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

For details on the file format see Chapter A.3, "Reference: ASCII File Export Format", on page 158.

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

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

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

Remote command:
`MMEMory:STORe<n>:TRACe` on page 151

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

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

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

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

Remote command:
`MMEMory:STORe<n>:IQ:STATe` on page 153
`MMEMory:STORe<n>:IQ:COMMent` on page 153

6.2 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 R&S FSWP Analog Demodulation 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 "IQ 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".

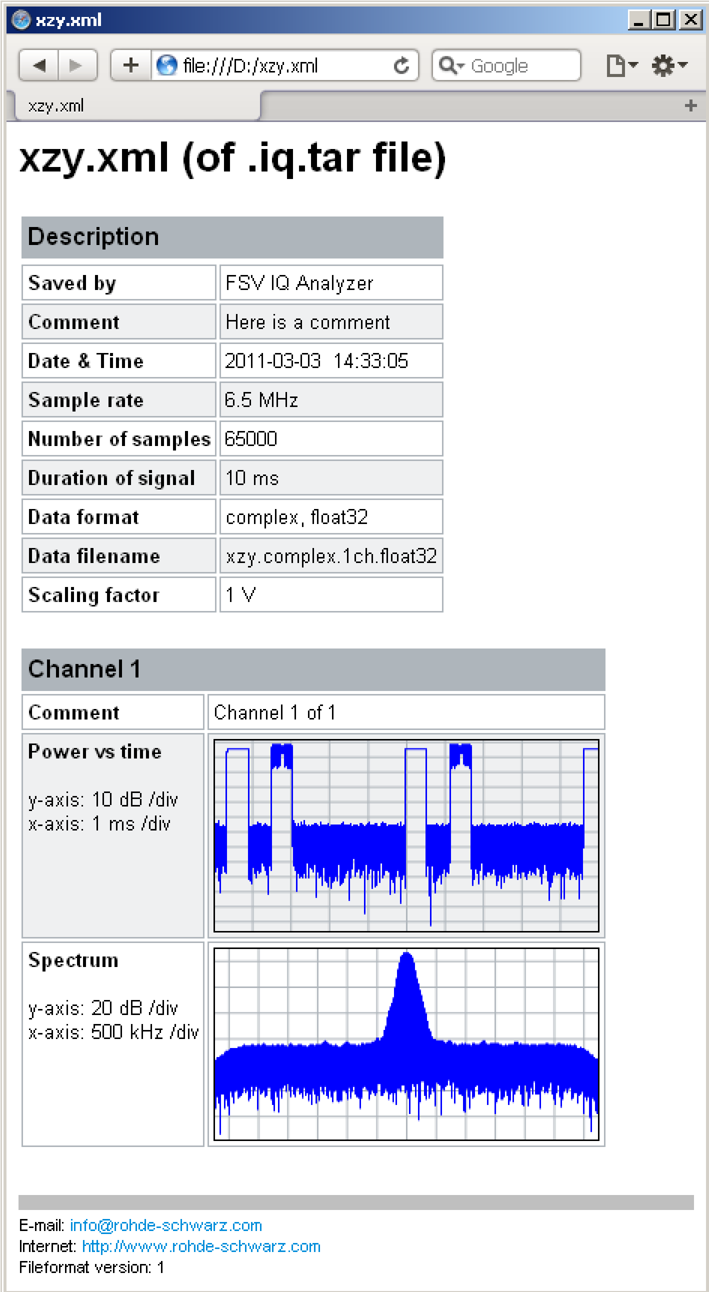
   The stored data is loaded from the file and displayed in the current application.

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.



7 How to Perform Measurements in the Analog Demodulation Application

The following step-by-step instructions demonstrate how to perform an Analog Demodulation measurement with the R&S FSWP-K7 option.

1. Press the MODE key and select the "Analog Demod" application.
2. Select the "Overview" softkey to display the "Overview" for an Analog Demodulation measurement.
3. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's center frequency.
4. Select the "Data Acquisition" button and define the bandwidth parameters for the input signal:
   (Note: in MSRA mode, define the analysis interval using the same settings.)
   - "Demodulation Bandwidth": the span of the input signal to be demodulated
   - "Measurement Time": how long the input signal is to be measured
   - "Resolution Bandwidth": how precise the signal is to be demodulated
   - "Capture Offset" (multistandard mode only): the offset of the analysis interval from the start of the capture buffer
5. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an offline demodulation trigger to start capturing data only when a useful signal is transmitted.
6. Select the "Demod/Display" button and select the demodulation displays that are of interest to you (up to 6).
   Arrange them on the display to suit your preferences.
7. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
8. Select the "Demodulation Settings" button to define demodulation parameters for each evaluation:
   - Configure the "Squelch" function (on the "Demod" tab) to suppress noise during demodulation.
   - For time domain evaluations, zoom into the areas of interest by defining a zoom area (on the "Demod" tab).
   - For AF evaluations, use special filters to eliminate certain effects of demodulation or to correct pre-emphasized modulated signals (on the "AF Filters" tab).
   - Adapt the diagram scaling to the displayed data (on the "Scaling" tab).
9. Select the "Analysis" button in the "Overview" to make use of the advanced analysis functions in the demodulation displays.

- Configure a trace to display the average over a series of sweeps (on the "Trace" tab; if necessary, increase the "Sweep Count" in the "Data Acquisition" settings).
- Configure markers and delta markers to determine deviations and offsets within the demodulated signal (on the "Marker" tab).
- Use special marker functions to calculate phase noise or an n dB down bandwidth (on the "Marker Config" tab).
- Configure a limit check to detect excessive deviations (on the "Lines" tab).

10. Start a new sweep with the defined settings.
    In multistandard mode you may want to stop the continuous measurement mode by the Sequencer and perform a single data acquisition:
    a) Select the Sequencer icon ( ) from the toolbar.
    b) Set the Sequencer state to "OFF".
    c) Press the RUN SINGLE key.
11. Optionally, export the trace data of the demodulated signal to a file.
    a) In the "Traces" tab of the "Analysis" dialog box, switch to the "Trace Export" tab.
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

8 Measurement Example: Demodulating an FM Signal

A practical example for a basic Analog Demodulation measurement is provided here. It demonstrates how operating and measurement errors can be avoided using correct configuration settings.

The measurement is performed using the following devices:

- An R&S FSWP with the optional Spectrum application and the optional Analog Demodulation application
- A vector signal generator, e.g. R&S SMW

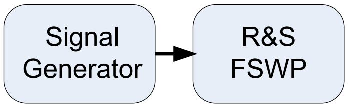


Figure 8-1: Test setup

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

Frequency:	500 MHz
Level:	-10 dBm
Modulation:	FM
Modulation frequency:	10 kHz
Frequency deviation:	50 kHz

Procedure:

1. Preset the R&S FSWP.
2. Set the center frequency to *500 MHz*.
3. Set the reference level to *0 dBm*.
4. Select the MODE key and then the "Analog Demod" button.

   By default, the FM Time Domain result display and a Result Summary are shown.

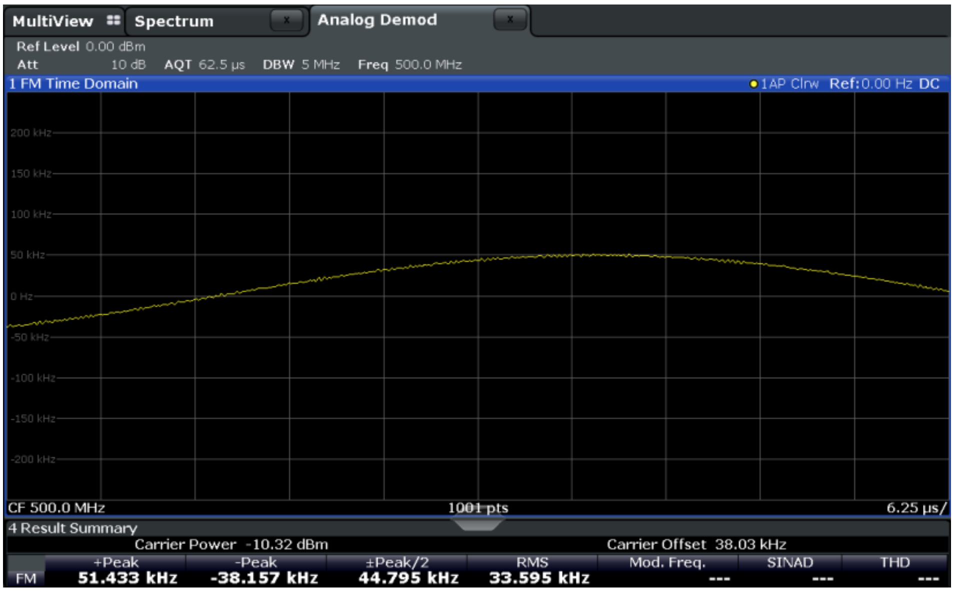


Figure 8-2: Default Analog Demodulation measurement result display

5. Set the measurement time (AQT) to *1 ms* in order to measure 10 periods of the signal.
6. Adjust the y-axis scaling to the measured frequency deviation automatically by selecting the "Scale Config" softkey and, in the "Scaling" tab, setting "AF Auto Scale" to "ON".

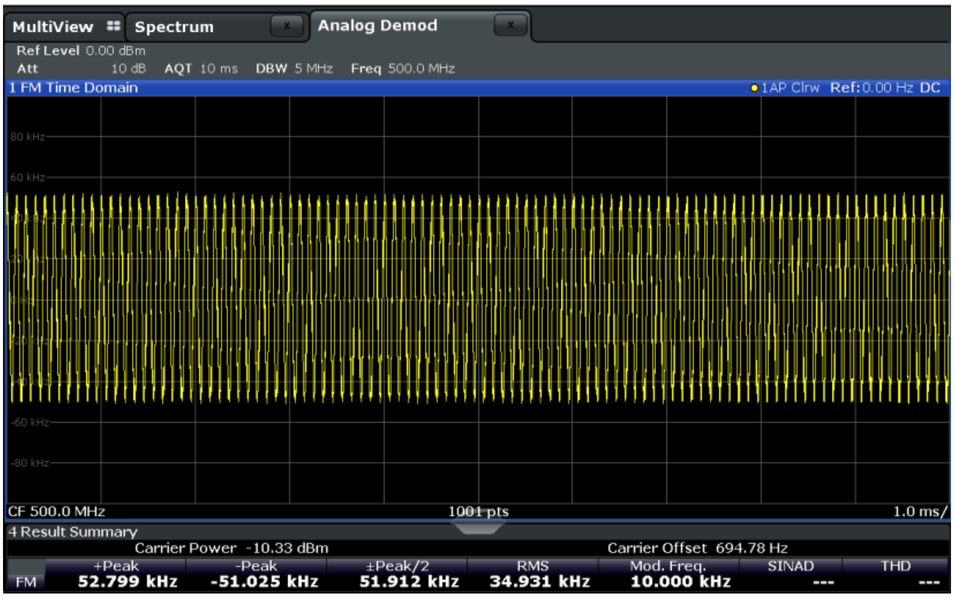


Figure 8-3: Auto-scaled measurement of 10 signal periods (continuous)

7. Display the RF spectrum of the measured signal to determine the required demodulation bandwidth. Select the "Display Config" softkey and add an "RF Spectrum" window to the display.

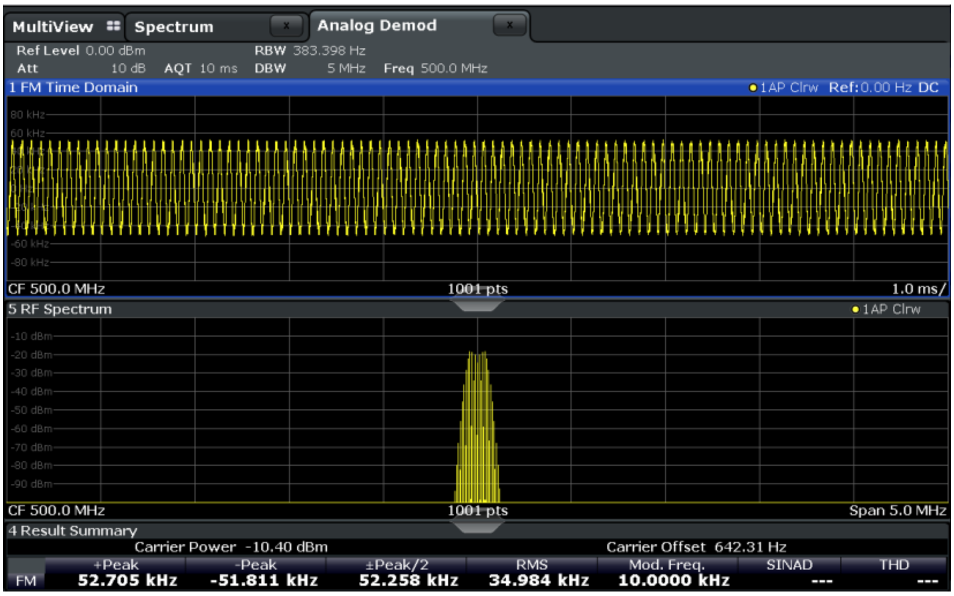


Figure 8-4: RF spectrum of FM signal with default demodulation bandwidth = 5 MHz

8. As you can see in Figure 8-4, the default demodulation bandwidth of 5 MHz is much too large - the actual signal takes up only a small part of the displayed range. That means that any noise or additional signals apart from the FM signal of interest may be included in the measured results. Select the "Demod BW" softkey and reduce the value to *200 kHz*.

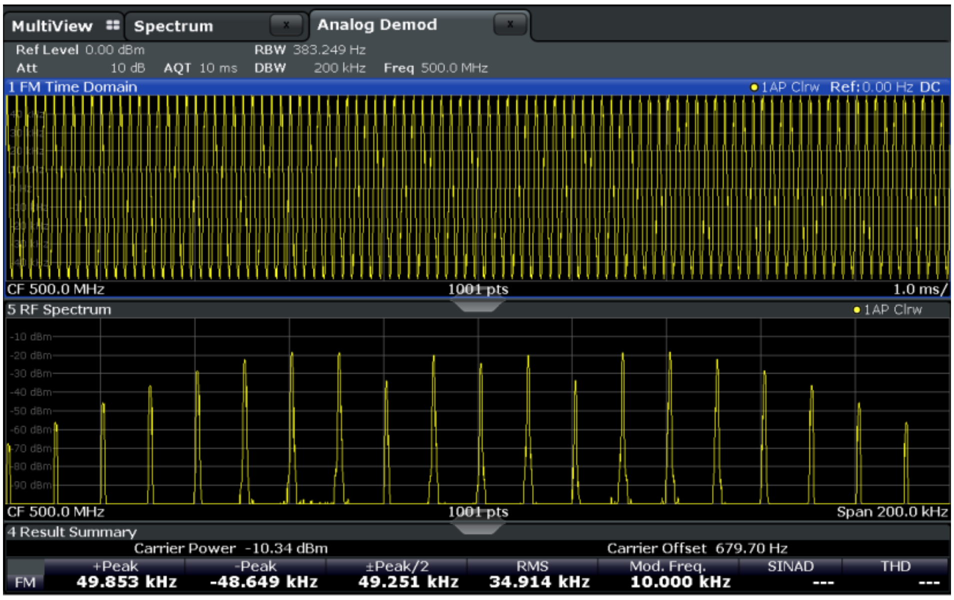


Figure 8-5: RF spectrum with demodulation bandwidth = 200 kHz

The span is automatically reduced to 200 kHz as well, as only the demodulated range can be displayed.

9. Now the RF spectrum shows that part of the FM signal is cut off. The missing signal parts are not included in the calculated results. Increase the demodulation bandwidth to *400 kHz* to include the entire signal, but no interfering frequencies.

   The span is not automatically increased for the wider DBW since it may be useful to display only a small range from the demodulated bandwidth. However, this means the RF spectrum will still not show the entire signal.

10. Increase the span manually to show the entire demodulated bandwidth:
    a) Select the RF Spectrum window.
    b) Press the SPAN key.
    c) Select the "Full Span" softkey.

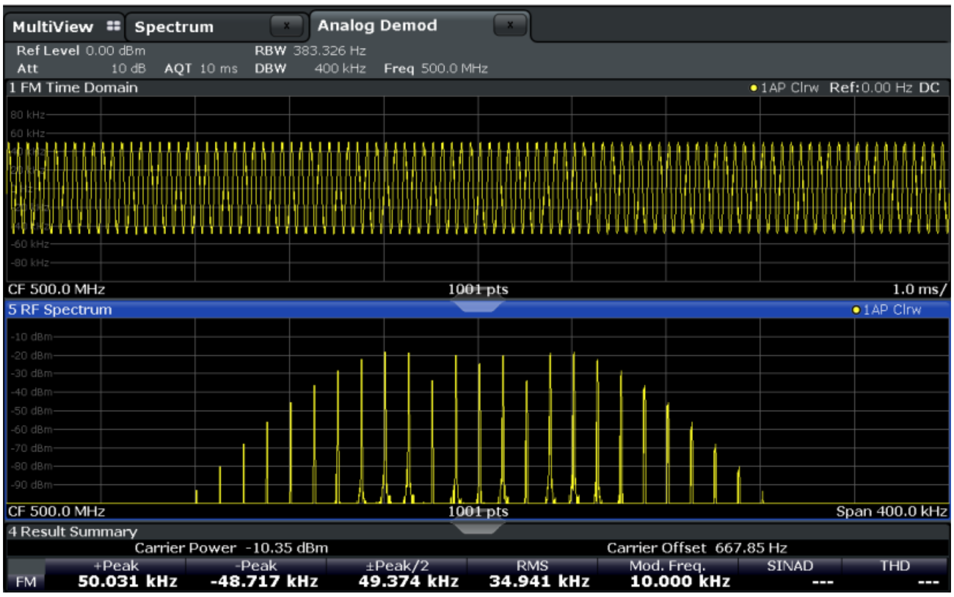


Figure 8-6: RF spectrum with demodulation bandwidth = 400 kHz

11. Once the correct DBW has been determined, you can replace the RF spectrum by the FM spectrum result display to analyze the spectrum of the FM signal. Select the "Display Config" softkey and move an "FM Spectrum" window over the "RF Spectrum" window in the display.

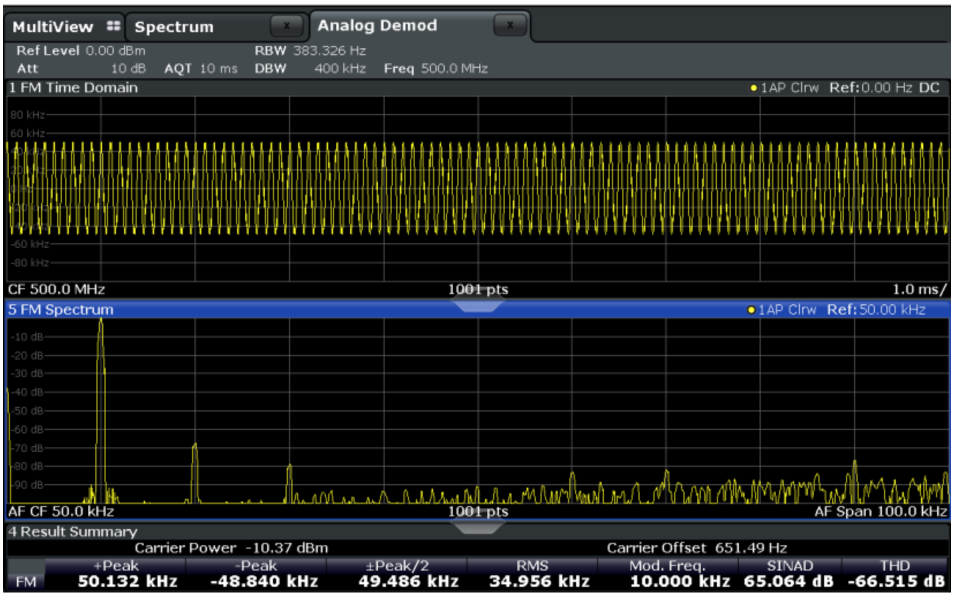
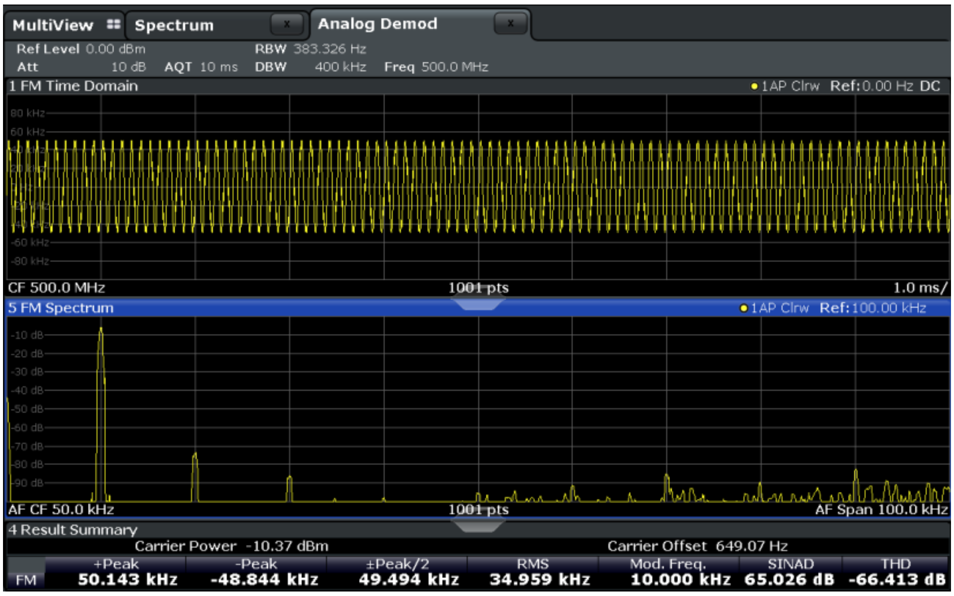


Figure 8-7: FM spectrum and Result Summary including SINAD and THD values

From the FM spectrum, the SINAD and THD are also calculated and displayed in the Result Summary.

12. Since the "AF Auto Scale" function is enabled, the "FM Spectrum" diagram is scaled according to the current measurement automatically. Each diagram is scaled individually, so that the reference values at the top of the two diagrams can differ (100 kHz in the "FM Time Domain" versus 50 kHz in the "FM Spectrum". However, you can adjust the values manually.
    a) Select the "FM Spectrum" window to set the focus in it.
    b) Press the AMPT key and select the "Scale Config" softkey.
    c) Disable the "AF Auto Scale" function.
    d) Define the new reference value (at 100% = top of the diagram) as *100 kHz*.



Note that while the reference values at the top of both y-axes are now identical, the reference values indicated in the window title bars are not. This is due to the fact that, by default, in AF time domain displays the reference value is defined at the reference position 50 % (=center of diagram), while in AF frequency domains it is defined at the position 100 % (= top of diagram).

9 Optimizing and Troubleshooting the Measurement

If the results do not meet your expectations, consider the following notes and tips to optimize the measurement.

Determining the demodulation bandwidth

A frequent cause for measurement errors and false results is an **incorrectly defined demodulation bandwidth** (DBW).

If the DBW is too large, the actual signal takes up only a small part of the demodulated range. That means that any noise or additional signal parts may be included in the measured results, which are then false.

On the other hand, if the DBW is too small, part of the signal is cut off and thus not included in the calculation of the results.

An easy way to determine the required DBW is to display the RF spectrum of the input signal. If the entire signal is displayed there and takes up most of the diagram width, the DBW should be appropriate.

This procedure is demonstrated in the measurement example described in Chapter 8, "Measurement Example: Demodulating an FM Signal", on page 74.

For further recommendations on finding the correct demodulation bandwidth see Chapter 3.2, "Demodulation Bandwidth", on page 22.

Adjusting the displayed span

Be aware that the span of the RF Spectrum display is not automatically increased for a wider DBW, since it may be useful to display only a small range from the demodulated bandwidth. However, this means the RF spectrum may not show the entire demodulated bandwidth. In this case you must increase the span manually to show the entire signal.

Determining the SINAD and THD

The signal-to-noise-and-distortion ratio (SINAD) and the total harmonic distortion (THD) of the demodulated signal are a good indicator of the signal quality sent by the DUT. Both values are calculated inside the AF spectrum span and thus only if an AF spectrum window is displayed. If either value deviates strongly from the expected result, make sure the demodulation bandwidth is defined correctly (see Determining the demodulation bandwidth).

10 Remote Commands for Analog Demodulation

10.1 Remote Commands to Select the Application

INSTrument:CREate:DUPLicate

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

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

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

Usage: Event

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

This command adds an additional measurement channel.

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

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see INSTrument:LIST? on page 83.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see INSTrument:LIST? on page 83).

Example: `INST:CRE PNO, 'PhaseNoise 2'`
Adds an additional phase noise display named "PhaseNoise 2".

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

This command replaces a measurement channel with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types see INSTrument:LIST? on page 83.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see INSTrument:LIST? on page 83).

Example: `INST:CRE:REPL 'PhaseNoise',PNO,'PNO2'`
Replaces the channel named 'PhaseNoise' by a new measurement channel of type 'Phase Noise' named 'PNO2'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

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

Parameters:

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

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

Usage: Event

INSTrument:LIST?

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

Return values:

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

Example:
: `INST:LIST?`
Result for 2 measurement channels:
`'PNO','PhaseNoise','PNO','PhaseNoise2'`

Usage:
: Query only

Table 10-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Phase Noise	PNOISE	Phase Noise
Spectrum (R&S FSWP-B1)	SANALYZER	Spectrum
I/Q Analyzer (R&S FSWP-B1)	IQ	IQ Analyzer
Analog Demodulation (R&S FSWP-K7)	ADEM	Analog Demod
Noise Figure Measurements (R&S FSWP-K30)	NOISE	Noise
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

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

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

Example:
: `INST:REN 'PhaseNoise','PNO'`
Renames the channel with the name PhaseNoise' to 'PNO'.

Usage:
: Setting only

INSTrument[:SELect] <ChannelType>

Selects the channel type for the current channel.

See also `INSTrument:CREate[:NEW]` on page 81.

For a list of available channel types see Table 10-1.

Parameters:

<ChannelType>	**ADEMod** Analog Demodulation application, R&S FSWP–K7

SYSTem:PRESet:CHANnel[:EXECute]

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

Use `INST:SEL` to select the channel.

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

Usage:	Event
Manual operation:	See "Preset Channel" on page 30

10.2 Remote Commands to Configure Analog Demodulation

10.2.1 Configuring Standards

[SENSe:]ADEMod<n>:PRESet[:STANdard] <Standard>

This command loads a measurement configuration.

Standard definitions are stored in an xml file. The default directory for Analog Demodulation standards is `C:\r_s\instr\user\predefined\AdemodPredefined`.

(<n> is irrelevant.)

Parameters:

<Standard> String containing the file name.
If you have stored the file in a subdirectory of the directory mentioned above, you have to include the relative path to the file.

Return values:

<Standard> The query returns the name of the currently loaded standard.

Manual operation: See "Load Standard" on page 28

[SENSe:]ADEMod<n>:PRESet:RESTore

This command restores the default configurations of predefined Analog Demodulation standards.

Note that the command will overwrite customized standards that have the same name as predefined standards.

(<n> is irrelevant.)

Usage: Event

Manual operation: See "Restore Standard Files" on page 29

[SENSe:]ADEMod<n>:PRESet:STORe <Standard>

This command saves the current Analog Demodualtion measurement configuration.

Standard definitions are stored in an xml file. The default directory for Analog Demodualtion standards is `C:\r_s\instr\user\predefined\AdemodPredefined`.

(<n> is irrelevant.)

Parameters:

<Standard> String containing the file name.
You can save the file in a subdirectory of the directory mentioned above. In that case, you have to include the relative path to the file.

Manual operation: See "Save Standard" on page 29

10.2.2 Configuring Inputs and Outputs

10.2.2.1 Configuring the Input

INPut:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer after an overload condition occured 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.

(For details on the status register see the R&S FSWP User Manual).

The command works only if the overload condition has been eliminated first.

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 31

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSWP in order to measure the harmonics for a DUT, for example.

This function requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 32

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 31.

Parameters:

<State> ON | OFF | 0 | 1

*RST: OFF

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 31

INPut:IMPedance <Impedance>

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

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

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 31
See "Unit" on page 37

10.2.2.2 Configuring External Generators

The External Generator Control is available as an option.

Please refer to the User Manual of the R&S FSWP for a comprehensive list and description of remote commands necessary to control external generators.

10.2.2.3 Configuring Outputs

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the R&S FSWP on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source" on page 33

OUTPut:ADEMod[:ONLine]:AF[:CFRequency] <Frequency>

This command defines the cutoff frequency for the AC highpass filter (for AC coupling only, see `[SENSe:]ADEMod<n>:AF:COUPling` on page 116).

Parameters:

<Frequency> numeric value

Range: 10 Hz to DemodBW/10 (= 300 kHz for active demodulation output)

*RST: 100 Hz

Example: `OUTP:ADEM:ONL:AF:CFR 100Hz`

Manual operation: See "AC Cutoff Frequency" on page 36

OUTPut:ADEMod[:ONLine]:SOURce <WindowName>

This command selects the result display whose results are output. Only active time domain results can be selected.

Parameters:

<WindowName>

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

FOCus
Dynamically switches to the currently selected window. If a window is selected that does not contain a time-domain result display, the selection is ignored and the previous setting is maintained.

Example:
```
OUTP:ADEM:ONL:SOUR 'AnalogDemod'
```
OR:
```
DISP:WIND1:SEL
OUTP:ADEM:SOUR FOC
```

Manual operation: See "Output Selection" on page 35

OUTPut:ADEMod[:ONLine][:STATe] <State>

This command enables or disables online demodulation output to the IF/VIDEO/DEMOD output connector on the rear panel of the R&S FSWP.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `OUTP:ADEM ON`

Manual operation: See "Online Demodulation Output State" on page 35

OUTPut:IF:IFFRequency <Frequency>

This command defines the frequency for the IF output of the R&S FSWP. The IF frequency of the signal is converted accordingly.

This command is available in the time domain and if the IF/VIDEO/DEMOD output is configured for IF.

Parameters:

<Frequency> *RST: 50.0 MHz

Manual operation: See "IF (Wide) Out Frequency" on page 33

OUTPut:IF[:SOURce] <Source>

Defines the type of signal available at the IF/VIDEO/DEMOD or IF OUT 2 GHZ connector of the R&S FSWP.

Note that you can use the audio frequency output only if the IF output source is "Video".

Parameters:

<Source>

IF
The measured IF value is available at the IF/VIDEO/DEMOD output connector.

VIDeo
The displayed video signal (i.e. the filtered and detected IF signal, 200mV) is available at the IF/VIDEO/DEMOD output connector.
This setting is required to provide demodulated audio frequencies at the output.

*RST: IF

Example: `OUTP:IF VID`
Selects the video signal for the IF/VIDEO/DEMOD output connector.

Manual operation: See "IF/Video Output" on page 33

OUTPut:TRIGger<port>:DIRection <Direction>

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

Suffix:

<port> Selects the used trigger port.
<2>: selects trigger port 2 (on the rear panel).

Parameters:

<Direction> **INPut**
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 1/2" on page 33

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the signal generated at the trigger output.

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

Suffix:

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

Parameters:

<Level> **HIGH**
TTL signal.

LOW
0 V

*RST: LOW

Manual operation: See "Trigger 1/2" on page 33
See "Level" on page 34

OUTPut:TRIGger<port>:OTYPe <OutputType>

This command selects the type of signal generated at the trigger output.

Note: For offline AF or RF triggers, no output signal is provided.

Suffix:
<port> Selects the trigger port to which the output is sent.
2 = trigger port 2 (rear panel)

Parameters:
<OutputType> **DEVice**
Sends a trigger signal when the R&S FSWP has triggered internally.
TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.
UDEFined
Sends a user defined trigger signal. For more information see `OUTPut:TRIGger<port>:LEVel`.
*RST: DEVice

Manual operation: See "Output Type" on page 34

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

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

Usage: Event

Manual operation: See "Send Trigger" on page 34

OUTPut:TRIGger<port>:PULSe:LENGth <Length>

This command defines the length of the pulse generated at the trigger output.

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

Parameters:
<Length> Pulse length in seconds.

Manual operation: See "Pulse Length" on page 34

10.2.3 Configuring Level Characteristics

Commands useful to configure level characteristics described elsewhere:

- `INPut:COUPling` on page 86
- `INPut:IMPedance` on page 87

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all power-based measurement windows (regardless of the <n> suffix).

Parameters:

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Unit" on page 37

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

This command defines the reference level (for all traces, <t> is irrelevant).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm

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

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 37

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces, <t> is irrelevant).

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Shifting the Display (Offset)" on page 37

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

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

Parameters:

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

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

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 38

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSWP determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuation Mode / Value" on page 38

INPut:GAIN[:VALue] <Gain>

This command selects the gain level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 94).

The command requires the additional preamplifier hardware option.

Parameters:
<Gain> 15 dB | 30 dB

The availability of gain levels depends on the model of the R&S FSWP.
R&S FSWP8: 15dB and 30 dB
R&S FSWP26 or higher: 30 dB

*RST: OFF

Example: `INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 38

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off. It requires the optional preamplifiier hardware.

Parameters:
<State> ON | OFF

*RST: OFF

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

Usage: SCPI confirmed

Manual operation: See "Preamplifier" on page 38

[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 FSWP or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 38

10.2.4 Defining Frequency Characteristics

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Usage: SCPI confirmed

Manual operation: See "Center frequency" on page 39

[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 95.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency Stepsize" on page 39

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType>

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.
(for RF spectrum result display)

RBW
Couples the step size to the resolution bandwidth. Available for measurements in the time domain.
(for all result displays except RF spectrum)

OFF
Decouples the step size.

*RST: SPAN

Example: `FREQ:CENT:STEP:LINK SPAN`

Manual operation: See "Center Frequency Stepsize" on page 39

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

This command defines a step size factor if the center frequency step size is coupled to the span or the resolution bandwidth.

Parameters:

<Factor> 1 to 100 PCT

*RST: 10

Example: `FREQ:CENT:STEP:LINK:FACT 20PCT`

Manual operation: See "Center Frequency Stepsize" on page 39

10.2.5 Configuring Trigger

Useful commands to configure triggered measurements described elsewhere:

- `OUTPut:TRIGger<port>:DIRection` on page 90
- `OUTPut:TRIGger<port>:LEVel` on page 90
- `OUTPut:TRIGger<port>:OTYPe` on page 90
- `OUTPut:TRIGger<port>:PULSe:IMMediate` on page 91
- `OUTPut:TRIGger<port>:PULSe:LENGth` on page 91

TRIGger[:SEQuence]:BBPower:HOLDoff <Period>

This command defines the holding time before the baseband power trigger event.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 97 command for new remote control programs.

Parameters:

<Period> Range: 150 ns to 1000 s
*RST: 150 ns

Example:
`TRIG:SOUR BBP`
Sets the baseband power trigger source.
`TRIG:BBP:HOLD 200 ns`
Sets the holding time to 200 ns.

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

Manual operation: See "Drop-Out Time" on page 43

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).

Note: If you perform gated measurements in combination with the IF Power trigger, the R&S FSWP ignores the holding time for frequency sweep, FFT sweep, zero span and I/Q data measurements.

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 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 43

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

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

Parameters:
<Offset> *RST: 0 s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 43

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

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 43

TRIGger[:SEQuence]:LEVel:AM[:ABSolute] <Level>

The command sets the level when RF power signals are used as trigger source.

For triggering to be successful, the measurement time must cover at least 5 periods of the audio signal.

Parameters:
<Level> Range: -100 to +30
*RST: -20 dBm
Default unit: dBm

Example: `TRIG:LEV:AM -30 dBm`
Sets the RF power signal trigger threshold to -30 dBm

Manual operation: See "Trigger Level" on page 42

TRIGger[:SEQuence]:LEVel:AM:RELative <Level>

The command sets the level when AM-modulated signals are used as trigger source.

For triggering to be successful, the measurement time must cover at least 5 periods of the audio signal.

Parameters:

<Level> Range: -100 to +100
*RST: 0 %
Default unit: %

Example: `TRIG:LEV:AM:REL -20 %`
Sets the AM trigger threshold to -20 %

Manual operation: See "Trigger Level" on page 42

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

Suffix:

<port> Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on rear panel)

Parameters:

<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 42

TRIGger[:SEQuence]:LEVel:FM <Level>

The command sets the level when FM-modulated signals are used as trigger source.

For triggering to be successful, the measurement time must cover at least 5 periods of the audio signal.

Parameters:

<Level> Range: -10 to +10
*RST: 0 Hz
Default unit: MHz

Example: `TRIG:LEV:FM 10 kHz`
Sets the FM trigger threshold to 10 kHz

Manual operation: See "Trigger Level" on page 42

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 or preamplification 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

Example: `TRIG:LEV:IFP -30DBM`

Manual operation: See "Trigger Level" on page 42

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 or preamplification is considered when the trigger level is analyzed.

Parameters:

<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

Manual operation: See "Trigger Level" on page 42

TRIGger[:SEQuence]:LEVel:PM <Level>

The command sets the level when PM-modulated signals are used as trigger source.

For triggering to be successful, the measurement time must cover at least 5 periods of the audio signal.

Parameters:

<Level> Range: -1000 to +1000
*RST: 0 RAD
Default unit: RAD | DEG

Example: `TRIG:LEV:PM 1.2 RAD`
Sets the PM trigger threshold to 1.2 rad

Manual operation: See "Trigger Level" on page 42

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

This command defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Parameters:

<TriggerLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -20 dBm

Example: `TRIG:LEV:RFP -30dBm`

Manual operation: See "Trigger Level" on page 42

TRIGger[:SEQuence]:SLOPe <Type>

This command selects the trigger slope.

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 43

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXT | EXT2
Trigger signal from one of the TRIGGER INPUT/OUTPUT connectors.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency

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.

PSEN
External power sensor

AF
AF power signal

FM
FM power signal

AM
corresponds to the RF power signal

AMRelative
corresponds to the AM signal

PM
PM power signal

*RST: IMMediate

Example:

`TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation:

See "Trigger Source" on page 40
See "Free Run" on page 41
See "Ext. Trigger 1/2" on page 41
See "I/Q Power" on page 41
See "IF Power" on page 41
See "FM / AM / PM / RF (Offline)" on page 42
See "Time" on page 42
See "RF Power" on page 42

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

Example: `TRIG:SOUR TIME`
Selects the time trigger input for triggering.
`TRIG:TIME:RINT 50`
The measurement starts every 50 s.

10.2.6 Defining Settings Automatically

Commands useful for automatic configuration described elsewhere:

- `[SENSe:]ADJust:LEVel` on page 94

[SENSe:]ADJust:ALL

This command initiates a measurement to determine and set the ideal settings for the current task automatically (only once for the current measurement).

This includes:

- Center frequency
- Reference level
- Scaling

Example: `ADJ:ALL`

Usage: Event

Manual operation: See "Adjusting all Determinable Settings Automatically (Auto All)" on page 64

[SENSe:]ADJust:CONFigure:DURation <Duration>

In order to determine the ideal reference level, the R&S FSWP performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:DURation:MODE` is set to `MANual`.

Parameters:

<Duration> Numeric value in seconds

Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example:
`ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

Manual operation: See "Changing the Automatic Measurement Time (Meastime Manual)" on page 65

[SENSe:]ADJust:CONFigure:DURation:MODE <Mode>

In order to determine the ideal reference level, the R&S FSWP performs a measurement on the current input data. This command selects the way the R&S FSWP determines the length of the measurement .

Parameters:

<Mode>

AUTO
The R&S FSWP determines the measurement length automatically according to the current input data.

MANual
The R&S FSWP uses the measurement length defined by `[SENSe:]ADJust:CONFigure:DURation` on page 103.

*RST: AUTO

Manual operation: See "Resetting the Automatic Measurement Time (Meastime Auto)" on page 64
See "Changing the Automatic Measurement Time (Meastime Manual)" on page 65

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 94 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines a lower threshold the signal must fall below (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example:
`SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level falls below 18 dBm.

Manual operation: See "Lower Level Hysteresis" on page 65

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

When the reference level is adjusted automatically using the `[SENSe:]ADJust:LEVel` on page 94 command, the internal attenuators and the preamplifier are also adjusted. In order to avoid frequent adaptation due to small changes in the input signal, you can define a hysteresis. This setting defines an upper threshold the signal must exceed (compared to the last measurement) before the reference level is adapted automatically.

Parameters:

<Threshold> Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level will only be adjusted when the signal level rises above 22 dBm.

Manual operation: See "Upper Level Hysteresis" on page 65

[SENSe:]ADJust:CONFigure:TRIG <State>

Defines the behaviour of the measurement when adjusting a setting automatically (using `SENS:ADJ:LEV ON`, for example).

Parameters:

<State>

ON | 1
The measurement for automatic adjustment waits for the trigger.

OFF | 0
The measurement for automatic adjustment is performed immediately, without waiting for a trigger.

*RST: 1

[SENSe:]ADJust:FREQuency

This command sets the center frequency to the frequency with the highest signal level in the current frequency range.

Example: `ADJ:FREQ`

Usage: Event

Manual operation: See "Adjusting the Center Frequency Automatically (Auto Freq)" on page 64

[SENSe:]ADJust:SCALe:Y:AUTO[:CONTinuous] <State>

Activates automatic scaling of the y-axis in all diagrams according to the current measurement results. Currently auto-scaling is only available for AF measurements. RF power and RF spectrum measurements are not affected by the auto-scaling.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `SENS:ADJ:SCAL:Y:AUTO ON`

Manual operation: See "AF Auto Scale" on page 59

10.2.7 Configuring Data Acquisition

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSWP User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` 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 FSWP 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 FSWP on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>:CONMeas

This command restarts a (single) measurement that has been stopped (using `ABORt`) or finished in single measurement mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate<n>[:IMMediate]`, this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Suffix:
<n> irrelevant

Usage: Event

Manual operation: See "Continue Single Sweep" on page 47

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual measurement channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

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

If the measurement mode is changed for a measurement channel while the Sequencer is active the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

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

Manual operation: See "Continuous Sweep/RUN CONT" on page 47

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 108.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 115.

Suffix:
<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 115).

Suffix:

<n> irrelevant

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

Usage: Event

INITiate<n>:SEQuencer:MODE <Mode>

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

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 115).

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

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

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

Suffix:

<n> irrelevant

Parameters:

<Mode>

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

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

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

*RST: CONTinuous

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

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

With measurement 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

Usage: Event

Manual operation: See "Single Sweep/ RUN SINGLE" on page 47

[SENSe:]ADEMod<n>:MTIMe <Time>

This command defines the measurement time for analog demodulation.

(<n> is irrelevant.)

Parameters:
<Time> *RST: 62.5us

Example: `ADEM:MTIM 62.5us`
Sets the measurement time to 62.5 µs.

Manual operation: See "Measurement Time (AQT)" on page 46

[SENSe:]ADEMod<n>:RLENgth?

This command returns the record length set up for the current analog demodulation measurement.

(<n> is irrelevant.)

Example: `ADEM:RLEN?`
Returns the current record length.

Usage: Query only

[SENSe:]ADEMod<n>:SET <SampleRate> | <RecordLength> | <TriggerSource> | <TriggerSlope> | <OffsetSamples> | <NoOfMeas>

This command configures the analog demodulator of the instrument.

(<n> is irrelevant.)

Parameters:

<SampleRate>

numeric value
The frequency at which measurement values are taken from the A/D-converter and stored in I/Q memory.

*RST: 8 MHz

<RecordLength>

Number of samples to be stored in I/Q memory.

Range: 1 to 400001 with AF filter or AF trigger active, 1 to 480001 with both AF filter and AF trigger deactive
*RST: 501)

<TriggerSource>

IMMediate | EXTernal | EXT2 | EXT3 | IFPower | RFPower| AF | AM | AMRelative | FM | PM
Note: After selecting IF Power, the trigger threshold can be set with the `TRIGger[:SEQuence]:LEVel:IFPower` command.

*RST: IMMediate

<TriggerSlope>

POSitive | NEGative

Used slope of the trigger signal.
The value indicated here will be ignored for <trigger source> = IMMediate.

*RST: POSitive

<OffsetSamples>

Number of samples to be used as an offset to the trigger signal.
The value indicated here is ignored for <trigger source> = "IMMediate".

*RST: 0

<NoOfMeas>

Number of repetitions of the measurement to be executed. The value indicated here is especially necessary for the average/ maxhold/minhold function.

Range: 0 to 32767
*RST: 0

Example:

```
ADEM:SET 8MHz,32000,EXT,POS,-500,30
```

Performs a measurement at:
sample rate = 8 MHz
record length = 32000
trigger source = EXTernal
trigger slope = POSitive
offset samples = -500 (500 samples before trigger occurred)
# of meas = 30

[SENSe:]ADEMod<n>:SPECtrum:BANDwidth|BWIDth[:RESolution] <Bandwidth>

Defines the resolution bandwidth for data acquisition.

From the specified RBW and the demodulation span set by `[SENSe:]ADEMod<n>:SPECtrum:SPAN[:MAXimum]` on page 122 or `[SENSe:]BANDwidth|BWIDth:DEMod` on page 113, the required measurement time is calculated. If the available measurement time is not sufficient for the given bandwidth, the measurement time is set to its maximum and the resolution bandwidth is increased to the resulting bandwidth.

This command is identical to `SENS:BAND:RES`, see the R&S FSWP User Manual.

(<n> is irrelevant.)

Parameters:

<Bandwidth> refer to data sheet

*RST: 61.2 kHz

Example: `ADEM:SPEC:BAND 61.2kHz`
Sets the resolution bandwidth to 61.2 kHz.

[SENSe:]ADEMod<n>:SRATe?

This command returns the sample rate set up for the current analog demodulation measurement.

(<n> is irrelevant.)

Example: `ADEM:SRAT?`
Returns the current sample rate.

Usage: Query only

[SENSe:]AVERage<n>:COUNt <AverageCount>

This command defines the number of measurements that the application uses to average traces (for all windows, <n> is irrelevant).

In case of continuous sweep mode, the application calculates the moving average over the average count.

In case of single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<AverageCount> If you set a average count of 0 or 1, the application performs one single measurement in single sweep mode.
In continuous sweep mode, if the average count is set to 0, a moving average over 10 measurements is performed.

Range: 0 to 200000
*RST: 0

Usage: SCPI confirmed

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

This command sets the bandwidth for analog demodulation. Depending on the selected demodulation bandwidth, the instrument selects the required sample rate.

This command is identical to `SENS:ADEM:BAND:DEM`.

Parameters:

<Bandwidth> *RST: 5 MHz

Example: `BAND:DEM 1MHz`
Sets demodulation bandwidth to 1 MHz

Manual operation: See "Demodulation Bandwidth" on page 45

[SENSe:]BANDwidth|BWIDth:DEMod:TYPE <FilterType>

This command defines the type of demodulation filter to be used.

This command is identical to `SENS:ADEM:BAND:DEM:TYPE`:

Parameters:

<FilterType>

FLAT
Standard flat demodulation filter

GAUSs
Gaussian filter for optimized settling behaviour

*RST: FLAT

Manual operation: See "Demodulation Filter" on page 46

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

This command defines the resolution bandwidth and decouples the resolution bandwidth from the span.

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

Parameters:

<Bandwidth> refer to data sheet

*RST: RBW: AUTO is set to ON; DBW: 3MHz

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

Usage: SCPI confirmed

Manual operation: See "Resolution Bandwidth" on page 46

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for applications in MSRA mode, not for the MSRA Master. It has a similar effect as the trigger offset in other measurements.

Parameters:

<Offset> This parameter defines the time offset between the capture buffer start and the start of the extracted application data. The offset must be a positive value, as the application can only analyze data that is contained in the capture buffer.

Range: 0 to <Record length>
*RST: 0

Manual operation: See "Capture Offset" on page 46

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of measurements that the application uses to average traces.

In case of continuous measurement mode, the application calculates the moving average over the average count.

In case of single measurement mode, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:

<SweepCount> When you set a sweep count of 0 or 1, the R&S FSWP performs one single measurement in single measurement mode.
In continuous measurement mode, if the sweep count is set to 0, a moving average over 10 measurements is performed.

Range: 0 to 200000
*RST: 0

Example:
```
SWE:COUN 64
```
Sets the number of measurements to 64.
```
INIT:CONT OFF
```
Switches to single measurement mode.
```
INIT;*WAI
```
Starts a measurement and waits for its end.

Usage: SCPI confirmed

Manual operation: See "Sweep / Average Count" on page 48

[SENSe:]SWEep:POINts <SweepPoints>

This command defines the number of measurement points to analyze after a measurement.

Example:
```
SWE:POIN 251
```

Usage: SCPI confirmed

Manual operation: See "Sweep Points" on page 48

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 FSWP 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`

10.2.8 Configuring Demodulation

10.2.8.1 Basic Demodulation Settings

The basic demodulation measurement parameters define how the measurement is performed.

Useful commands described elsewhere:

- Chapter 10.2.8.2, "Time Domain Zoom Settings", on page 117

Basic demodulation commands:

[SENSe:]ADEMod<n>:AF:COUPling <Coupling>

This command selects the coupling of the AF path of the analyzer in the specified window.

Parameters:

<Coupling> AC | DC

*RST: AC (PM); DC (FM)

Example: `ADEM:AF:COUP DC`
Switches on DC coupling.

Manual operation: See "AF Coupling" on page 35

[SENSe:]ADEMod<n>:PM:RPOint[:X] <Time>

This command determines the position where the phase of the PM-demodulated signal is set to 0 rad. The maximum possible value depends on the measurement time selected in the instrument; this value is output in response to the query `ADEM:PM:RPO:X? MAX`.

(<n> is irrelevant.)

Parameters:

<Time> 0 s to measurement time

*RST: 0 s

Example: `ADEM:PM:RPO 500us`
Sets the position where the phase to 0 rad setting to 500 µs.

Usage: SCPI confirmed

Manual operation: See "Zero Phase Reference Position (PM Time Domain only)" on page 51

[SENSe:]ADEMod<n>:SQUelch[:STATe] <State>

This command activates the squelch function, i.e. if the signal falls below a defined threshold (see `[SENSe:]ADEMod<n>:SQUelch:LEVel` on page 117), the demodulated data is automatically set to 0.

(<n> is irrelevant.)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DEM:SQU ON`
Signals below the level threshold are squelched.

Manual operation: See "Squelch State" on page 49

[SENSe:]ADEMod<n>:SQUelch:LEVel <Threshold>

This command defines the level threshold below which the demodulated data is set to 0 if squelching is enabled (see `[SENSe:]ADEMod<n>:SQUelch[:STATe]` on page 116).

(<n> is irrelevant.)

Parameters:
<Threshold> numeric value
The absolute threshold level
Range: -150 dBm to 30 dBm
*RST: -40 dBm

Example: `DEM:SQU:LEV -80`
If the signal drops below -80 dBm, the demodulated data is set to 0.

Manual operation: See "Squelch Level" on page 49

10.2.8.2 Time Domain Zoom Settings

Using the time domain zoom, the demodulated data for a particular time span is extracted and displayed in more detail.

[SENSe:]ADEMod<n>:ZOOM:LENGth <Length>

The command allows you to define the length of the time domain zoom area for the analog-demodulated measurement data in the specified window manually. If the length is defined manually using this command, the zoom mode is also set to manual.

Parameters:
<Length> *RST: sweep time
Length of the zoom area in seconds.

Example: `ADEM:ZOOM:LENG 2s`
Zoom mode is set to manual and the zoom length to 2 seconds.

Manual operation: See "Length" on page 51

[SENSe:]ADEMod<n>:ZOOM:LENGth:MODE <Mode>

The command defines whether the length of the zoom area for the analog-demodulated measurement data is defined automatically or manually in the specified window.

Parameters:

<Mode> AUTO | MAN

AUTO
(Default:) The number of sweep points is used as the zoom length.

MAN
The zoom length is defined manually using `[SENSe:]ADEMod<n>:ZOOM:LENGth`.

*RST: AUTO

Example: `ADEM:ZOOM:LENG:MODE MAN`
Zoom function uses the length defined manually.

Manual operation: See "Length" on page 51

[SENSe:]ADEMod<n>:ZOOM:STARt <Time>

The command selects the start time for the zoomed display of analog-demodulated measurements in the specified window. The maximum possible value depends on the measurement time, which is set and can be queried with the `[SENSe:]ADEMod<n>:MTIMe` command.

If the zoom function is enabled, the defined number of sweep points are displayed from the start time specified with this command.

Parameters:

<Time> Range: 0 s to (measurement time – zoom length)
*RST: 0 s

Example: `ADEM:ZOOM:STAT ON`
Switches on the zoom function
`ADEM:ZOOM:STAR 500us`
Sets the starting point of the display to 500 µs.

Manual operation: See "Start" on page 50

[SENSe:]ADEMod<n>:ZOOM[:STATe] <State>

The command enables or disables the time domain zoom function for the analog-demodulated measurement data in the specified window.

If the zoom function is enabled, the defined number of sweep points are displayed from the start time specified with `[SENSe:]ADEMod<n>:ZOOM:STARt` on page 118.

If the zoom function is disabled, data reduction is used to adapt the measruement points to the number of points available on the display.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `ADEM:ZOOM ON`
Switches on the zoom function

Manual operation: See "State" on page 50

10.2.8.3 Configuring the Demodulation Spectrum

The demodulation spectrum defines which span of the demodulated data is evaluated.

AF Evaluation

These settings are only available for AF Spectrum evaluations, not in the time domain.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

The suffix <t> is irrelevant.

Parameters:

<Value> numeric value WITHOUT UNIT (unit according to the result display)

Defines the range per division (total range = 10*<Value>)

*RST: depends on the result display

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Dev per Division/ Db per Division" on page 57

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, <t> is irrelevant).

The R&S FSWP adjusts the scaling of the y-axis accordingly.

For measurements with the optional external generator control, the command defines the position of the reference value.

Parameters:

<Position> *RST: 100 PCT = AF spectrum display; 50 PCT = time display

Example: `DISP:TRAC:Y:RPOS 50PCT`

Usage: SCPI confirmed

Manual operation: See "Reference Value Position" on page 58
See "Ref Level Position" on page 60

DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing <ScalingType>

This command selects the scaling of the y-axis (for all traces, <t> is irrelevant).

For AF spectrum displays, only the parameters "LINear" and "LOGarithmic" are permitted.

Parameters:

<ScalingType>

LOGarithmic
Logarithmic scaling.

LINear
Linear scaling in %.

LDB
Linear scaling in the specified unit.

PERCent
Linear scaling in %.

*RST: LOGarithmic

Example: `DISP:TRAC:Y:SPAC LIN`
Selects linear scaling in %.

Usage: SCPI confirmed

Manual operation: See "Deviation" on page 59
See "Scaling" on page 60

[SENSe:]ADEMod<n>:AF:CENTer <Frequency>

This command sets the center frequency for AF spectrum result display.

(<n> is irrelevant.)

Parameters:

<Frequency> *RST: 1.25 MHz

Manual operation: See "AF Center" on page 52

[SENSe:]ADEMod<n>:AF:SPAN <Span>

This command sets the span (around the center frequency) for AF spectrum result display.

The span is limited to DBW/2 (see `[SENSe:]BANDwidth|BWIDth:DEMod` on page 113).

(<n> is irrelevant.)

Parameters:

<Span>	*RST:	9 MHz

Example: `ADEM:AF:SPAN 200 kHz`
Sets the AF span to 200 kHz

Manual operation: See "AF Span" on page 52

[SENSe:]ADEMod<n>:AF:SPAN:FULL

This command sets the maximum span for AF spectrum result display.

The maximum span corresponds to DBW/2 (see `[SENSe:]BANDwidth|BWIDth:DEMod` on page 113).

(<n> is irrelevant.)

Example: `ADEM:BAND 5 MHz`
Sets the demodulation bandwidth to 5 MHz
`ADEM:AF:SPAN:FULL`
Sets the AF span to 2.5 MHz

Manual operation: See "AF Full Span" on page 52

[SENSe:]ADEMod<n>:AF:STARt <Frequency>

This command sets the start frequency for AF spectrum result display.

(<n> is irrelevant.)

Parameters:

<Frequency>	*RST:	0 MHz

Example: `ADEM:AF:STAR 0 kHz`
Sets the AF start frequency to 0 kHz
`ADEM:AF:STOP 500 kHz`
Sets the AF stop frequency to 500 kHz

Manual operation: See "AF Start" on page 52

[SENSe:]ADEMod<n>:AF:STOP <Frequency>

This command sets the stop frequency for AF spectrum result display.

(<n> is irrelevant.)

Parameters:
<Frequency> *RST: 9 MHz

Example: `ADEM:AF:STAR 0 kHz`
Sets the AF start frequency to 0 kHz
`ADEM:AF:STOP 500 kHz`
Sets the AF stop frequency to 500 kHz

Manual operation: See "AF Stop" on page 52

RF Evaluation

These settings are only available for RF evaluation, both in time and frequency domain.

Useful commands described elsewhere

- `[SENSe:]FREQuency:CENTer` on page 95
- `[SENSe:]BANDwidth|BWIDth:DEMod` on page 113

Specific commands:

[SENSe:]ADEMod<n>:SPEC:SPAN:ZOOM <Span>

This command sets the span (around the center frequency) for RF spectrum result display.

The span is limited to the demodulation bandwidth (see `[SENSe:]BANDwidth|BWIDth:DEMod` on page 113).

(<n> is irrelevant.)

Parameters:
<Span> *RST: 5 MHz

Example: `ADEM:SPEC:SPAN:ZOOM 200 kHz`
Sets the rF span to 200 kHz

Manual operation: See "Span" on page 53

[SENSe:]ADEMod<n>:SPECtrum:SPAN[:MAXimum] <FreqRange>

Sets the DBW to the specified value and the span (around the center frequency) of the RF data to be evaluated to its new maximum (the demodulation bandwidth).

(<n> is irrelevant.)

Parameters:
<FreqRange> *RST: 5 MHz
Default unit: Hz

Manual operation: See "Span" on page 53
See "RF Full Span" on page 54

10.2.8.4 (Post-processing) AF Filters

The AF filter reduces the evaluated bandwidth of the demodulated signal and can define a weighting function. AF filters are only available for AM or FM time domain evaluations.

[SENSe:]FILTer<n>:AWEighted[:STATe] <State>

This command activates/deactivates the "A" weighting filter for the specified evaluation.

For details on weighting filters see "Weighting" on page 55.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:AWE ON`

Activates the A weighting filter.

Manual operation: See "Weighting" on page 55

[SENSe:]FILTer<n>:AOFF

This command switches all AF filters for the selected evaluation off.

Usage: Setting only

Manual operation: See "Deactivating all AF Filters" on page 56

[SENSe:]FILTer<n>:CCIR:WEIGhted[:STATe] <State>

This command activates/deactivates the weighted CCIR filter for the specified evaluation.

For details on weighting filters see "Weighting" on page 55.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:CCIR:WEIG ON`
Activates the weighted CCIR filter.

Manual operation: See "Weighting" on page 55

[SENSe:]FILTer<n>:CCIR:[:UNWeighted][:STATe] <State>

This command activates/deactivates the unweighted CCIR filter in the specified window.

For details on weighting filters see "Weighting" on page 55.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:CCIR:UNW ON`
Activates the unweighted CCIR filter.

Manual operation: See "Weighting" on page 55

[SENSe:]FILTer<n>:CCIT <State>

This command activates/deactivates the CCITT (CCITT P.53) weighting filter for the specified evaluation.

For details on weighting filters see "Weighting" on page 55.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:CCIT ON`
Activates the CCITT weighting filter.

Manual operation: See "Weighting" on page 55

[SENSe:]FILTer<n>:DEMPhasis:TCONstant

This command selects the deemphasis for the specified evaluation.

For details on deemphasis refer to "Deemphasis" on page 56.

Parameters:

25 us | 50 us | 75 us | 750 us

*RST: 50 us

Example: `FILT:DEMP:TCON 750us`
Selects the deemphasis for the demodulation bandwidth range from 800 Hz to 4 MHz with a time constant of 750 µs.

Manual operation: See "Deemphasis" on page 56

[SENSe:]FILTer<n>:DEMPhasis[:STATe] <State>

This command activates/deactivates the selected deemphasis for the specified evaluation.

For details about deemphasis refer to "Deemphasis" on page 56.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:DEMP ON`

Activates the selected deemphasis.

Manual operation: See "Deemphasis" on page 56

[SENSe:]FILTer<n>:HPASs:FREQuency[:ABSolute] <FilterType>

This command selects the high pass filter type for the specified evaluation.

For details on the high pass filters refer to "High Pass" on page 54.

Parameters:

<FilterType> 20 Hz | 50 Hz | 300 Hz

*RST: 300Hz

Default unit: Hz

Example: `FILT:HPAS:FREQ 300Hz`

Selects the high pass filter for the demodulation bandwidth range from 800 Hz to 8 MHz.

Manual operation: See "High Pass" on page 54

[SENSe:]FILTer<n>:HPASs:FREQuency:MANual <Frequency>

This command selects the cutoff frequency of the high pass filter for the specified evaluation.

For details on the high pass filters refer to "High Pass" on page 54.

Parameters:

<Frequency> numeric value

Range: 0 to 3 MHz

*RST: 15kHz

Example: `FILT:HPAS:FREQ:MAN 3MHz`

The AF results are restricted to frequencies lower than 3 MHz.

Manual operation: See "High Pass" on page 54

[SENSe:]FILTer<n>:HPASs[:STATe] <State>

This command activates/deactivates the selected high pass filter for the specified evaluation.

For details on the high pass filter refer to "High Pass" on page 54.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:HPAS ON`
Activates the selected high pass filter.

Manual operation: See "High Pass" on page 54

[SENSe:]FILTer<n>:LPASs:FREQuency[:ABSolute] <FilterType>

This command selects the absolute low pass filter type for the specified evaluation

For details on the low pass filter refer to "Low Pass" on page 55.

Parameters:

<FilterType> 3kHz | 15kHz | 150kHz

*RST: 15kHz

Example: `FILT:LPAS:FREQ 150kHz`
Selects the low pass filter for the demodulation bandwidth range from 400 kHz to 16 MHz.

Manual operation: See "Low Pass" on page 55

[SENSe:]FILTer<n>:LPASs:FREQuency:MANual <Frequency>

This command selects the cutoff frequency of the low pass filter for the specified evaluation.

For details on the low pass filter refer to "Low Pass" on page 55.

Parameters:

<Frequency> numeric value

Range: 0 to 3 MHz
*RST: 15kHz

Example: `FILT:LPAS:FREQ:MAN 150kHz`
The AF results are restricted to frequencies lower than 150 kHz.

Manual operation: See "Low Pass" on page 55

[SENSe:]FILTer<n>:LPASs:FREQuency:RELative <FilterType>

This command selects the relative low pass filter type for the specified evaluation

For details on the low pass filter refer to "Low Pass" on page 55.

Parameters:

<FilterType> 5PCT | 10PCT | 25PCT

*RST: 25PCT

Example: `FILT:LPAS:FREQ:REL 25PCT`

Selects the low pass filter as 25 % of the demodulation bandwidth.

Manual operation: See "Low Pass" on page 55

[SENSe:]FILTer<n>:LPASs[:STATe] <State>

This command activates/deactivates the selected low pass filter for the specified evaluation.

For details on the low pass filter refer to "Low Pass" on page 55.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `FILT:LPAS ON`

Activates the selected low pass filter.

Manual operation: See "Low Pass" on page 55

10.2.8.5 Defining the Scaling and Units

The scaling parameters define the range of the demodulated data to be displayed.

10.2.8.6 Scaling for AF Evaluation

These settings are only available for AF evaluations.

Useful commands described elsewhere:

- `[SENSe:]ADJust:SCALe:Y:AUTO[:CONTinuous]` on page 106
- `[SENSe:]ADEMod<n>:AF:COUPling` on page 116
- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 119
- `DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 120

Specific commands:

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue <Value>

This command defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

Suffix:

<t> irrelevant

Parameters:

<Value> *RST: AM time domain: 0 PCT; FM time domain: 0 Hz; PM time domain: 0 rad; AM spectrum: 100 PCT; FM spectrum: 250 kHz; PM spectrum: 10 rad;

Example: `DISP:TRAC:Y:RVAL 0`
Sets the value assigned to the reference position to 0 Hz

Manual operation: See "Reference Value" on page 58

10.2.8.7 Scaling for RF Evaluation

These commands are required for RF evaluations and the result summary.

- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 119
- `DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing` on page 120
- `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE` on page 128

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe] <Range>

This command defines the display range of the y-axis (for all traces, <t> is irrelevant).

Parameters:

<Range> If the y-axis shows the power, the unit is dB with a range from 10 dB to 200 dB.
If the y-axis shows the frequency, the unit is Hz with a variable range.
*RST: 100 dB (frequency domain), 500 kHz (time domain)

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

Manual operation: See "Range" on page 59

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, <t> is irrelevant).

Usage: SCPI confirmed

Manual operation: See "Auto Scale Once" on page 60

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MODE <Mode>

This command selects the type of scaling of the y-axis (for all traces, <t> is irrelevant).

When the display update during remote control is off, this command has no immediate effect.

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 60

10.2.8.8 Units

The units define how the demodulated data is displayed.

UNIT<n>:ANGLe <Unit>

This command selects the unit for angles (for PM display, <n> is irrelevant).

This command is identical to `CALC:UNIT:ANGL`

Parameters:

<Unit> DEG | RAD

*RST: RAD

Example: `UNIT:ANGL DEG`

Manual operation: See "Phase Unit (Rad/Deg)" on page 61

UNIT<n>:THD <Mode>

Selects the unit for THD measurements (<n> is irrelevant).

This command is identical to `CALC:UNIT:THD`

Parameters:

<Mode> DB | PCT

*RST: DB

Example: `UNIT:THD PCT`

Manual operation: See "THD Unit (% / DB)" on page 61

10.2.8.9 Relative Demodulation Results

The following commands are required to obtain relative demodulation results.

CONFigure:ADEMod:RESults:AM:DETector<det>:REFerence <RefValue>
CONFigure:ADEMod:RESults:FM:DETector<det>:REFerence <RefValue>
CONFigure:ADEMod:RESults:PM:DETector<det>:REFerence <RefValue>

Defines the reference value to be used for relative demodulation results and recalculates the results. If necessary, the detector is activated.

A reference value *0* would provide infinite results and is thus automatically corrected to *0.1*.

Suffix:
<det> 1: Positive peak; 2: Negative peak; 3: Average of positive and negative peaks (+/-PK/2); 4: RMS
Detector function used for relative demodulation

Parameters:
<RefValue> double value

The unit depends on the demodulation type:
AM: %
FM: Hz
PM: depends on `UNIT<n>:ANGLe` setting

*RST: 1.0

Example: See `CONFigure:ADEMod:RESults:PM:DETector<det>:STATe` on page 130

Manual operation: See "Reference Value" on page 62

CONFigure:ADEMod:RESults:AM:DETector<det>:STATe <State>
CONFigure:ADEMod:RESults:FM:DETector<det>:STATe <State>
CONFigure:ADEMod:RESults:PM:DETector<det>:STATe <State>

Activates relative demodulation for the selected detector. If activated, the demodulated result is set in relation to the reference value defined by `CONFigure:ADEMod:RESults:AM:DETector<det>:REFerence`.

Suffix:
<det> 1: Positive peak; 2: Negative peak; 3: Average of positive and negative peaks (+/-PK/2); 4: RMS
Detector function used for relative demodulation

Parameters:
<State> ON | OFF | 1 | 0
*RST: OFF

Example: `CONF:ADEM:RES:PM:DET2:STAT ON`
Activates relative demodulation for the negative peak detector.
`CONF:ADEM:RES:UNIT PCT`
Defines the unit for relative values as percent.
`CONF:ADEM:RES:PM:DET2:REF 1.415%`
Sets the reference value for the negative peak detector to 1.415 %.
`CONF:ADEM:RES:PM:DET2:MODE AVER`
Sets the negative peak detector to average mode.
`CONF:ADEM:RES:PM:DET2:REF:MEAS`
Sets the reference value for the negative peak detector to the average of the currently calculated value and the previous reference value.

Manual operation: See "State" on page 62

CONFigure:ADEMod:RESults:AM:DETector<det>:REFerence:MEAStoref
CONFigure:ADEMod:RESults:FM:DETector<det>:REFerence:MEAStoref
CONFigure:ADEMod:RESults:PM:DETector<det>:REFerence:MEAStoref

Sets the reference value to be used for relative demodulation results to the currently measured value *for all relative detectors*.

If necessary, the detectors are activated.

A reference value *0* would provide infinite results and is thus automatically corrected to *0.1*.

Suffix:
<det> irrelevant

Example: See `CONFigure:ADEMod:RESults:PM:DETector<det>:STATe` on page 130

Usage: Event

Manual operation: See "Meas -> Reference" on page 63

CONFigure:ADEMod:RESults:AM:DETector<det>:MODE <Mode>
CONFigure:ADEMod:RESults:FM:DETector<det>:MODE <Mode>
CONFigure:ADEMod:RESults:PM:DETector<det>:MODE <Mode>

Defines the mode with which the demodulation result is determined.

Suffix:

<det> 1: Positive peak; 2: Negative peak; 3: Average of positive and negative peaks (+/-PK/2); 4: RMS
Detector function used for relative demodulation

Parameters:

<Mode>

WRITe
Overwrite mode: the detector value is overwritten by each sweep. This is the default setting.

AVERage
The average result is determined over all sweeps.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSWP saves each result only if the new value is greater than the previous one.

*RST: WRITe

Example: See `CONFigure:ADEMod:RESults:PM:DETector<det>:STATe` on page 130

Manual operation: See "Mode" on page 62

CONFigure:ADEMod:RESults:UNIT <Unit>

This command selects the unit for relative demodulation results.

Parameters:

<Unit> PCT | DB

*RST: PCT

Example:

`CONF:ADEM:RES:AM:DET2:STAT ON`
Activates relative demodulation for the negative peak detector.
`CONF:ADEM:RES:AM:DET2:MODE AVER`
Sets the negative peak detector to average mode.
`CONF:ADEM:RES:UNIT PCT`
Defines the unit for relative values as percent.
`CONF:ADEM:RES:AM:DET2:REF 1.415%`
Sets the reference value for relative results to 1.415 %.

Manual operation: See "Relative Unit" on page 61

10.3 Configuring the Result Display

10.3.1 General Window Commands

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

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SING

Example: `DISP:FORM SPL`

DISPlay[: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 137).

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:LARG`

10.3.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

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

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

This command adds a window to the display in the active measurement channel.

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

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

Parameters:

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

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

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

Return values:

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

Example: `LAY:ADD? '1',BEL,'XTIM:AM:RELative[:TDOMain]'`
Adds an AM Time Domain display below window 1.

Usage: Query only

Manual operation: See "AM Time Domain" on page 9
See "FM Time Domain" on page 10
See "PM Time Domain" on page 11
See "AM Spectrum" on page 12
See "FM Spectrum" on page 13
See "PM Spectrum" on page 14
See "RF Time Domain" on page 15
See "RF Spectrum" on page 16
See "Result Summary" on page 17
See "Marker Table" on page 18
See "Marker Peak List" on page 19

Table 10-2: <WindowType> parameter values for AnalogDemod application

Parameter value	Window type
MTABle	Marker table
PEAKlist	Marker peak list
RSUMmary	Result summary
'XTIM:AM'	RF Time Domain (= RF power)
'XTIM:AM:RELative'	AM Time Domain
'XTIM:AM:RELative:AFSPec-trum'	AM Spectrum
'XTIM:FM'	FM Time Domain
'XTIM:FM:AFSPectrum'	FM Spectrum
'XTIM:PM'	PM Time Domain
'XTIM:PM:AFSPectrum'	PM Spectrum
'XTIM:SPECtrum'	RF Spectrum

LAYout:CATalog[:WINDow]?

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

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

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

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

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

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Event

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

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

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

Parameters:

<WindowName>	String containing the name of the existing window. By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.
<WindowType>	Type of result display you want to use in the existing window. See `LAYout:ADD[:WINDow]?` on page 134 for a list of available window types.
Example:	`LAY:REPL:WIND '1',MTAB` Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 133 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

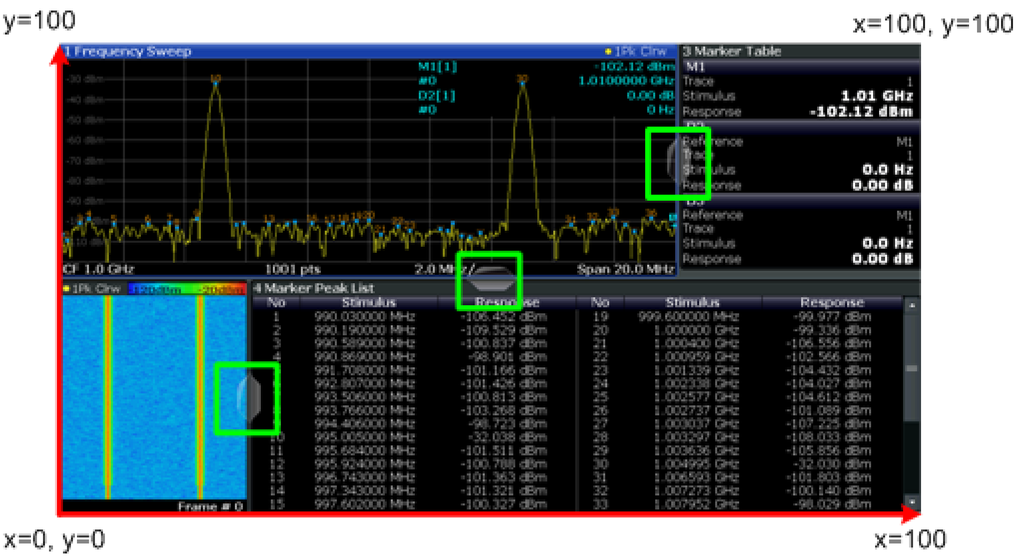


Figure 10-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1>	The index of one window the splitter controls.
<Index2>	The index of a window on the other side of the splitter.

<Position>	New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu). The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 10-1.) The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically. Range: 0 to 100

Example:
```
LAY:SPL 1,3,50
```
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example:
```
LAY:SPL 1,4,70
```
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

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

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

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

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

Parameters:

<Direction>	LEFT | RIGHt | ABOVe | BELow
<WindowType>	Type of measurement window you want to add. See `LAYout:ADD[:WINDow]?` on page 134 for a list of available window types.

Return values:

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

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

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

Return values:

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

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

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

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

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

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

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

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 134 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

10.4 Working with Measurement Results

10.4.1 Retrieving Results

Useful commands to retrieve results described elsewhere:

- `[SENSe:]ADEMod<n>:PM:RPOint[:X]` on page 116

[SENSe:]ADEMod:AM[:ABSolute][:TDOMain][:TYPE]? <TraceMode>
[SENSe:]ADEMod:AM:RELative[:TDOMain][:TYPE]? <TraceMode>
[SENSe:]ADEMod:AM:RELative:AFSPectrum[:TYPE]? <TraceMode>
[SENSe:]ADEMod:FM[:TDOMain][:TYPE]? <TraceMode>
[SENSe:]ADEMod:FM:AFSPectrum[:TYPE]? <TraceMode>
[SENSe:]ADEMod:PM[:TDOMain][:TYPE]? <TraceMode>
[SENSe:]ADEMod:PM:AFSPectrum[:TYPE]? <TraceMode>
[SENSe:]ADEMod<n>:SPECtrum[:TYPE] <TraceMode1>, <TraceMode2>, <TraceMode3>, <TraceMode4>, <TraceMode5>, <TraceMode6>

This command selects the trace modes of the evaluated signal to be measured simultaneously. For each of the six available traces a mode can be defined.

The trace modes are configured identically for all windows with a specific evaluation (<n> is irrelevant). The following table indicates which command syntax refers to which evaluation method.

Command syntax	**Evaluation method**
AM[:ABSolute][:TDOMain]	RF time domain
AM:RELative[:TDOMain]	AM time domain
AM:RELative:AFSPectrum	AM spectrum
FM[:TDOMain]	FM time domain
FM:AFSPectrum	FM spectrum
PM[:TDOMain]	PM time domain
PM:AFSPectrum	PM spectrum
SPECtrum	RF spectrum

Parameters:

<TraceMode>

WRITe
Overwrite mode: the trace is overwritten by each sweep. This is the default setting.

AVERage
The average is formed over several sweeps.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSWP 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 FSWP 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.

OFF
Hides the selected trace.

*RST: WRITe,OFF,OFF,OFF,OFF,OFF

Example:

`ADEM:AM AVER,MAXH,MINH,OFF,OFF,OFF`
Determines average, max hold and min hold values simultaneously for the traces 1-3 of the RF time domain evaluation.
`ADEM:AM WRIT,OFF,OFF,OFF,OFF,OFF`
Determines only the current measurement values for trace 1.
`ADEM:AM OFF,OFF,OFF,OFF,OFF,OFF`
Switches AM demodulation off.

[SENSe:]ADEMod:AM[:ABSolute][:TDOMain]:RESult? <TraceMode>
[SENSe:]ADEMod:AM:RELative[:TDOMain]:RESult? <TraceMode>
[SENSe:]ADEMod:AM:RELative:AFSPectrum:RESult? <TraceMode>
[SENSe:]ADEMod:FM[:TDOMain]:RESult? <TraceMode>
[SENSe:]ADEMod:FM:AFSPectrum:RESult? <TraceMode>
[SENSe:]ADEMod:PM[:TDOMain]:RESult? <TraceMode>
[SENSe:]ADEMod:PM:AFSPectrum:RESult? <TraceMode>
[SENSe:]ADEMod<n>:SPECtrum:RESult? <TraceMode>

This command reads the result data of the evaluated signal in the specified trace mode. The data format of the output data block is defined by the FORMat command (see `FORMat[:DATA]` on page 143).

The trace results are configured for a specific evaluation (<n> is irrelevant). The following table indicates which command syntax refers to which evaluation method, as well as the output unit of the results.

Command syntax	Evaluation method	Output unit
AM[:ABSolute][:TDOMain]	RF time domain	dBm
AM:RELative[:TDOMain]	AM time domain	%
AM:RELative:AFSPectrum	AM spectrum	%
FM[:TDOMain]	FM time domain	kHz
FM:AFSPectrum	FM spectrum	kHz
PM[:TDOMain]	PM time domain	rad or °
PM:AFSPectrum	PM spectrum	rad or °
SPECtrum	RF spectrum	dBm (logarithmic display) or V (linear display).

Query parameters:

<TraceMode> WRITe | AVERage | MAXHold | MINHold | VIEW

The specified trace mode must be one of those configured by `SENS:ADEM:<Evaluation>:TYPE`, see `[SENSe:]ADEMod<n>:SPECtrum[:TYPE]` on page 141. Otherwise a query error is generated.

Example:

`ADEM:AM AVER,MAXH,MINH`
Sets up RF time domain results to be measured
`INIT; *WAI`
Starts measurement and waits for sync
`FORM ASC`
Selects output format
`ADEM:AM:RES? AVER`
Reads RF time domain average results
`ADEM:AM:RES? MAXH`
Reads RF time domain max hold results
`ADEM:AM:RES? MINH`
Reads RF time domain min hold results

Usage: Query only

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from the R&S FSWP to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSWP. The R&S FSWP automatically recognizes the data it receives, regardless of the format.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
The format setting `REAL` is used for the binary transmission of trace data.
For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example: `FORM REAL,32`

Usage: SCPI confirmed

TRACe<n>[:DATA]

This command queries current trace data and measurement results.

The data format depends on `FORMat[:DATA]`.

Query parameters:

<ResultType> Selects the type of result to be returned.

TRACE1 | ... | TRACE6
Returns the trace data for the corresponding trace.

Return values:

<TraceData> 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.)

Example: `TRAC? TRACE3`
Queries the data of trace 3.

Usage: SCPI confirmed

CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:AFRequency[:RESult]?

This command queries the modulation (audio) frequency for the demodulation method in the selected window.

(<m> is irrelevant.)

Parameters:
<ModFreq> Modulation frequency in Hz.

Usage: Query only

CALCulate:MARKer:FUNCtion:ADEMod:AM[:RESult<t>]? <MeasType>
CALCulate:MARKer:FUNCtion:ADEMod:FM[:RESult<t>]? <MeasType>
CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:PM[:RESult<t>]? <MeasType>

This command queries the current value of the demodulated signal for the specified trace (as displayed in the Result Summary in manual operation).

Note that all windows with the same evaluation method have the same traces, thus the window is irrelevant.

(<m> is irrelevant.)

Query parameters:
<MeasType> PPEak | MPEak | MIDDle | RMS

PPEak
Postive peak (+PK)

MPEak | NPEak
Negative peak (-PK)

MIDDle
Average of positive and negative peaks ±PK/2

RMS
Root mean square value

Example:
`CALC:FEED 'XTIM:PM:TDOM'`
Switches on the PM time domain result display.
`DISP:TRAC ON`
Switches on the trace.
`CALC:MARK:FUNC:ADEM:PM? PPE`
Queries the peak value of the demodulated PM trace.

Usage: Query only

Manual operation: See "Result Summary" on page 17

CALCulate:MARKer:FUNCtion:ADEMod:AM[:RESult<t>]:RELative? <MeasType>
CALCulate:MARKer:FUNCtion:ADEMod:FM[:RESult<t>]:RELative? <MeasType>
CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:PM[:RESult<t>]:RELative? <MeasType>

This command queries the current *relative* value of the demodulated signal for the specified trace (as displayed in the Result Summary in manual operation).

Note that all windows with the same evaluation method have the same traces, thus the window (<n>) and marker <m> are irrelevant.

The unit of the results depends on the `CONFigure:ADEMod:RESults:UNIT` setting.

Query parameters:

<MeasType>

PPEak
Postive peak (+PK)

MPEak | NPEak
Negative peak (-PK)

MIDDle
Average of positive and negative peaks ±PK/2

RMS
Root mean square value

Example:

`CALC:FEED 'XTIM:PM:TDOM'`
Switches on the PM time domain result display.
`DISP:TRAC ON`
Switches on the trace.
`CALC:MARK:FUNC:ADEM:PM? PPE`
Queries the peak value of the demodulated PM trace.

Usage: Query only

Manual operation: See "Result Summary" on page 17

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Parameters:

<Position>

Numeric value that defines the marker position on the x-axis.
The position is relative to the reference marker.
A query returns the absolute position of the delta marker.

Range: The value range and unit depend on the measurement and scale of the x-axis.

Example:

`CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

The unit depends on the application of the command.

Table 10-3: Analog demodulation measurements

Parameter, measuring function or result display	Output unit
AM result display	% (lin) dB (log)
FM result display	Hz (lin) dB (log)
PM result display	rad | deg (lin) dB (log)
RF result display	dB (Range Log or Range Linear %) % (Range Linear %)

Return values:

<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example:

`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:CARRier[:RESult]?

This command queries the carrier power, which is determined from the Clr/Write data.

(<m> is irrelevant.)

Return values:

<CPower> Power of the carrier without modulation in dBm.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:FERRor[:RESult<t>]?

This command queries the carrier offset (= frequency error) for FM and PM demodulation. The carrier offset is determined from the current measurement data (CLR/WRITE). The modulation is removed using low pass filtering.

The offset thus determined differs from that calculated in the `[SENSe:]ADEMod<n>:FM:OFFSet?` command which uses averaging to determine the frequency deviation.

(<m> is irrelevant.)

Return values:

<CarrOffset> The deviation of the calculated carrier frequency to the ideal carrier frequency in Hz.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:SINad:RESult<t>?

This command queries the result of the signal-to-noise-and-distortion (SINAD) measurement in the specified window for the specified trace.

Note that this value is only calculated if an AF Spectrum window is displayed.

(<m> is irrelevant.)

Parameters:

<SINAD> The signal-to-noise-and-distortion ratio in dB.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:THD:RESult<t>?

This command queries the result of the total harmonic distortion (THD) measurement in the specified window.

Note that this value is only calculated if an AF Spectrum window is displayed.

(<m> is irrelevant.)

Parameters:

<THD> Total harmonic distortion of the demodulated signal in dB.

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis. The unit is either Hz (frequency domain) or s (time domain) or dB (statistics).

Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`

Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 18
See "Marker Peak List" on page 19

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

Result display	Output unit
AM	%
FM	Hz
PM	rad/deg (defined with `UNIT<n>:ANGLe` on page 129)
RF	dB (Range Log or Range Linear %) % (Range Linear dB)

Return values:
<Result> Result at the marker position.

Example:
`INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 18
See "Marker Peak List" on page 19

[SENSe:]ADEMod<n>:FM:OFFSet? <ResultType>

This command calculates the FM carrier offset from the currently available measurement data set.

The offset thus determined differs from the one calculated by the `CALCulate<n>:MARKer<m>:FUNCtion:ADEMod:FERRor[:RESult<t>]?` on page 147 command since, for determination of the frequency deviation, the modulation is removed by means of low pass filtering, producing results that are different from those obtained by averaging.

(<n> is irrelevant.)

Query parameters:

<ResultType> IMMediate | AVERage

IMMediate
The current measurement results are used to calculate the FM offset

AVERage
The measurement results that were averaged over the given number of measurements are used to calculate the FM offset
If no average measurement was active during the last measurement sequence only the `[SENSe:]ADEMod<n>:FM:OFFSet? IMMediate` command will return a correct result (data to calculate the offset are taken from the last measured data set). `[SENSe:]ADEMod<n>:FM:OFFSet? AVERage` will cause a query error in this case.

Example:
`ADEM:SET 8MHz,32000,EXT,POS,-500,30`
Sets up demodulator parameters to execute 30 measurements
`ADEM:FM AVER,OFF,OFF`
Selects FM results to perform averaging
`INIT; WAI`
Starts measurement and waits for sync
`ADEM:FM:OFFS? IMM`
Reads FM offset of last measurement of the sequence of 30
`ADEM:FM:OFFS? AVER`
Reads FM offset averaged over 30 measurements

Usage: Query only

[SENSe:]ADEMod<n>:PM:RPOint[:X] <Time>

This command determines the position where the phase of the PM-demodulated signal is set to 0 rad. The maximum possible value depends on the measurement time selected in the instrument; this value is output in response to the query `ADEM:PM:RPO:X? MAX`.

(<n> is irrelevant.)

Parameters:

<Time> 0 s to measurement time

*RST: 0 s

Example:
`ADEM:PM:RPO 500us`
Sets the position where the phase to 0 rad setting to 500 µs.

10.4.2 Exporting Trace Results

Trace results can be exported to a file.

For more commands concerning data and results storage see the R&S FSWP User Manual.

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

This command exports trace data from the specified window to an ASCII file.

Secure User Mode

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

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

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

Parameters:

<Trace> Number of the trace to be stored
(This parameter is ignored if the option "Export all Traces and all Table Results" is activated in the Export configuration settings, see `FORMat:DEXPort:TRACes` on page 152).

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 3,'C:\TEST.ASC'`
Stores trace 3 from window 1 in the file `TEST.ASC`.

Usage: SCPI confirmed

Manual operation: See "Export Trace to ASCII File" on page 68

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator.
Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

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.

See Chapter A.3, "Reference: ASCII File Export Format", on page 158 for details.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Usage: SCPI confirmed

FORMat:DEXPort:TRACes <Selection>

This command selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 151).

Parameters:

<Selection>

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. Result Summary, marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

Usage: SCPI confirmed

10.5 Analyzing Results

The functionality to analyze measurement results is the same as that of the Spectrum application.

For a comprehensive list and description of remote commands, please refer to the corresponding topics in the R&S FSWP User Manual.

10.6 Importing and Exporting Data

MMEMory:LOAD:IQ:STATe 1,<FileName>

This command restores I/Q data from a file.

Parameters:
<FileName> String containing the path and name of the source file.

Example: Loads IQ data from the specified file.

Usage: Setting only

Manual operation: See "I/Q Import" on page 68

MMEMory:STORe<n>:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

The suffix <n> is 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 69

MMEMory:STORe<n>:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The suffix <n> is irrelevant.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Secure User Mode

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

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

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

Parameters:
1

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores the captured I/Q data to the specified file.

Manual operation: See "I/Q Export" on page 69

10.7 Programming Example

In this example we will configure and perform an analog demodulation measurement to demonstrate the remote control commands.

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

Frequency:	500 MHz
Level:	-10 dBm
Modulation:	FM
Modulation frequency:	10 kHz
Frequency deviation:	50 kHz

```
//-----------Preparing the measurement ------------

*RST
//Reset the instrument
FREQ:CENT 500 MHz
//Set the center frequency to 500 MHz
DISP:TRAC:Y:SCAL:RLEV 0
//Set the reference level to 0 dBm

//---------- Activating an Analog Demod measurement channel -----------

INST:CRE:NEW ADEM,'FMDemodulation'
//Activate an Analog Demodulation measurement channel named "FMDemodulation"

//--------- Configuring data acquisition ------------------

ADEM:MTIM 1ms
//Set the measurement time to 1 ms (=10 periods)
SENS:ADJ:SCAL:Y:AUTO ON
//Optimize the scaling of the y-axis for the current measurement (continuously)
BAND:DEM 400 kHz
//Set the demodulation bandwidth to 400 kHz
TRIG:SOUR FM
//Use (offline) FM trigger
TRIG:LEV:FM 500MHz
//Trigger when signal reaches 500 MHz
```

```
//----------- Configuring the result display --------------------

LAY:ADD:WIND? '1',BEL,'XTIM:FM:AFSP'
//Add an FM Spectrum result display below FM Time Domain
ADEM:FM:AFSP WRIT,AVER,OFF,OFF,OFF,OFF
//Defines two traces in the FM Spectrum: 1: Clear/write, 2: average
ADEM:SET 8MHz,32000,FM,POS,-500,30
//Set analog demodulator to execute 30 sweeps with 32000 samples each
//at a sample rate of 8 MHz; use FM trigger, trigger on positive slope
//with a pretrigger offset of 500 samples

//--------------Performing the Measurement-----

INIT:CONT OFF
//Stop continuous sweep
INIT;*WAI
//Start a new measurement with 30 sweeps and wait for the end

//---------------Retrieving Results-------------

CALC:MARK:FUNC:ADEM:CARR?
//Queries the carrier power
//Result: -10.37 [dBm]
CALC2:MARK:FUNC:ADEM:SIN:RES?
//Queries the signal-to-noise-and-distortion ratio from the FM Spectrum
//Result: 65.026 [dB]
CALC2:MARK:FUNC:ADEM:THD:RES?
//Queries the total harmonic distortion of the demodulated signal
//from the FM Spectrum
//Result: -66.413 [dB]
CALC:MARK:FUNC:ADEM:FERR?
//Queries the FM carrier offset (=frequency error) for the most recent
//measurement (trace 1)
//Result: 649.07 [Hz]
ADEM:FM:OFFS? AVER
//Queries FM carrier offset averaged over 30 measurements
//Result: 600 [Hz]
TRAC:DATA? TRACE1
//Retrieve the trace data of the most recent measurement (trace 1)
//Result: -1.201362252,-1.173495054,-1.187217355,-1.186594367,-1.171583891,
//-1.188250422,-1.204138160,-1.181404829,-1.186317205,-1.197872400, [...]
TRAC:DATA? TRACE2
//Retrieve the averaged trace data for all 30 measurements (trace 2)
//Result: -1.201362252,-1.173495054,-1.187217355,-1.186594367,-1.171583891,
//-1.188250422,-1.204138160,-1.181404829,-1.186317205,-1.197872400, [...]
```

Annex

A Reference

A.1 Predefined Standards and Settings

You can configure the Analog Demodulation application using predefined standard settings. This allows for quick and easy configuration for commonly performed measurements.

For details see Chapter 4, "Configuration", on page 27.

Provided standard files

The instrument comes prepared with the following standard settings:

- AM Broadcast
- FM Narrowband
- FM Broadcast
- Frequency Settling
- None (default settings)

The default storage location for the settings files is:
`C:\R_S\Instr\user\predefined\AdemodPredefined`.

Predefined settings

The following parameters can be stored in a standard settings file. Any parameters that are not included in the xml file are set to their default values when the standard is loaded.

Measurement settings:

- DBW
- AQT
- Demod Filter
- Sweep Points
- Squelch (State, Level)
- Units (Phase, THD)
- RF Span

Window display settings:

- Position
- State
- Window number

- Window type (all evaluation methods supported by the Analog Demodulation application; see Chapter 2, "Measurements and Result Displays", on page 9)
- Scaling (Ref Position, Dev per Division)
- Time Domain Zoom (State, Start, Length)

AF specific settings:

- AF Center
- AF Span
- AF Filters (Lowpass, Highpass, Deemphasis, Weighting)
- Scaling for Spectrum (Ref Value, Deviation)
- Scaling for Time Domain (Ref Value, AF Coupling (FM/PM only))

Table A-1: List of predefined standards and settings

Setting	AM Broadcast	FM Narrowband	FM Broadcast	Frequency Settling *)	None (Default)
Demod. bandwidth	100 kHz	100 kHz	400 kHz	5 MHz	5 MHz
Aquisition time	100 ms	100 ms	100 ms	10 ms	62.5 µs
Input coupling	AC	AC	AC		AC
Squelch level				-30 dBm	-20 dBm
Windows	RF Spectrum AM Time Domain AM Spectrum Result Summary	RF Spectrum FM Time Domain FM Spectrum Result Summary	RF Spectrum FM Time Domain FM Spectrum Result Summary	FM Time Domain RF Time Domain	FM Time Domain Result Summary
AF filter - Highpass	20 kHz	50 Hz			-
AF filter - Lowpass	15 kHz	3 kHz	150 kHz		-
RF Spectrum					
Span	50 kHz	25 kHz	400 kHz		
AM/FM Time Domain					
Time domain zoom	10 ms	10 ms	10 ms		-
Dev per division		1 kHz	20 kHz	100 kHz	50 kHz
AM/FM Spectrum					
Start freq.	0 Hz	0 Hz	0 Hz		
Stop freq.	15 kHz	5 kHz	63.33 kHz		
Ref. value		5 kHz	75 kHz		
*) The Frequency Settling scenario requires a manually defined trigger					

A.2 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]`. 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.

A.3 Reference: ASCII File Export Format

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

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

The file of the Phase Noise application contains several sections, each section containing related data as shown in the tables below. Each section can contain header information and / or result information (header information is represented by a blue font in the tables below).

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

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

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

A.4 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.

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.

A.4.1 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>FSV-K10</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 A.4.2, "I/Q Data Binary File", on page 163). 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 A.4.2, "I/Q Data Binary File", on page 163). 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 FSWP). 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>
```


A.4.2 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 Remote Commands (Analog Demodulation)

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