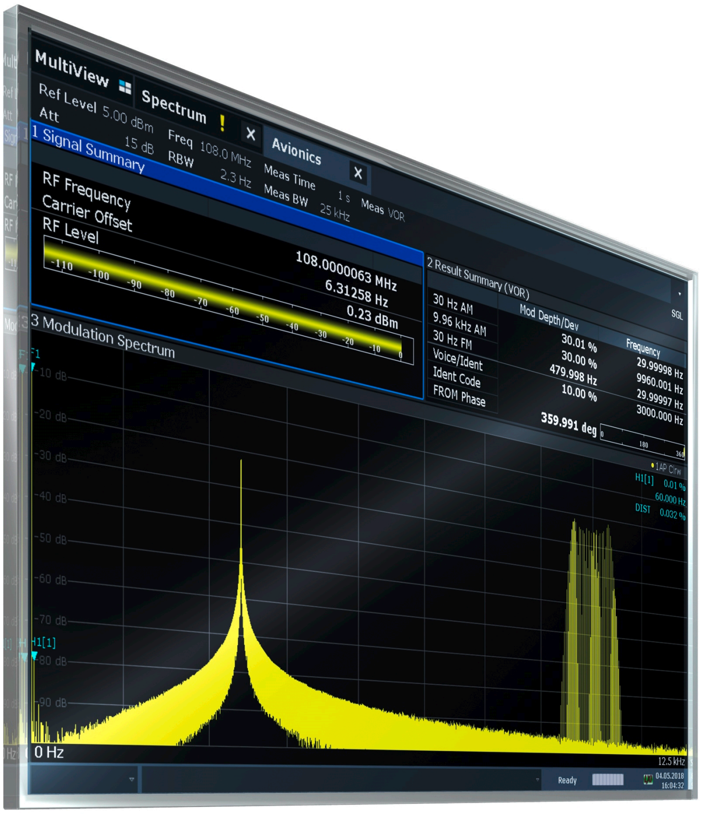
R&S®FSW-K15
Avionics (VOR/ILS) Measurements
User Manual



1177617502
Version 15

ROHDE&SCHWARZ
Make ideas real

This manual applies to the following FSW models with firmware version 6.10 and later:

- R&S®FSW8 (1331.5003K08 / 1312.8000K08)
- R&S®FSW13 (1331.5003K13 / 1312.8000K13)
- R&S®FSW26 (1331.5003K26 / 1312.8000K26)
- R&S®FSW43 (1331.5003K43 / 1312.8000K43)
- R&S®FSW50 (1331.5003K50 / 1312.8000K50)
- R&S®FSW67 (1331.5003K67 / 1312.8000K67)
- R&S®FSW85 (1331.5003K85 / 1312.8000K85)

The following firmware options are described:

- FSW-K15 (1331.4388.02)

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1177.6175.02 | Version 15 | R&S®FSW-K15

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

Contents

1 Documentation overview

This section provides an overview of the FSW user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/FSW

Further documents are available at:

www.rohde-schwarz.com/product/FSW

1.1 Getting started manual

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

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

1.2 User manuals and help

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

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

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

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

1.3 Service manual

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

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

https://gloris.rohde-schwarz.com

1.4 Instrument security procedures

Deals with security issues when working with the FSW in secure areas. It is available for download on the internet.

1.5 Printed safety instructions

Provides safety information in many languages. The printed document is delivered with the product.

1.6 Specifications and brochures

The specifications document, also known as the data sheet, contains the technical specifications of the FSW. It also lists the firmware applications and their order numbers, and optional accessories.

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

See www.rohde-schwarz.com/brochure-datasheet/FSW

1.7 Release notes and open-source acknowledgment (OSA)

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

The software uses several valuable open source software packages. An open source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/FSW

1.8 Application notes, application cards, white papers, etc.

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

See www.rohde-schwarz.com/application/FSW

1.9 Videos

Find various videos on Rohde & Schwarz products and test and measurement topics on YouTube: https://www.youtube.com/@RohdeundSchwarz

2 Welcome to the R&S FSW Avionics (VOR/ILS) measurements application

The FSW-K15 is a firmware application that adds functionality to perform VOR/ILS measurements to the FSW.

The FSW-K15 features:

- Demodulation of avionics (VOR/ILS) signals
- Modulation accuracy evaluation
- Maximum accuracy and temperature stability due to digital down-conversion
- No evidence of typical errors of analog down-conversion and demodulation like AM ⇔ FM conversion, deviation error, frequency response or frequency drift at DC coupling

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

General FSW functions

The application-independent functions for general tasks on the FSW are also available for VOR/ILS measurements and are described in the FSW user manual. In particular, this comprises the following functionality:

- Data management
- General software preferences and information

The latest version is available for download at the product homepage.

For further information see the Rohde & Schwarz Application Note 1MA193: "Aeronautical radio navigation measurement solutions".

Installation

You can find detailed installation instructions in the FSW Getting Started manual or in the Release Notes.

2.1 Starting the R&S FSW Avionics (VOR/ILS) measurements application

The R&S FSW Avionics (VOR/ILS) measurements application adds a new application to the FSW.

To activate the R&S FSW Avionics (VOR/ILS) measurements application

1. Press [MODE] on the front panel of the FSW.

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

2. Select the "Avionics" item.

The FSW opens a new measurement channel for the R&S FSW Avionics (VOR/ILS) measurements application.

The measurement is started immediately with the default settings. It can be configured in the VOR/ILS "Overview" dialog box, which is displayed when you select "Overview" from any menu (see Chapter 5.1, "Configuration overview", on page 43).

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.

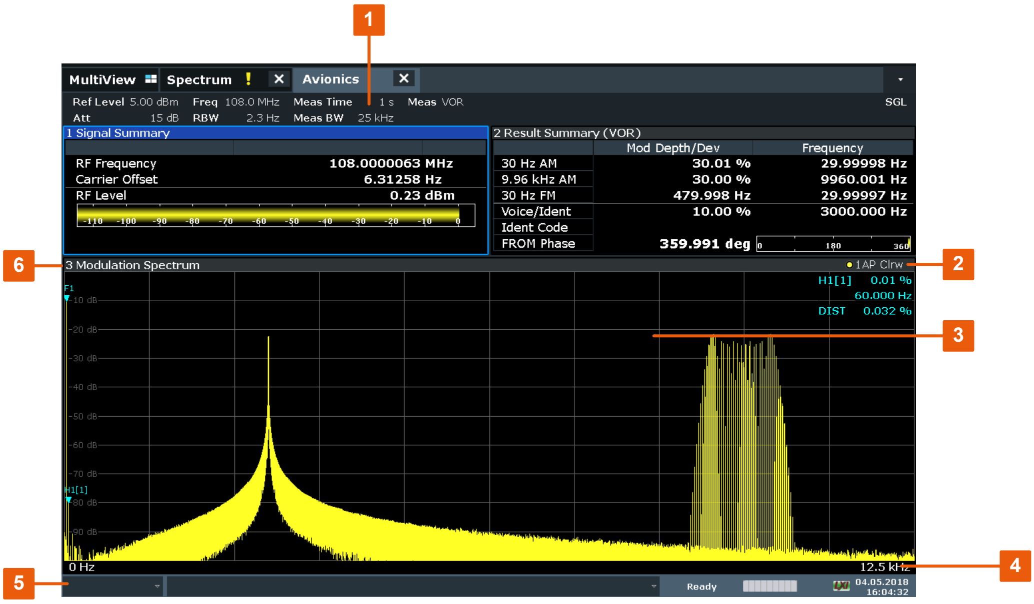
Only one measurement can be performed at any time, namely the one in the currently active channel. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

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 (including 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 FSW User Manual.

2.2 Understanding the display information

The following figure shows a measurement diagram during analyzer operation. 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+6 = Window title bar with diagram-specific (trace) information
3 = Diagram area with marker information
4 = Diagram footer with diagram-specific information, depending on measurement application
5 = Instrument status bar with error messages, progress bar and date/time display

Channel bar information

In the R&S FSW Avionics (VOR/ILS) measurements application, the FSW shows the following settings:

Table 2-1: Information displayed in the channel bar in the R&S FSW Avionics (VOR/ILS) measurements application

"Ref Level"	Reference level
"Att"	Mechanical and electronic RF attenuation
"Freq"	Center frequency
"RBW"	Resolution bandwidth
"Meas Time"	Measurement time for data acquisition.
"Meas BW"	Demodulation bandwidth
"Meas"	Measurement type (ILS/VOR)
"SGL"	The sweep is set to single sweep mode.

In addition, the channel bar also displays information on instrument settings that affect the measurement results even though this is not immediately apparent from the display of the measured values (e.g. transducer or trigger settings). This information is displayed only when applicable for the current measurement.

For details see the FSW Getting Started manual.

Window title bar information

For diagrams, the header provides the following information:

Figure 2-1: Window title bar information in the R&S FSW Avionics (VOR/ILS) measurements application

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

Diagram footer information

The diagram footer (beneath the diagram) contains the frequency range.

Status bar information

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

3 Measurement basics

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

3.1 General information on ILS and VOR/DVOR

The following topics summarize some background information on the related avionics standards. The provided overview information is intended as explanation of the used terms and does not aim to be comprehensive.

3.1.1 The instrument landing system (ILS)

An instrument landing system is used in aircraft during the landing approach to monitor the correct approach path to the runway.

Using the globally standardized system ILS, an aircraft on a defined glide-path receives highly accurate position information in reference to the glide-path during landing. This landing path is described by the intersection of a vertical glide-slope level and a horizontal localizer plane.

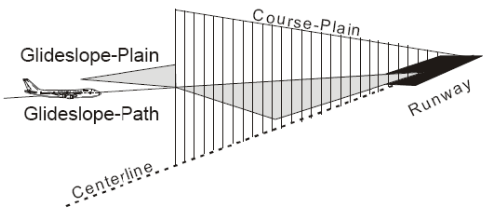


Figure 3-1: Basics of the ILS

An ILS system consists of three independent subsystems:

- A glide slope for vertical guidance.
- A localizer for horizontal guidance.
- (optional) marker beacons

3.1.1.1 Localizer basics

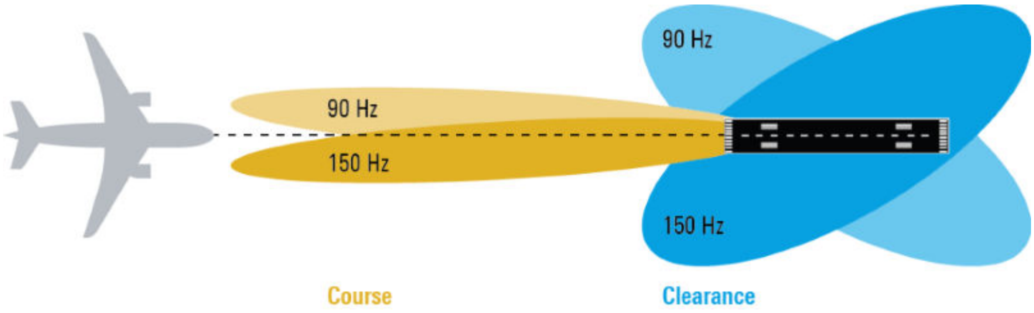
The localizer transmitter is located near the end of the runway (nearest to the start of the aircraft approach). Typically, horizontally aligned antennas transmit two intersecting main beams beside one another at carrier frequencies between 108 MHz and 112 MHz. As seen from the approaching aircraft coming in for a landing, the left beam is usually modulated at 90 Hz and the right beam at 150 Hz.

The information on position is provided after demodulation of the beam signals by evaluating the difference in depth of modulation (DDM).

DDM = m(x90) – m(x150)

The following scenarios are possible:

- Predominance of the 90 Hz beam: the aircraft is too far to the left and must turn to the right
- Predominance of the 150 Hz beam: the aircraft is too far to the right and must turn to the left
- The signal strength from both beams is equal: the aircraft is in the center, on the right course.



Course and clearance signals

The landing path is divided into the region further away from the runway, referred to as the course, and the runway itself, referred to as the clearance. Localizers are positioned in both areas, however they transmit their ILS signals using different frequencies, one that must travel farther, one for close-up. The frequencies differ only in a few kilohertz. The aircraft always receives both signals, and cannot (and need not) distinguish the two. However, for test purposes, it can be useful to measure the signals individually.

Morse code identification signal

The localizer not only allows the aircraft to determine its position, it also provides identification of the ILS transmitter. The localizer periodically transmits a Morse code at 1020 Hz which uniquely identifies the transmitter. The receiver thus knows that the ILS is operating correctly and that it is receiving the correct signal. The glide slope station does not transmit an identification signal.

3.1.1.2 Glide slope basics

The following description is taken from the Rohde & Schwarz Application Note 1MA193: "Aeronautical radio navigation measurement solutions".

The glide slope transmitter is located near the end of the runway (nearest to the start of the aircraft approach).

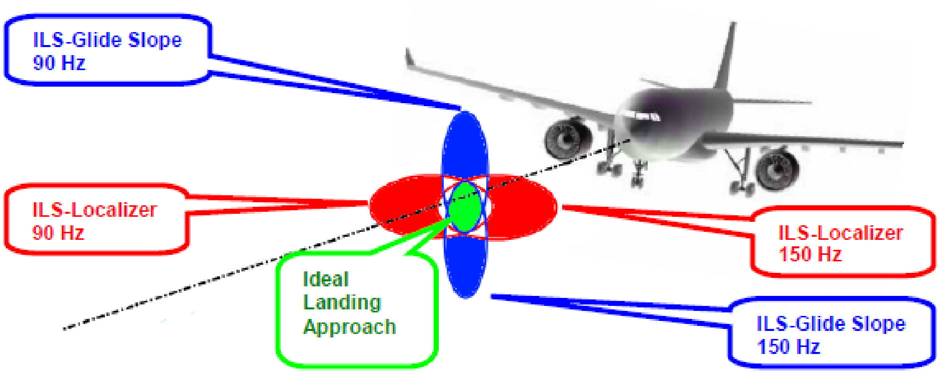


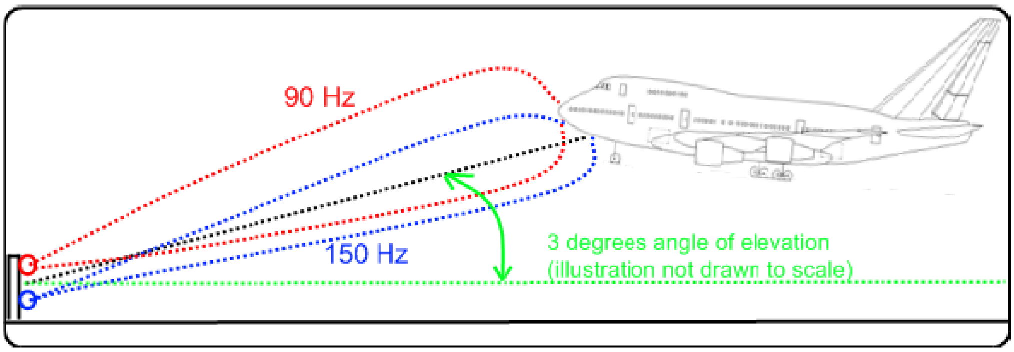
Figure 3-2: Approach navigation using instrument landing system (ILS)

Typically, vertically aligned antennas transmit two intersecting main beams on top of one another at carrier frequencies between 329 MHz and 335 MHz. The top beam is usually modulated at 90 Hz and the beam below at 150 Hz.

The information on position is provided after demodulation of the beam signals by evaluating the difference in depth of modulation (DDM). The following scenarios are possible:

- Predominance of the 90 Hz beam: the aircraft is too high and must descend
- Predominance of the 150 Hz beam: the aircraft is too low and needs to climb
- The signal strength from both beams is equal: the aircraft is in the center, on the right course.

If there is a predominance of the 90 Hz beam, then the aircraft is too high and must descend. A predominant 150 Hz means that the aircraft is too low and needs to climb.



3.1.2 VHF omnidirectional radio range (VOR)

Very high frequency (VHF) omnidirectional radio range (VOR) is a radio navigation system for short and medium distance navigation. The VOR radio navigation aid supplies the aircraft with directional information, angle information relative to the magnetic north from the site of the beacon. Thus, it helps aircraft to determine their position and stay on course. The range covered by a VOR station is ideally a circle around the VOR station with a radius depending on the flight altitude.

A VOR system consists of a ground transmission station and a VOR receiver on board the aircraft.

Ground transmitter

The transmitter stations operate at VHF frequencies of 108 MHz to 118 MHz, with the code identification (COM/ID) transmitting on a modulation tone of 1.020 kHz. It emits two types of signals:

- An omnidirectional reference signal (REF) that can consist of two parts:
  - 30 Hz frequency modulated (FM) sine wave on subcarrier 9.96 kHz from amplitude modulation (AM) carrier
  - 1020 Hz AM modulated sine wave Morse code
- A directional positioning signal, variable (VAR): 30 Hz AM modulated sine waves with variable phase shift

VOR receiver

The VOR receiver obtains the directional information by measuring the phase difference of two 30 Hz signals transmitted by the beacon. A conventional VOR station (CVOR) transmits with a rotating antenna. From the rotation, a sine wave AM signal arises in the receiver, whose phase position depends on the present angle of rotation. The rotation frequency of the antenna sets the modulation frequency at 30 Hz.

Instead of using a rotating antenna, DVOR stations (Doppler) divide the circumference of the antenna into 48 or 50 segments, covering each segment by its own antenna. Each antenna transmits the unmodulated subcarrier from one antenna to the next, so that the signal completes the round trip 30 times per second.

To determine the radial, the phase difference to a reference phase must be measured. This reference phase must be independent of the rotation of the antenna. Thus, it is modulated with a frequency deviation of 480 Hz in FM onto a secondary carrier with 9.96 kHz. It is then emitted over a separate antenna with a round characteristic.

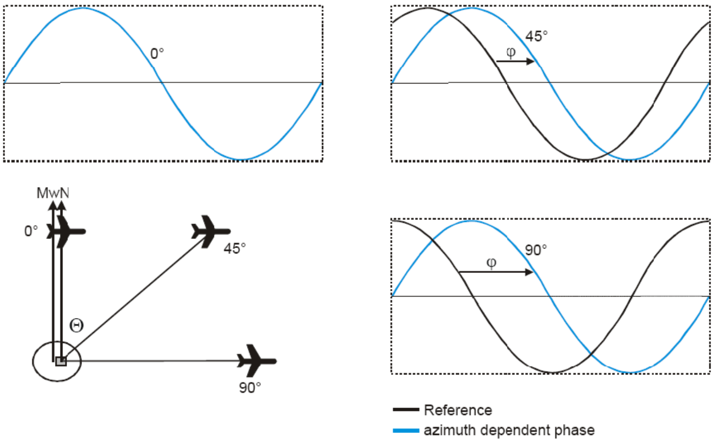


Figure 3-3: Basics of the VOR phase angles (Φ) depending on the azimuth angle (Θ)

The frequency modulated secondary carrier for the reference phase is itself again modulated in AM on the RF carrier of the VOR station. In addition to the signals necessary for navigation, a Morse code with 1020 Hz can be transmitted on the VOR carrier. Also, speech in the usual AF from 300 Hz to 3.3 kHz can be transmitted. Often the voice channel of a VOR station is used for the transmission of ATIS (Automatic Terminal Information Service) messages. The Morse code can be used to identify the VOR station, similar to the "Morse code identification signal" on page 15 in the ILS signal.

The spectrum of a VOR signal is therefore composed of the carrier and three modulated components.

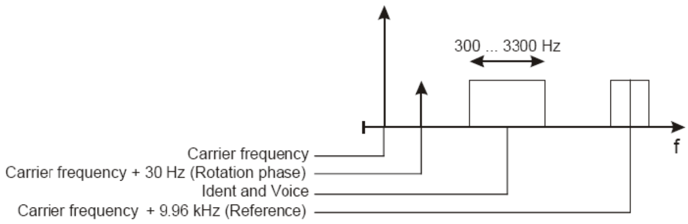


Figure 3-4: Example of the VOR Spectrum

The identical modulation degree m = 0.3 for all three components was selected in ICAO annex-10 [63] such that the total signal still contains 10% modulation reserve. The carrier is therefore not suppressed at any time. The 9960 Hz reference carrier is FM modulated with 480 Hz deviation. The VOR signal generation as under ICAO is shown below.

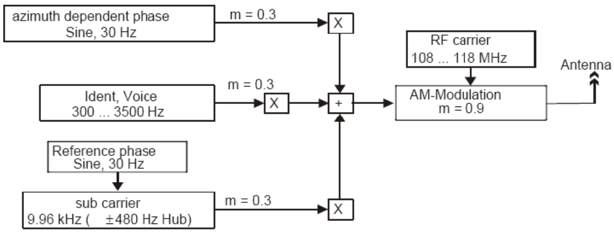


Figure 3-5: Basics of the VOR signal generation

3.1.3 DVOR (doppler VHF omni-directional range)

Like a VOR beacon, a DVOR beacon transmits an RF signal in which the two phase angles are coded. From the difference between these phases, the receiver can calculate its position in reference to the DVOR. In contrast to the VOR signal, the meaning of the reference and azimuth-dependent phase is opposite. This means that the reference phase is no longer emitted in FM through the secondary carrier. Instead, the 30 Hz reference signal is emitted in AM from a fixed antenna.

In DVOR the azimuth-dependent phase is generated using the Doppler effect. The Doppler effect is such that the receiving frequency f_{rx} increases when there is radial relative movement of a receiver with a speed v_x towards the transmitter. Correspondingly, it decreases when there is movement away from the transmitter.

The following figure shows the 50 circularly arranged single antennas of a DVOR station. The secondary carrier to be transmitted on (+9.96 kHz carrier) is distributed using an electronic multiplexer on the circularly arranged antenna. Thus, the transmission signal seems to revolve at 30 Hz in the circle.

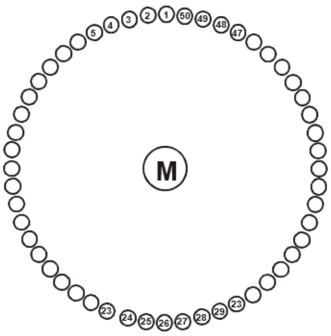


Figure 3-6: Basics of a DVOR system

The circles shown in the above figure symbolize radial transmitters. The transmission antenna in the center of the circle (M) transmits the reference phase in the form of the 30 Hz AM modulated carrier and the identifier of the station. The Doppler shift corresponds to the FM deviation.

In practice both sidebands of the secondary carrier (carrier + 9.96 kHz and carrier - 9.96 kHz) are created separately and fed into the antenna array spatially displaced by 180°. Therefore two super-imposed individual antennas are emitting at one period in time, each being one sideband of the total signal. In the far field, there is the effect of an FM signal on the receiver. One sideband component always increases in frequency due to the Doppler effect, while the other component decreases in frequency. The reason for this complex method of signal generation lies in the high accuracy which can be obtained for the azimuth-dependent phase.

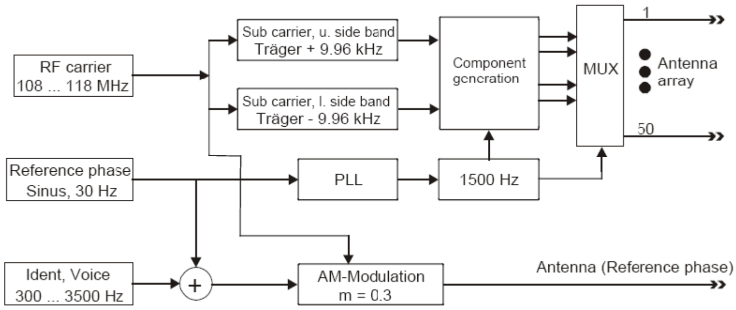


Figure 3-7: Basics of the DVOR signal generation

3.2 Description of the VOR/ILS measurement demodulator

The following chapter describes the functions of the VOR/ILS measurement demodulator in the R&S FSW Avionics (VOR/ILS) measurements application.

By sampling (digitization) already at the IF and digital down-conversion to the baseband (I/Q), the demodulator achieves maximum accuracy and temperature stability. There is no evidence of typical errors of an analog down-conversion and demodulation like AM ⇔ FM conversion, deviation error, frequency response or frequency drift at DC coupling.

3.2.1 Circuit description - block diagrams

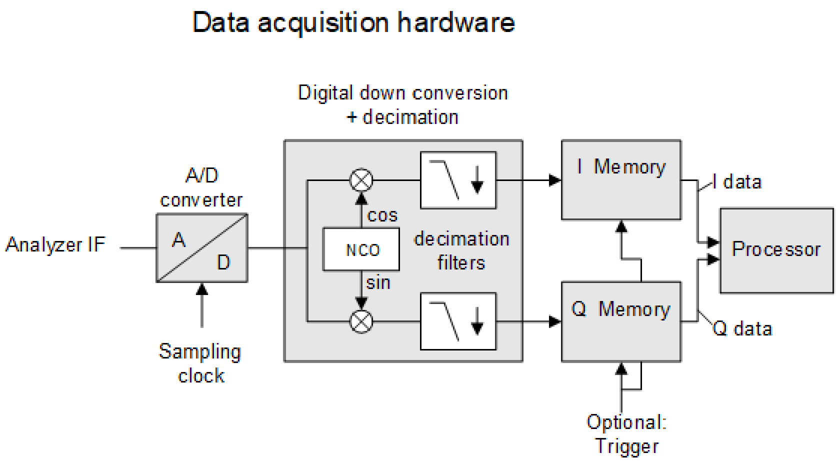


Figure 3-8: Block diagram of analyzer signal processing

Figure 3-8 shows the analyzer's hardware from the IF to the processor. The A/D converter samples the IF.

Lowpass filtering and reduction of the sampling rate follow the down-conversion to the complex baseband. The decimation depends on the selected demodulation bandwidth. Useless over-sampling at narrow bandwidths is avoided, saving calculating time and increasing the maximum recording time.

3.2.2 ILS demodulator

The software demodulator runs on the main processor of the analyzer. The demodulation process is shown below. All calculations are performed simultaneously with the same I/Q data set.

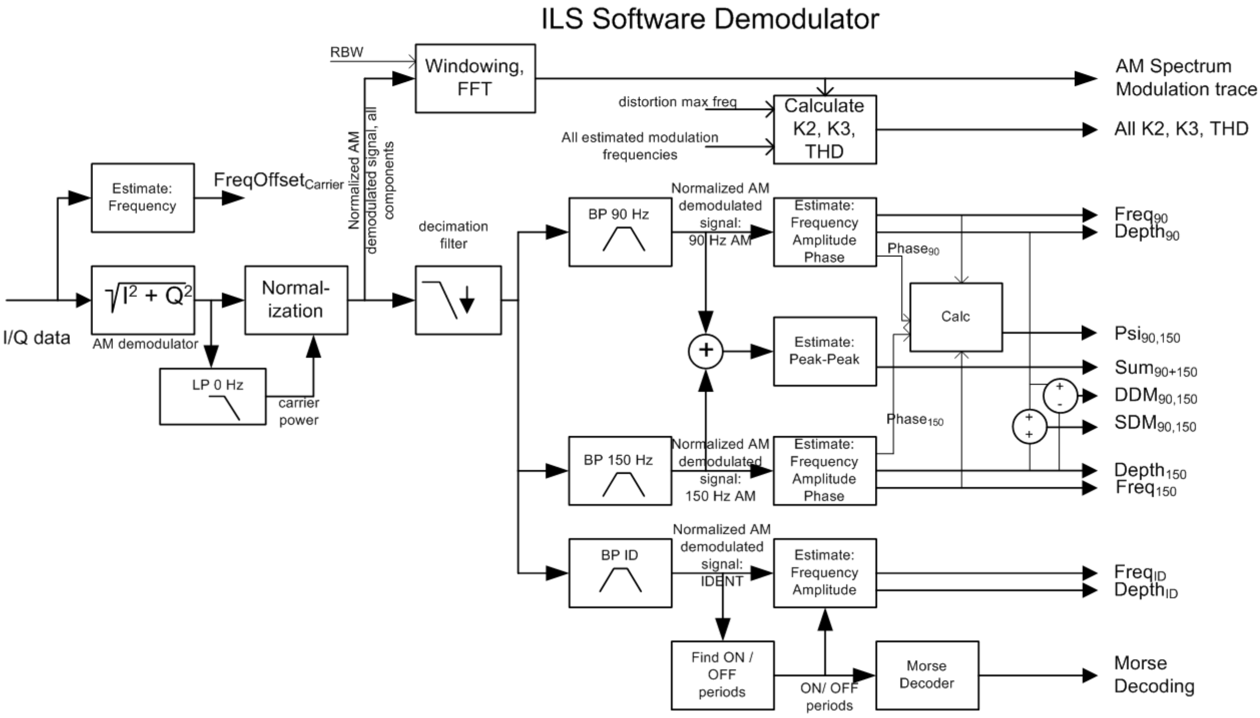


Figure 3-9: Block diagram of ILS software demodulator

The ILS demodulation basically comprises two bandpass filters with 90 Hz and 150 Hz center frequencies. To meet the required selectivity with a reasonable filter order, the AM signal must be decimated in frequency before filtering.

The optional ID signal is separated by a bandpass filter with a frequency range from 300 Hz to 4000 Hz.

A Morse decoder detects and decodes the ON and OFF periods in the identifier signal.

AM modulation depth

To obtain the AM depth, a lowpass filter must calculate the mean carrier power, while suppressing all other signal components. The mean carrier power is then used to normalize the instantaneous magnitude of the I/Q signal. The result is the AM modulation depth signal vs. time.

The following AM depths and their derivatives are calculated:

- "$Depth_{90}$": Modulation depth of the 90 Hz signal
- "$Depth_{150}$": Modulation depth of the 150 Hz signal
- "$Depth_{ID}$": Modulation depth of the identification/voice signal.
  - For a demodulation bandwidth of 12.5 kHz or larger: from 300 Hz to 4 kHz.
  - For a demodulation bandwidth of 3.2 kHz: from 300 Hz to 1.6 kHz
  - For a demodulation bandwidth of 800 Hz: not supported
- "Sum90+150": Modulation depth of the signal containing both the 90 Hz and the 150 Hz component. Measured as peak-to-peak value after interpolating the signal.
- "SDM90,150": Sum of modulation depths: "Depth90" + "Depth150"
- "DDM90,150": Difference in modulation depths: "Depth90" - "Depth150"

AF frequencies

The following AF frequencies are calculated:

- "Freq90": Modulating frequency of the 90 Hz signal
- "Freq150": Modulating frequency of the 150 Hz signal
- "FreqID": Modulating frequency of the identification/voice signal.
  - For a demodulation bandwidth of 12.5 kHz or larger: from 300 Hz to 4 kHz.
  - For a demodulation bandwidth of 3.2 kHz: from 300 Hz to 1.6 kHz
  - For a demodulation bandwidth of 800 Hz: not supported

Phase angle 90/150 Hz

The phase angle is calculated using the estimated phases and frequencies of the 90 Hz and the 150 Hz signal. It describes the phase of the 150 Hz signal at the time the 90 Hz signal crosses zero. If both involved frequencies have their ideal 3 to 5 ratio the phase angle is valid. Phase angles exceeding ± 60° lead to ambiguous results. If one of the two involved signals is turned off or if the frequency ratio is not 3 to 5, this result does not make sense.

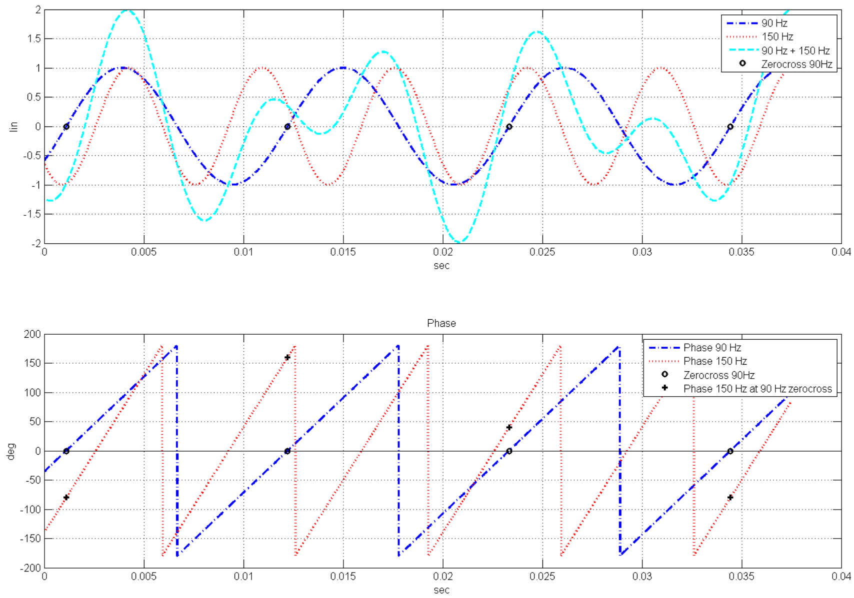


Figure 3-10: Phase angle ambiguity

Example: ILS phase difference of 40 degrees

When the 90 Hz signal crosses zero, the 150 Hz signal has the following phase values:

-80 deg, +160 deg, +40 deg, -80 deg, etc.

If you add or subtract 120 degrees, the ambiguity is eliminated: all values become 40 degrees.

ILS distortion

The ILS software demodulator also analyzes AM AF distortions. The AM modulation depth vs time signal is processed by an FFT, using a user-defined resolution bandwidth. The trace is displayed in the "Modulation Spectrum" display. The K2, K3 and THD results of the AM components are calculated based on the FFT trace and the estimated modulation frequencies.

3.2.3 VOR demodulator

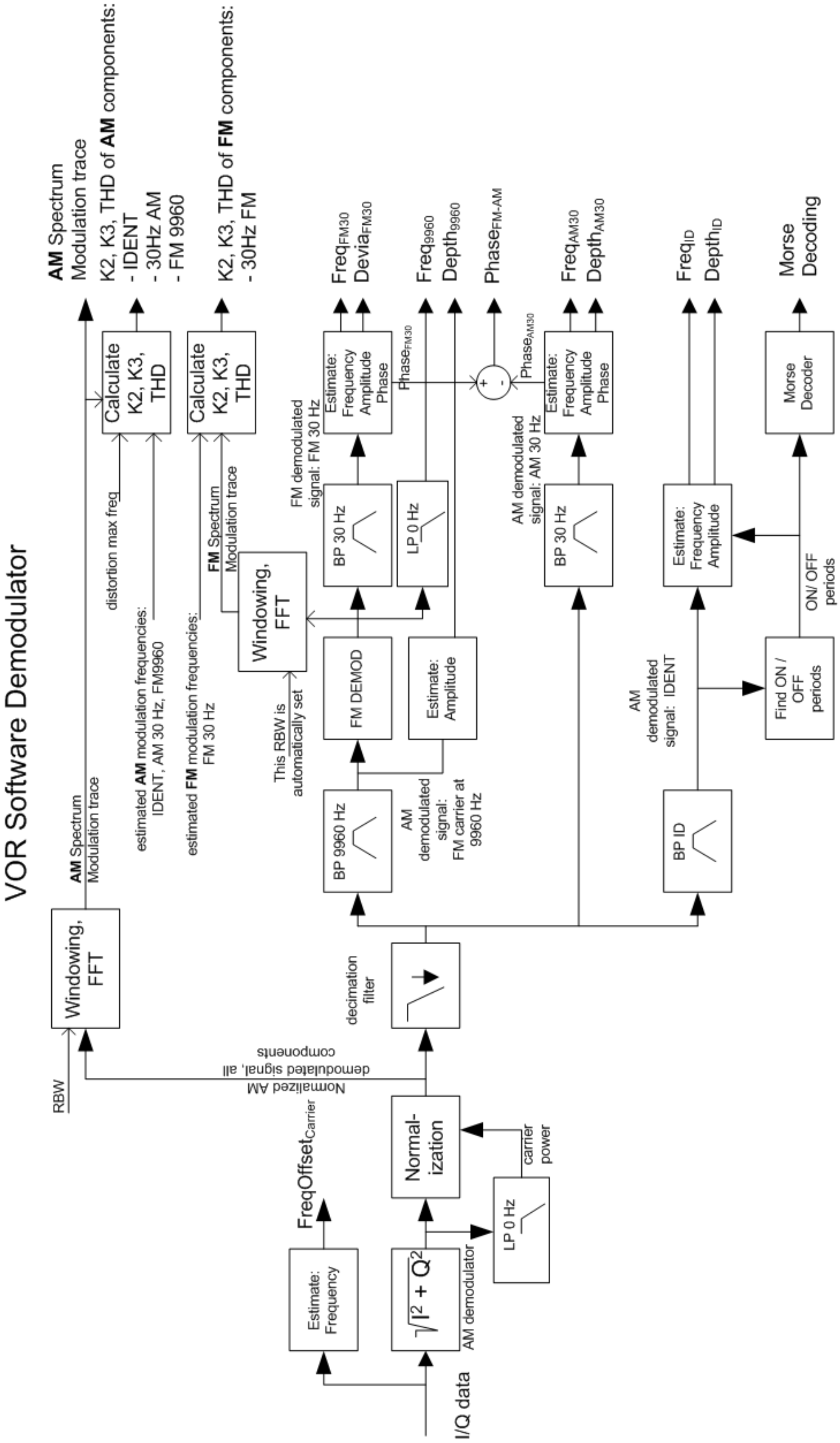


Figure 3-11: Block diagram of the VOR software demodulator

The VOR signal contains three AM modulated components that must be separated in a first step:

- Rotational signal (30 Hz)
- Identification/voice part (300 Hz to 4 kHz)
- FM modulated carrier (9960 Hz ± 700 Hz)

To obtain the AM depth, a lowpass filter must calculate the mean carrier power, while suppressing all other signal components. The mean carrier power is then used to normalize the instantaneous magnitude of the I/Q signal. The result is the AM modulation depth signal vs. time. The three AM components are separated using bandpass filters covering the individual frequency ranges.

A Morse decoder detects and decodes the ON and OFF periods in the identifier signal.

The separated FM modulated carrier is passed through an FM demodulator. The FM carrier frequency (nominal 9960 Hz) is calculated as the average output value of the FM demodulator. To obtain the 30 Hz reference signal, the FM demodulator output is filtered by the same narrow 30 Hz bandpass as the 30 Hz AM rotational component. FM deviation is calculated using the estimated magnitude of the 30 Hz reference signal.

The azimuth is calculated as the phase difference of the 30 Hz reference signal and the 30 Hz rotational signal.

VOR distortion

In the VOR software demodulator two kinds of signals are analyzed regarding distortions:

- AM Distortion: The AM modulation depth vs time signal is processed by an FFT, with a user-defined resolution bandwidth. The trace is displayed in the "Modulation Spectrum" display. The K2, K3 and THD results of the AM components are calculated based on the FFT trace and the estimated modulation frequencies.
- FM Distortion: The FM modulation depth vs time signal is processed by an FFT, using a resolution bandwidth automatically set by the application. You cannot view the resulting trace. The K2, K3 and THD results of the FM components are calculated based on the FFT trace and the estimated modulation frequencies.

3.2.3.1 AM modulation depth

To obtain the AM depth, a lowpass filter must calculate the mean carrier power, while suppressing all other signal components. The mean carrier power is then used to normalize the instantaneous magnitude of the I/Q signal. The result is the AM modulation depth signal versus time. It is then used to calculate the following AM modulation depths:

- $Depth_{9960}$: AM modulation depth of the FM carrier, typically at 9960 Hz
- $Depth_{AM30}$: AM modulation depth of the 30 Hz rotational signal
- $Depth_{ID}$: AM modulation depth of the identification/voice signal

3.2.3.2 FM modulation depth

The FM deviation $Devia_{FM30}$ (typically 480 Hz) is calculated by estimating the magnitude of the FM demodulated 30 Hz reference signal.

3.2.3.3 Azimuth (phase difference at 30 hz)

The phases of both the 30 Hz FM and 30 Hz AM signal are estimated at exactly the same time instant. The azimuth (Phase FM-AM) is calculated as the phase difference between the two.

3.2.3.4 AF frequencies

In the VOR demodulator the AF frequencies are calculated:

- $Freq_{AM30}$: 30 Hz Rotational-signal (AM)
- $Freq_{FM30}$: 30 Hz Reference-signal (FM)
- $Freq_{ID}$: voice / identification; From 300 Hz to 4 kHz, typically 1020 Hz
- $Freq_{9960}$: The carrier frequency of the FM carrier, typically 9960 Hz; Calculated as mean value of the FM demodulator output

3.3 Impact of specific parameters

3.3.1 Demodulation bandwidth

The R&S FSW Avionics (VOR/ILS) measurements application captures I/Q data using digital filters with quasi-rectangular amplitude responses. The demodulation bandwidth defines the width of the filter's flat passband. This is not the 3 dB bandwidth, but the useful bandwidth which is distortion-free with regard to phase and amplitude.

Small demodulation bandwidths have the following advantages:

- Lower sample rate, less IQ data, higher measurement speed
- Only the signal of interest is captured, no adjacent signals and less noise captured, better SNR

Large demodulation bandwidths have the following advantages:

- A high carrier frequency offset of the DUT is no longer critical because the whole spectrum of the signal still falls in the filter's passband. FM to AM conversion is avoided (VOR mode)
- The "Modulation Spectrum" display allows for a wider span, showing harmonics of a higher order

It is recommended that you use the automatic configuration of the demodulation bandwidth, which applies the following settings:

- ILS
  DBW = 12.5 kHz, to capture the full identifier signal
- VOR
  DBW = 25 kHz, to capture the 9.96 kHz signal

If the demodulation bandwidth setting is changed, some demodulation results may not be available due to bandwidth limitations. For harmonic distortion measurement, the highest measured harmonic signal may be limited due to the demodulation bandwidth (see also "Distortion Max Frequency" on page 68).

The following tables show the relationship between the available demodulation bandwidths and measurement times for the different measurements.

Table 3-1: Available demodulation bandwidths and measurement times for ILS measurements

Demodulation BW	Meas time min	Meas time max	Meas time default
800 Hz	0.1 sec	133 sec	1 sec
3.2 KHz	0.1 sec	33.4 sec	1 sec
12.5 KHz	0.1 sec	8.356 sec	1 sec
50 KHz	0.1 sec	8.356 sec	1 sec
100 KHz	0.1 sec	8.356 sec	1 sec

Table 3-2: Available demodulation bandwidths and measurement times for VOR measurements

Demodulation BW	Meas time min	Meas time max	Meas time default
25 KHz	0.1 sec	30 sec	1 sec
50 KHz	0.1 sec	30 sec	1 sec
100 KHz	0.1 sec	30 sec	1 sec

3.3.2 Stability of measurement results

The stability of the algorithms used to estimate the modulation depths and Azimuth rely on a sufficient amount of data. This is achieved if at least five periods of the 30 Hz basic modulation frequency are recorded. Since the R&S FSW Avionics (VOR/ILS) measurements application automatically compensates for filter settling times internally, a measurement time of approximately 200 ms is required.

Note that the precision as specified in the specifications document is guaranteed only if the 30 Hz AM rotational component can be identified properly in the VOR analysis case.

3.3.3 Phase notation in VOR measurements

In VOR measurements, the phase can be provided using two different notations, indicated in the following illustration:

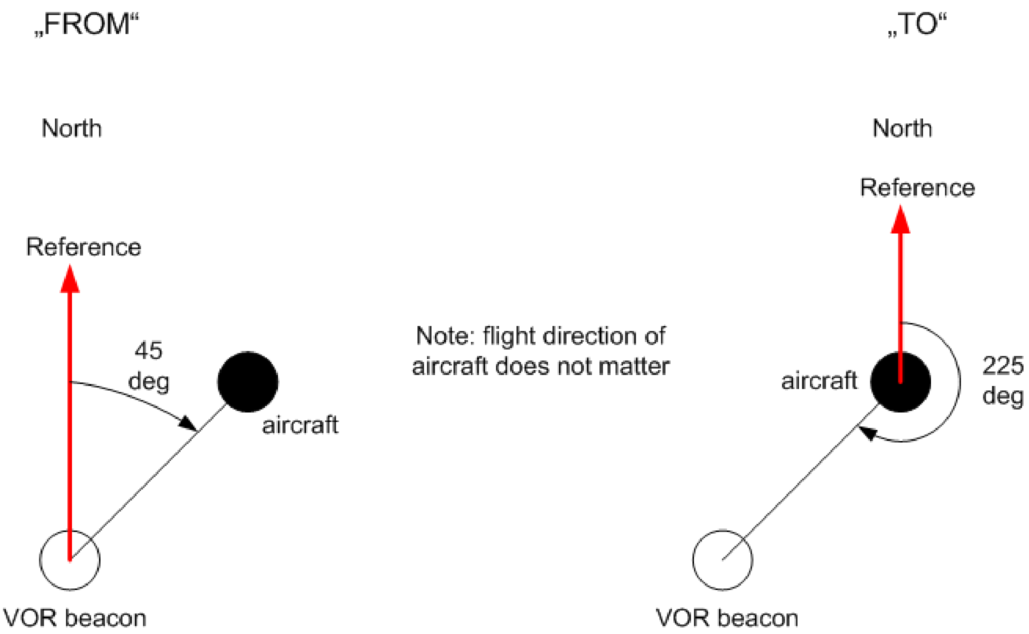


Figure 3-12: Phase notation in VOR measurements

Phase is always counted counter-clockwise, starting at the reference.

The reference depends on the selected notation:

- **FROM**: North direction at the VOR beacon
- **TO**: North direction at the receiver/ aircraft

To convert one notation to the other, use the following equation:

$Phase_{TO} = Phase_{FROM} + 180\ deg$

4 Measurements and result displays

The R&S FSW Avionics (VOR/ILS) measurements application provides two different measurements to determine the parameters described by the VOR/ILS specifications.

ILS measurement

The R&S FSW Avionics (VOR/ILS) measurements application demodulates the AM components of the ILS signal at the RF input and calculates characteristic parameters such as the modulation depth and frequency or phase for specific components. Furthermore, an FFT is performed on all components of the AF signal. The resulting AF spectrum allows you to measure the required components and their distortions (harmonics).

VOR measurement

The R&S FSW Avionics (VOR/ILS) measurements application demodulates the AM and FM components of the VOR signal at the RF input. Then it calculates characteristic parameters, such as the modulation depth, and frequency or phase for specific components and subcarriers. The VOR phase, i.e. the phase difference between the AM and FM signal components, is also calculated. Furthermore, an FFT is performed on all components of the AF signal. The resulting AF spectrum allows you to measure the required components and their distortions (harmonics).

Selecting the measurement type

To select a different measurement type, do one of the following:

- Select "Overview". In the "Overview", select "Select Measurement". Select the required measurement.
- Press [MEAS]. In the "Select Measurement" dialog box, select the required measurement.

Remote command:

`CALCulate<n>:AVIonics[:STANdard]` on page 97

4.1 Result displays for VOR/ILS measurements

Access: "Overview" ≥ "Display Config"

The captured VOR/ILS signal can be displayed using various evaluation methods. All evaluation methods available for VOR/ILS measurements are displayed in the evaluation bar in SmartGrid mode.

For details on working with the SmartGrid, see the FSW Getting Started manual.

By default, the ILS measurement results are displayed in the following windows:

- Signal Summary
- Result Summary
- Modulation Spectrum

The following evaluation methods are available for VOR/ILS measurements:

Signal Summary

Displays information on the input signal settings and measured values in one table.

A bargraph visualizes the signal strength compared to the current level settings. The peak power measured during the current or most recent measurement is indicated by a vertical yellow line in the graph. This is useful to detect underload or overload conditions at a glance.

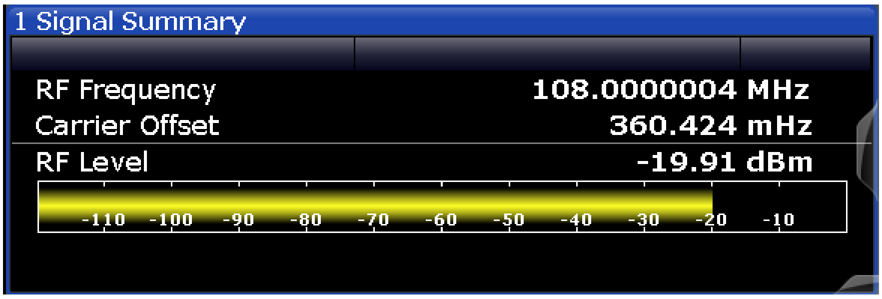


Figure 4-1: Signal summary for ILS signal

For details on individual parameters, see Chapter 4.2.1, "Signal characteristics", on page 34.

Remote command:
`LAY:ADD? '1',RIGH,SSUM`, see `LAYout:ADD[:WINDow]?` on page 124
Results:
`CALCulate<n>:AVIonics:FERRor[:RESult]?` on page 150
`CALCulate<n>:AVIonics:RFFRequency[:RESult]?` on page 151
`CALCulate<n>:AVIonics:CARRier[:RESult]?` on page 149

Result Summary

Displays the numerical measurement results for the demodulated signal components.

2 Result Summary (ILS)

	Mod Depth	Freq/Phase	K2	K3	THD
90 Hz AM	24.97 %	90.00002 Hz	0.008 %	0.010 %	0.028 %
150 Hz AM	14.98 %	150.00003 Hz	0.013 %	0.014 %	0.036 %
SDM(90+150)	39.95 %	0.012 deg	0.010 %	0.012 %	0.060 %
Voice/Ident	9.99 %	1020.0001 Hz	0.028 %	0.027 %	0.044 %
Ident Code	C MUC				
DDM	0.099904	-1 … 0 … 1			

Figure 4-2: Result summary for ILS signal

2 Result Summary (VOR)

	Mod Depth/Dev	Frequency
30 Hz AM	30.98 %	29.99976 Hz
9.96 kHz AM	27.97 %	9960.001 Hz
30 Hz FM	479.998 Hz	29.99991 Hz
Voice/Ident	9.99 %	1019.998 Hz
Ident Code	N/A	
FROM Phase	60.9933 deg	0 … 180 … 360

Figure 4-3: Result summary for VOR signal

The scale bar at the bottom of the table provides a quick overview at a glance. It indicates the difference in depth of modulation (DDM) for ILS, and the azimuth (FROM/TO phase) for VOR measurements graphically.

For details on individual parameters, see Chapter 4.2, "Avionics parameters", on page 34.

Note: If the result display is too narrow to display the complete table, the THD, K2 and K3 are hidden. Increase the width of the window to display the complete table.

Remote command:
`LAY:ADD? '1',RIGH,RSUM`, see `LAYout:ADD[:WINDow]?` on page 124
Results:
Chapter 9.7, "Retrieving results", on page 146

Distortion Summary
Displays the results of the harmonic distortion measurement.

4 Distortion Summary (ILS)

	K2	K3	THD
90 Hz AM	0.003 %	0.015 %	0.041 %
150 Hz AM	0.019 %	0.020 %	0.091 %
SDM(90+150)	0.007 %	0.016 %	0.105 %
Voice/Ident	0.097 %	---	0.097 %

Figure 4-4: Distortion summary for ILS signal

4 Distortion Summary (VOR)

	K2	K3	THD
30 Hz AM	0.006 %	0.005 %	0.024 %
9.96 kHz AM	---	---	---
30 Hz FM	---	---	---
Voice/Ident	0.015 %	0.033 %	0.065 %

Figure 4-5: Distortion summary for VOR signal

For details on individual parameters, see Chapter 4.2, "Avionics parameters", on page 34.

Remote command:
`LAY:ADD? '1',RIGH,DSUM`, see `LAYout:ADD[:WINDow]?` on page 124
Results:
Chapter 9.7, "Retrieving results", on page 146

Modulation Spectrum
Displays the FFT spectrum of the AF input signal.

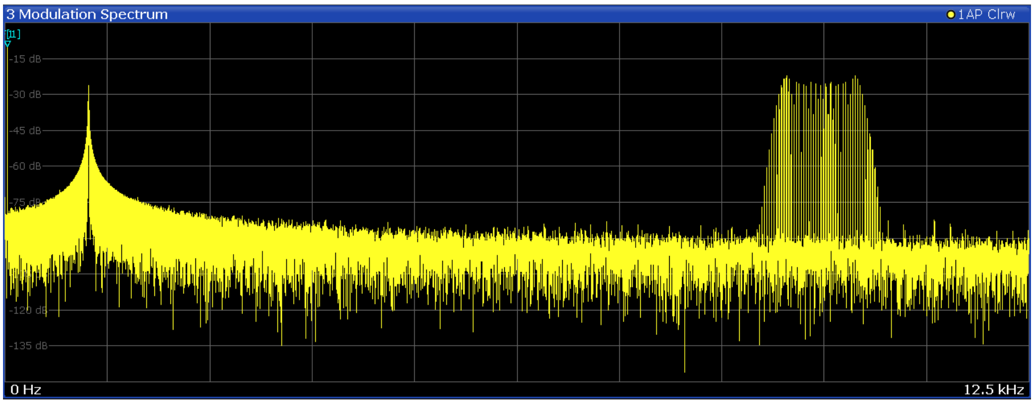


Figure 4-6: Modulation spectrum for a VOR signal

Two fixed markers (H1, F1) are always active and displayed in the "Modulation Spectrum" diagram. F1 indicates the currently selected Fundamental Frequency for distortion measurement, as well as the measured power level. A third marker, F2, is set to a second fundamental frequency for ILS measurements on the 90 Hz + 150 Hz components only. H1 indicates the currently selected frequency for distortion measurement (see Harmonic Frequency). Furthermore, the results include the power measured at that frequency, and the distortion at this frequency in relation to the power at the fundamental frequency.

Note: The marker results can be displayed in a separate Marker Table, if configured accordingly (see "Marker Table Display" on page 78).
The results of the F1, F2 markers are *only* displayed in the Marker Table.

The distortion for the H1 marker is *only* displayed in the "Modulation Spectrum" diagram.

As opposed to common markers, F1 and F2 markers cannot be repositioned manually, for example by dragging them on the screen. Their position is automatically defined by the Harmonic Frequency and Fundamental Frequency settings, respectively (see "Distortion" on page 68). These markers cannot be deactivated or configured.

Remote command:
`LAY:ADD? '1',RIGH,MSP`, see `LAYout:ADD[:WINDow]?` on page 124
Results:
`TRACe<n>[:DATA]?` on page 157
`CALCulate<n>:AVIonics:SHD:FREQuency` on page 152
`CALCulate<n>:AVIonics:SHD:RESult?` on page 153
`CALCulate<n>:AVIonics:SHD[:STATe]` on page 153

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

This table can be displayed automatically if configured accordingly (see "Marker Table Display" on page 78).

4 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
3	M1		1	0.0 Hz	-200.0 dB
3	D2	M1	1	0.0 Hz	0.0 dB
3	D3	M1	1	0.0 Hz	0.0 dB
3	D4	M1	1	0.0 Hz	0.0 dB
3	H1		1	30.0 Hz	-200.0 dB
3	F1		1	30.0 Hz	-200.0 dB

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

Note: Two fixed markers (H1, F1) are always active and displayed in the "Marker Table". F1 indicates the currently selected Fundamental Frequency for distortion measurement, as well as the measured power level. A third marker, F2, is set to a second fundamental frequency for ILS measurements on the 90 Hz + 150 Hz components only. H1 indicates the currently selected frequency for distortion measurement (see Harmonic Frequency) and the power measured at that frequency.
The distortion at this frequency (measured as the power in relation to the power at the fundamental frequency) is indicated as an additional marker result in the Modulation Spectrum.

As opposed to common markers, F1 and F2 markers cannot be repositioned manually, for example by dragging them on the screen. Their position is automatically defined by the Harmonic Frequency and Fundamental Frequency settings, respectively (see "Distortion" on page 68). These markers cannot be deactivated or configured.

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 124
Results:
`CALCulate<n>:MARKer<m>:X` on page 139
`CALCulate<n>:MARKer<m>:Y?` on page 146
Results:
`CALCulate<n>:AVIonics:SHD:FREQuency` on page 152

CALCulate<n>:AVIonics:SHD:RESult? on page 153
CALCulate<n>:AVIonics:SHD[:STATe] on page 153

4.2 Avionics parameters

The VOR/ILS measurements capture the I/Q data of the VOR/ILS signal and determine the following I/Q parameters in a single measurement:

4.2.1 Signal characteristics

The following parameters characterize the measured signal in general and are available for all VOR/ILS measurements.

RF Frequency

Measured RF (=carrier) frequency of the signal

Remote command:
CALC:AVI:RFFR?

Carrier Offset

Difference between measured frequency and frequency setting ("Center Frequency" on page 50)

Positive value if the signal's carrier frequency is higher than expected

Remote command:
CALC:AVI:FERR?

RF Level

Measured RF signal level

Remote command:
CALC:AVI:CARR?

4.2.2 ILS parameters

For ILS measurements, the following parameters are determined.

90 Hz AM depth
AM modulation depth of 90 Hz ILS component

Remote command:
`CALC:AVI:AM:DEPT? '90'`

90 Hz AM frequency
AF frequency of 90 Hz ILS component

Remote command:
`CALC:AVI:AM:FREQ? '90'`

90 Hz AM THD
Total harmonic distortion of 90 Hz ILS component

(THD = the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency)

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? '90'`

150 Hz AM depth
AM modulation depth of 150 Hz ILS component

Remote command:
`CALC:AVI:AM:DEPT? '150'`

150 Hz AM frequency
AF frequency of 150 Hz ILS component

Remote command:
`CALC:AVI:AM:FREQ? '150'`

150 Hz AM THD
Total harmonic distortion of 150 Hz ILS component

Remote command:
`CALC:AVI:THD:RES? '150'`

90+150 Hz AM depth
(Remote query only)

Total AM modulation depth of the 90 Hz and the 150 Hz components, taking the phase between the components into account.

Remote command:
`CALC:AVI:AM:DEPT? '90+150'`

90+150 Hz AM phase
Phase angle measurement between 90 Hz and 150 Hz AM signal (90 Hz = reference signal); measurement range: ±60 degrees

Remote command:
`CALC:AVI:PHAS?`

90+150 Hz AM THD
Total harmonic distortion of the 90 Hz and the 150 Hz components

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? '90+150'`

Voice / IDENT AM depth
AM Modulation depth of identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS signal components

Remote command:
`CALC:AVI:AM:DEPT? 'ID'`

Voice / IDENT AM frequency
AM frequency of identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS signal components

Remote command:
`CALC:AVI:AM:FREQ? 'ID'`

Voice / IDENT AM THD
Total harmonic distortion of the identifier signal component

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? 'ID'`

Ident Code
Morse code of identifier

Remote command:
`CALC:AVI:AM:CODE?`

SDM
Sum in Depth of Modulation (SDM); arithmetic sum of the modulation depth of the 90 Hz and the 150 Hz components without any influence of the phase between the components.

Remote command:
`CALC:AVI:SDM?`

ILS DDM
Difference in depth of modulation (DDM) between 90 Hz and 150 Hz AM signal ($m_{90\ Hz}$ – $m_{150\ Hz}$)

The unit depends on the ILS DDM setting.

Remote command:
`CALC:AVI:DDM?`

K2
Relative amplitude of an AF signal's second harmonic, calculated as:

<amplitude of second harmonic> / <amplitude of fundamental>

For 90 Hz + 150 Hz:

<mean amplitude of second harmonics> / <mean amplitude of fundamentals>

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:K2? '90'`
`CALC:AVI:THD:K2? '150'`
`CALC:AVI:THD:K2? '90+150'`
`CALC:AVI:THD:K2? 'ID'`

K3
Relative amplitude of an AF signal's third harmonic, calculated as:

<amplitude of third harmonic> / <amplitude of fundamental>

For 90 Hz + 150 Hz:

<mean amplitude of third harmonics> / <mean amplitude of fundamentals>

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:K3? '90'`
`CALC:AVI:THD:K3? '150'`
`CALC:AVI:THD:K3? '90+150'`
`CALC:AVI:THD:K3? 'ID'`

THD total
Total harmonic distortion relative to the fundamental frequency. Only distortions at frequencies below the specified Distortion Max Frequency parameter are taken into account in the following calculations.

For the 90 Hz, 150 Hz, and identification signal:

$$THD = \frac{\sqrt{A(2f)^2 + A(3f)^2 + A(4f)^2 + \ldots}}{A(1f)} * 100\%$$

A = measured modulation depth for the specified harmonic on a linear scale
f = fundamental frequency

For the 90 Hz + 150 Hz:

The nominator contains all frequencies N* 30 Hz (except 90 Hz, 150 Hz). The denominator is the average of the modulation depth at 90 Hz and at 150 Hz.

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? '90'`
`CALC:AVI:THD:RES? '150'`
`CALC:AVI:THD:RES? '90+150'`
`CALC:AVI:THD:RES? 'ID'`

4.2.3 VOR parameters

For VOR measurements, the following parameters are determined.

30 Hz AM depth
AM modulation depth of 30 Hz AM rotational signal

Remote command:
`CALC:AVI:AM:DEPT? '30'`

30 Hz AM frequency
AF frequency of 30 Hz AM rotational signal

Remote command:
`CALC:AVI:AM:FREQ? '30'`

30 Hz AM THD
Total harmonic distortion of 30 Hz component

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? '30'`

9.96 kHz AM depth
AM modulation depth of 9.96 kHz subcarrier

Remote command:
`CALC:AVI:AM:DEPT? '9960'`

9.96 kHz AM frequency
Mean carrier frequency of the FM modulated subcarrier, typically at 9.96 kHz

Remote command:
`CALC:AVI:AM:FREQ? '9960'`

9.96 kHz AM THD
Total harmonic distortion of 9.96 kHz component (FM carrier)

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? '9960'`

30 Hz FM depth
FM frequency deviation of 30 Hz subcarrier

Remote command:
`CALC:AVI:FM?`

30 Hz FM frequency
AF frequency of the 30 Hz reference signal

Remote command:
`CALC:AVI:FM:FREQ?`

30 Hz FM THD
Total harmonic distortion of 30 Hz component

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? '30FM'`

VOICE / IDENT AM depth
AM Modulation depth of identifier signal and speech band (300 Hz to 4 kHz)

Remote command:
`CALC:AVI:AM:DEPT? 'ID'`

VOICE / IDENT AM frequency
AM frequency of identifier signal and speech band (300 Hz to 4 kHz)

Remote command:
`CALC:AVI:AM:FREQ? 'ID'`

VOICE / IDENT AM THD
Total harmonic distortion of the identifier signal component

The unit depends on the Distortion setting.

Remote command:
`CALC:AVI:THD:RES? 'ID'`

VOR Phase
Phase angle measurement between 30 Hz AM & 30 Hz FM demodulated signal (in degrees)

Note the effect of the VOR Phase setting on the results!

Remote command:
`CALC:AVI:PHAS?`

K2
Relative amplitude of an AF signal's second harmonic, calculated as:

<amplitude of second harmonic> / <amplitude of fundamental>

The unit depends on the Distortion setting.

Remote command:
```
CALC:AVI:THD:K2? '30'
CALC:AVI:THD:K2? '30FM'
CALC:AVI:THD:K2? '9960'
CALC:AVI:THD:K2? 'ID'
```

K3
Relative amplitude of an AF signal's third harmonic, calculated as:

<amplitude of third harmonic> / <amplitude of fundamental>

The unit depends on the Distortion setting.

Remote command:
```
CALC:AVI:THD:K3? '30'
CALC:AVI:THD:K3? '30FM'
CALC:AVI:THD:K3? '9960'
CALC:AVI:THD:K3? 'ID'
```

THD
Total harmonic distortion relative to the fundamental frequency.

The unit depends on the Distortion setting.

For AM modulated components: Only distortions at frequencies below the specified Distortion Max Frequency parameter are taken into account in the following calculations.

For the 30 Hz AM rotational signal, 30 Hz reference signal, FM carrier at 9960 , and identification signal:

$$THD = \frac{\sqrt{A(2f)^2 + A(3f)^2 + A(4f)^2 + \ldots}}{A(1f)} * 100\%$$

A = measured modulation depth for the specified harmonic on a linear scale
f = fundamental frequency

Note: For the FM carrier at 9960 Hz, the distortion results are calculated slightly differently. Since it is an FM spectrum consisting of many lines, the harmonics and fundamentals cannot be calculated on distinct frequencies. Thus, the R&S FSW Avionics (VOR/ILS) measurements application integrates the values over a bandwidth centered around the estimated FM carrier frequency, or N times that frequency. The integration bandwidth is derived from the estimated FM carrier deviation and increases more and more with each next harmonic, as the bandwidth of the distortion products also broadens.

Remote command:
`CALC:AVI:THD:RES? '90'`
`CALC:AVI:THD:RES? '150'`
`CALC:AVI:THD:RES? '90+150'`
`CALC:AVI:THD:RES? 'ID'`

4.2.4 Harmonic distortion marker results (markers H1, F1, F2)

Three fixed markers (H1, F1, F2) are always active and displayed in the "Modulation Spectrum" diagram. They are used to calculate the harmonic distortion at specified frequencies.

F1, (F2)
Fundamental frequency

Reference frequency for harmonic distortion measurement (or frequencies for distortion measurement on multiple signal components)

Remote command:
`CALCulate<n>:AVIonics:THD:FREQuency:FUNDament`

H1
Harmonic frequency

Frequency at which harmonic distortion is measured; position of marker H1

Remote command:
`CALCulate<n>:AVIonics:SHD:FREQuency`

DIST
Distortion at harmonic frequency (H1)

Calculated as the relative difference between modulation at harmonic frequency and modulation at fundamental frequency (=$H1_{mod}/F1_{mod}$)*100

Remote command:
`CALCulate<n>:AVIonics:SHD:RESult?` on page 153

5 Configuration

Access: [MODE] > "Avionics"

VOR/ILS measurements require a special application on the FSW.

The settings required to configure each of these measurements are described here.

When you switch a measurement channel to the R&S FSW Avionics (VOR/ILS) measurements application the first time, a set of parameters is passed on from the currently active application. After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

When you activate a measurement channel in the R&S FSW Avionics (VOR/ILS) measurements application, a VOR measurement for the input signal is started automatically with the default configuration. The "Avionics" menu is displayed and provides access to the most important configuration functions.

Exporting I/Q Data

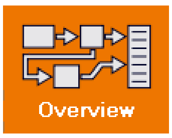
Access:

The I/Q data captured by the R&S FSW Avionics (VOR/ILS) measurements application can be exported for further analysis in external applications.

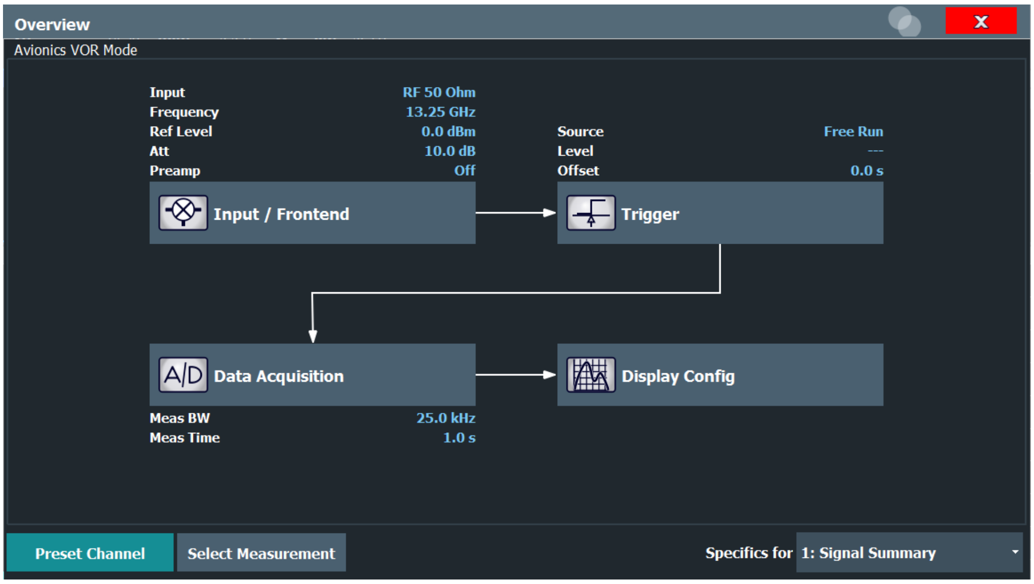
For details on exporting I/Q data, see the FSW I/Q Analyzer and I/Q Input User Manual.

5.1 Configuration overview

Access: all menus



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



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

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

1. Input and Frontend Settings
   See Chapter 5.2, "Input, output and frontend settings", on page 45
2. Trigger
   See Chapter 5.3, "Trigger settings", on page 58
3. Data Acquisition
   See Chapter 5.4, "Data acquisition and detection", on page 63
4. Display Configuration
   See Chapter 6.1, "Display configuration", on page 70

To configure settings

► Select any button to open the corresponding dialog box. To configure a particular setting displayed in the "Overview", simply select the setting on the touch screen. The corresponding dialog box is opened with the focus on the selected setting.

For step-by-step instructions on configuring VOR/ILS measurements, see Chapter 7, "How to perform VOR/ILS measurements", on page 84.

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

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

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 97

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

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

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

Select Measurement
Selects a measurement to be performed.

See "Selecting the measurement type" on page 29.

Remote command:
`CALCulate<n>:AVIonics[:STANdard]` on page 97

5.2 Input, output and frontend settings

Access: "Overview" ≥ "Input/Frontend"

The FSW can evaluate signals from different input sources and provide various types of output (such as noise or trigger signals).

The frequency and amplitude settings represent the "frontend" of the measurement setup.

5.2.1 Input source settings

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

Or: [INPUT/OUTPUT] > "Input Source Config"

The input source determines which data the FSW will analyze.

Further input sources

The R&S FSW Avionics (VOR/ILS) measurements application application can also process input from the following sources:

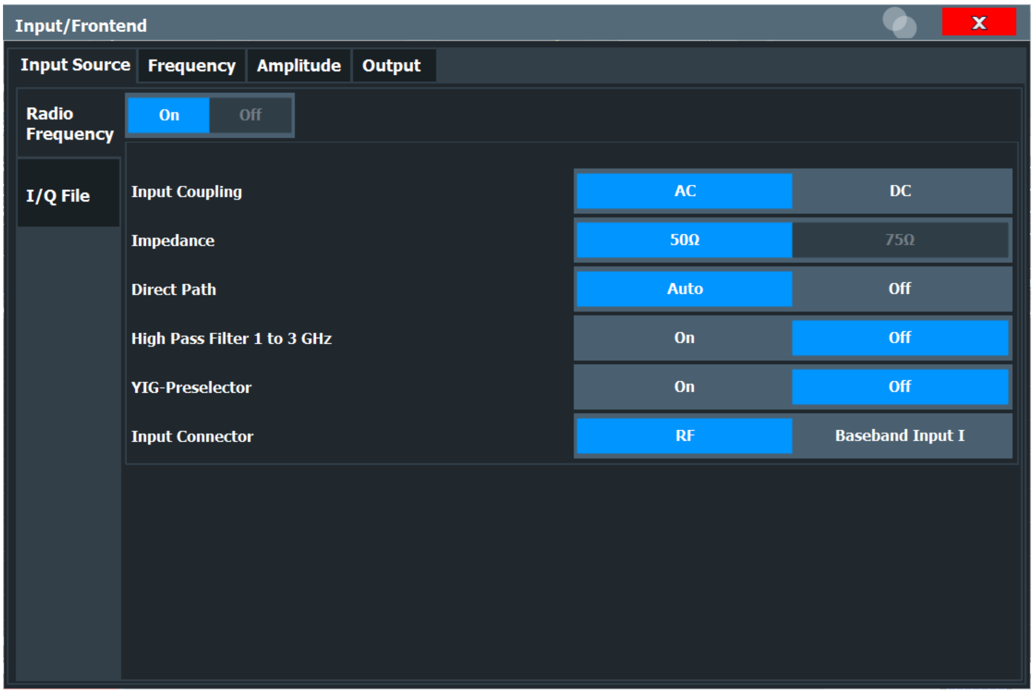
- I/Q Input files
- Probes

5.2.1.1 Radio frequency input

Access: "Overview" > "Input/Frontend" > "Input Source" > "Radio Frequency"

Or: [INPUT/OUTPUT] > "Input Source Config" > "Input Source" > "Radio Frequency"

The only input source for the R&S FSW Avionics (VOR/ILS) measurements application is "Radio Frequency", i.e. the signal at the [RF Input] connector of the FSW.



Radio Frequency State

Activates input from the "RF Input" connector.

For FSW85 models with two input connectors, you must define which input source is used for each measurement channel.

"Input 1" 1.00 mm RF input connector for frequencies up to 85 GHz (90 GHz with option R&S FSW-B90G)

"Input 2" 1.85 mm RF input connector for frequencies up to 67 GHz

Remote command:
`INPut:SELect` on page 101
`INPut:TYPE` on page 102

Input Coupling

The RF input of the FSW can be coupled by alternating current (AC) or direct current (DC).

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

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

Remote command:
`INPut:COUPling` on page 99

Impedance

For Avionics measurements, the impedance is always 50 Ω and cannot be changed.

Remote command:
`INPut:IMPedance` on page 101

Direct Path

Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be disabled. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

"Auto" (Default) The direct path is used automatically for frequencies close to zero.

"Off" The analog mixer path is always used.

Remote command:
`INPut:DPATh` on page 99

High Pass Filter 1 to 3 GHz
Activates an additional internal highpass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer 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-preselector, if available.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 100

YIG-Preselector
Enables or disables the YIG-preselector.

This setting requires an additional option on the FSW.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 101

Input Connector
Determines which connector the input data for the measurement is taken from.

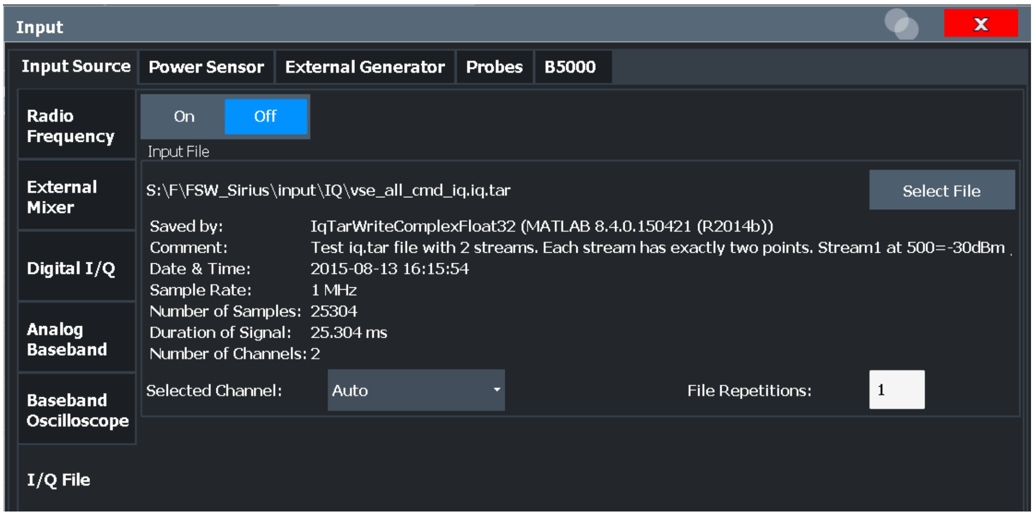
"RF"	(Default:) The "RF Input" connector
"RF Probe"	The "RF Input" connector with an adapter for a modular probe This setting is only available if a probe is connected to the "RF Input" connector.
"Baseband Input I"	The optional "Baseband Input I" connector This setting is only available if the optional "Analog Baseband" interface is installed and active for input. It is not available for the FSW67. For FSW85 models with two input connectors, this setting is only available for "Input 1".

Remote command:
`INPut:CONNector` on page 98

5.2.1.2 Settings for input from I/Q data files

Access: "Overview" > "Input/Frontend" > "Input Source" > "I/Q File"

Or: [INPUT/OUTPUT] > "Input Source Config" > "Input Source" > "I/Q File"



I/Q Input File State

Enables input from the selected I/Q input file.

If enabled, the application performs measurements on the data from this file. Thus, most measurement settings related to data acquisition (attenuation, center frequency, measurement bandwidth, sample rate) cannot be changed. The measurement time can only be decreased to perform measurements on an extract of the available data only.

Note: Even when the file input is disabled, the input file remains selected and can be enabled again quickly by changing the state.

Remote command:
`INPut:SELect` on page 101

Select I/Q data file

Opens a file selection dialog box to select an input file that contains I/Q data.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

For details on formats, see the FSW I/Q Analyzer and I/Q Input user manual.

The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`. For `.mat` files, Matlab® v4 is assumed.

Note: Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

Note: For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

The default storage location for I/Q data files is `C:\R_S\INSTR\USER`.

Remote command:
`INPut:FILE:PATH` on page 99

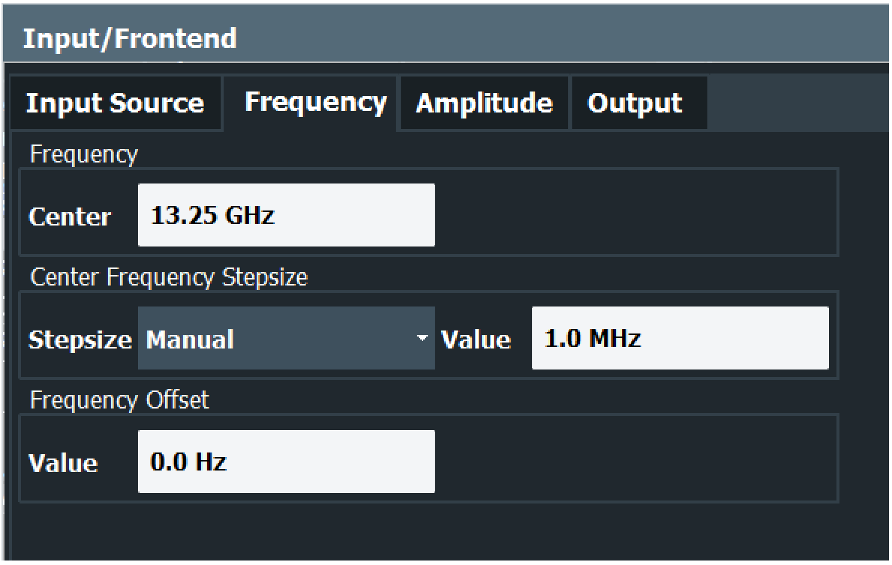
File Repetitions
Determines how often the data stream is repeatedly copied in the I/Q data memory to create a longer record. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Remote command:
`TRACe:IQ:FILE:REPetition:COUNt` on page 102

5.2.2 Frequency settings

Access: "Overview" > "Input/Frontend" > "Frequency"

Or: [FREQ]



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

Remote command:
`[SENSe:]FREQuency:CENTer` on page 103

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

When you use the rotary knob the center frequency changes in steps of only 1/10 of the span.

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

"= Center"	Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.
"Manual"	Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
`[SENSe:]FREQuency:CENTer:STEP` on page 103

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

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

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

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

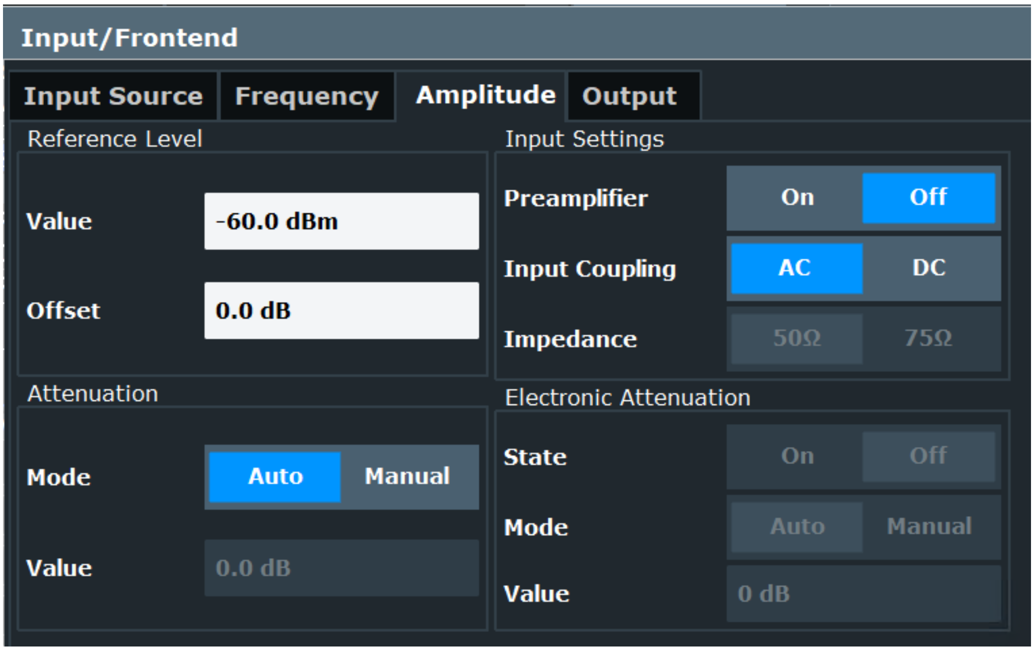
Remote command:
`[SENSe:]FREQuency:OFFSet` on page 104

5.2.3 Amplitude settings

Access: "Overview" > "Input/Frontend" > "Amplitude"

Or: [AMPT] > "Amplitude Config"

Amplitude settings affect the signal power or error levels.



Reference Level

Defines the expected maximum reference level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IF Overload" or "OVLD" status display.

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

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

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel`
on page 104

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 FSW so the application shows correct power results. All displayed power level results are shifted by this value.

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

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

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 105

RF Attenuation
Defines the mechanical attenuation for RF input.

Attenuation Mode / Value ← RF Attenuation
Defines the attenuation applied to the RF input of the FSW.

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

By default and when no (optional) electronic attenuation is available, mechanical attenuation is applied.

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 specifications document. 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 can lead to hardware damage.

Remote command:
`INPut:ATTenuation` on page 107
`INPut:ATTenuation:AUTO` on page 108

Using Electronic Attenuation
If the (optional) Electronic Attenuation hardware is installed on the FSW, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

Note: Electronic attenuation is not available for stop frequencies (or center frequencies in zero span) above 15 GHz.
In "Auto" mode, RF attenuation is provided by the electronic attenuator as much as possible to reduce the amount of mechanical switching required. Mechanical attenuation can provide a better signal-to-noise ratio, however.

When you switch off electronic attenuation, the RF attenuation is automatically set to the same mode (auto/manual) as the electronic attenuation was set to. Thus, the RF attenuation can be set to automatic mode, and the full attenuation is provided by the mechanical attenuator, if possible.

The electronic attenuation can be varied in 1 dB steps. If the electronic attenuation is on, the mechanical attenuation can be varied in 5 dB steps. Other entries are rounded to the next lower integer value.

For the FSW85, the mechanical attenuation can be varied only in 10 dB steps.

If the defined reference level cannot be set for the given attenuation, the reference level is adjusted accordingly and the warning "limit reached" is displayed in the status bar.

Remote command:
`INPut:EATT:STATe` on page 109
`INPut:EATT:AUTO` on page 108
`INPut:EATT` on page 108

Input Settings
Some input settings affect the measured amplitude of the signal, as well.

For information on other input settings, see Chapter 5.2.1.1, "Radio frequency input", on page 46.

Preamplifier ← Input Settings
If the (optional) internal preamplifier hardware is installed on the FSW, a preamplifier can be activated for the RF input signal.

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

Note: If an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For all FSW models except for FSW85, 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.

For older FSW43/FSW50/FSW67 models, the input signal is always ampilfied by about 30 dB when the preamplifier is active.

For FSW85 models, no preamplifier is available.

Remote command:
`INPut:GAIN:STATe` on page 106
`INPut:GAIN[:VALue]` on page 106

Ext. PA Correction ← Input Settings
This function is only available if an external preamplifier is connected to the FSW, and only for frequencies above 1 GHz. For details on connection, see the preamplifier's documentation.

Using an external preamplifier, you can measure signals from devices under test with low output power, using measurement devices which feature a low sensitivity and do not have a built-in RF preamplifier.

When you connect the external preamplifier, the FSW reads out the touchdown (`.S2P`) file from the EEPROM of the preamplifier. This file contains the s-parameters of the preamplifier. As soon as you connect the preamplifier to the FSW, the preamplifier is permanently on and ready to use. However, you must enable data correction based on the stored data explicitly on the FSW using this setting.

When enabled, the FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results. Any internal preamplifier, if available, is disabled.

For FSW85 models with two RF inputs, you can enable correction from the external preamplifier for each input individually, but not for both at the same time.

When disabled, no compensation is performed even if an external preamplifier remains connected.

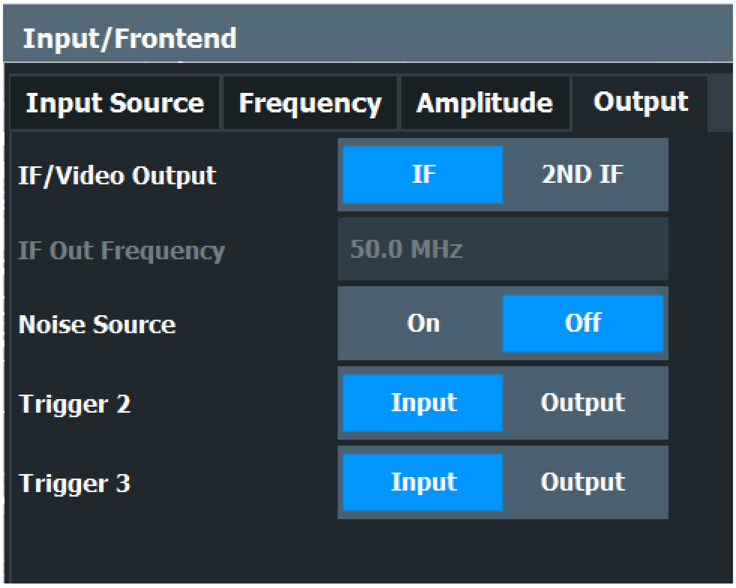
Remote command:
`INPut:EGAin[:STATe]` on page 105

5.2.4 Output settings

Access: "Overview" > "Input/Frontend" > "Output"

The FSW can provide output to special connectors for other devices.

For details on connectors refer to the FSW Getting Started manual, "Front / Rear Panel View" chapters.



How to provide trigger signals as output is described in detail in the FSW User Manual.

Noise Source Control

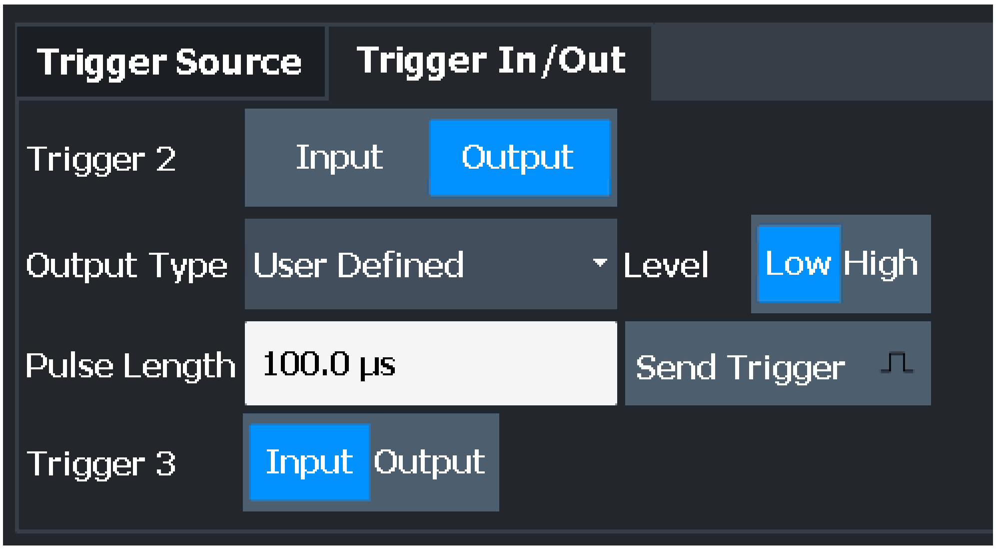
Enables or disables the 28 V voltage supply for an external noise source connected to the "Noise source control / Power sensor") connector. By switching the supply voltage for an external noise source on or off in the firmware, you can enable or disable the device as required.

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

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

Remote command:
`DIAGnostic:SERVice:NSOurce` on page 102

Trigger 2/3



The trigger input and output functionality depends on how the variable "Trigger Input/ Output" connectors are used.

"Trigger 1" "Trigger 1" is input only.

"Trigger 2" Defines the usage of the variable "Trigger Input/Output" connector on the front panel
(not available for FSW85 models with 2 RF input connectors)

"Trigger 3" Defines the usage of the variable "Trigger 3 Input/Output" connector on the rear panel

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

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

Remote command:
`OUTPut:TRIGger<tp>:DIRection` on page 113

Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the FSW triggers.

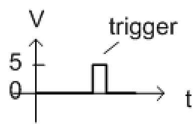
"Trigger Armed" Sends a (high level) trigger when the FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low-level signal at the "AUX" port (pin 9).

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

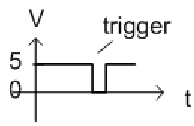
Remote command:
`OUTPut:TRIGger<tp>:OTYPe` on page 114

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector (for "Output Type": "User Defined".

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level" = "High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



low-level constant, high-level trigger



high-level constant, low-level trigger

Remote command:
`OUTPut:TRIGger<tp>:LEVel` on page 114

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<tp>:PULSe:LENGth` on page 115

Send Trigger ← Output Type ← Trigger 2/3
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. For example, for "Level" = "High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

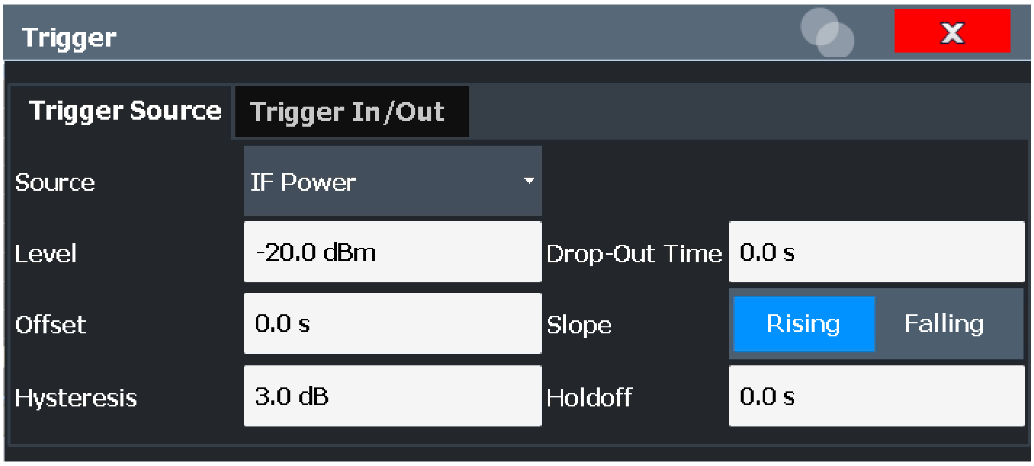
Which pulse level is sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<tp>:PULSe:IMMediate` on page 115

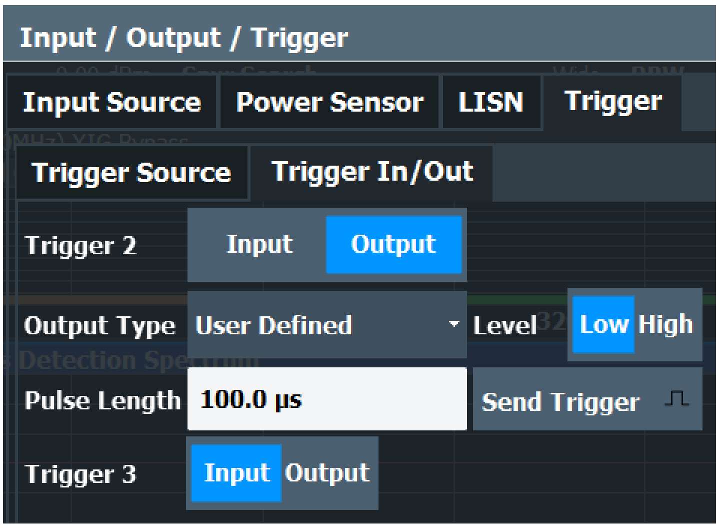
5.3 Trigger settings

Access: "Overview" > "Signal Capture" > "Trigger Source"

Trigger settings determine when the input signal is measured.



External triggers from one of the [TRIGGER INPUT/OUTPUT] connectors on the FSW are configured in a separate tab of the dialog box.



For step-by-step instructions on configuring triggered measurements, see the main FSW User Manual.

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

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

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 112

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

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 112

External Trigger 1/2/3 ← Trigger Source ← Trigger Source
Data acquisition starts when the TTL signal fed into the specified input connector meets or exceeds the specified trigger level.

(See "Trigger Level" on page 61).

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

For details, see the "Instrument Tour" chapter in the FSW Getting Started manual.

"External Trigger 1"
Trigger signal from the "TRIGGER 1 INPUT" connector.

"External Trigger 2"
Trigger signal from the "TRIGGER 2 INPUT / OUTPUT" connector.
For FSW85 models, "Trigger 2" is not available due to the second RF input connector on the front panel.

"External Trigger 3"
Trigger signal from the "TRIGGER 3 INPUT / OUTPUT" connector on the rear panel.

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`
`TRIG:SOUR EXT3`
See `TRIGger[:SEQuence]:SOURce` on page 112

IF Power ← Trigger Source ← Trigger Source
The FSW 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 threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. A reference level offset, if defined, is also considered. The trigger bandwidth at the intermediate frequency depends on the RBW and sweep type. For details on available trigger levels and trigger bandwidths, see the instrument specifications document.

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 specifications document.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 112

RF Power ← Trigger Source ← 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 resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels, see the instrument's specifications document.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the measurement can be aborted. 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 112

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

Remote command:
`TRIG:SOUR IQP`, see `TRIGger[:SEQuence]:SOURce` on page 112

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

For details on supported trigger levels, see the instrument specifications document.

Remote command:
`TRIGger[:SEQuence]:LEVel:IFPower` on page 111
`TRIGger[:SEQuence]:LEVel:IQPower` on page 111
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 111

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

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 109

Trigger Offset ← Trigger Source
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 (pretrigger)

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 110

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

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

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 110

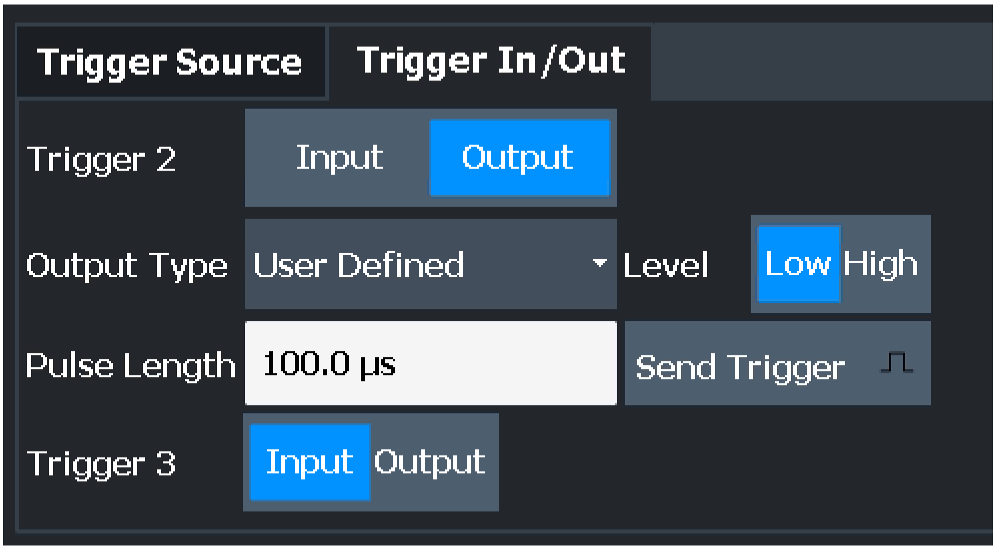
Trigger Holdoff ← Trigger Source
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 110

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

Remote command:
TRIGger[:SEQuence]:SLOPe on page 112

Trigger 2/3



The trigger input and output functionality depends on how the variable "Trigger Input/ Output" connectors are used.

"Trigger 1"	"Trigger 1" is input only.
"Trigger 2"	Defines the usage of the variable "Trigger Input/Output" connector on the front panel (not available for FSW85 models with 2 RF input connectors)
"Trigger 3"	Defines the usage of the variable "Trigger 3 Input/Output" connector on the rear panel
"Input"	The signal at the connector is used as an external trigger source by the FSW. Trigger input parameters are available in the "Trigger" dialog box.
"Output"	The FSW sends a trigger signal to the output connector to be used by connected devices. Further trigger parameters are available for the connector.

Remote command:
OUTPut:TRIGger<tp>:DIRection on page 113

Output Type ← Trigger 2/3
Type of signal to be sent to the output

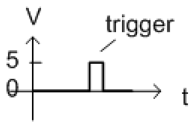
"Device Triggered"	(Default) Sends a trigger when the FSW triggers.
"Trigger Armed"	Sends a (high level) trigger when the FSW is in "Ready for trigger" state. This state is indicated by a status bit in the STATus:OPERation register (bit 5), as well as by a low-level signal at the "AUX" port (pin 9).

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

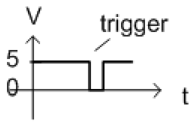
Remote command:
`OUTPut:TRIGger<tp>:OTYPe` on page 114

Level ← Output Type ← Trigger 2/3
Defines whether a high (1) or low (0) constant signal is sent to the trigger output connector (for "Output Type": "User Defined".

The trigger pulse level is always opposite to the constant signal level defined here. For example, for "Level" = "High", a constant high signal is output to the connector until you select the Send Trigger function. Then, a low pulse is provided.



low-level constant, high-level trigger



high-level constant, low-level trigger

Remote command:
`OUTPut:TRIGger<tp>:LEVel` on page 114

Pulse Length ← Output Type ← Trigger 2/3
Defines the duration of the pulse (pulse width) sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<tp>:PULSe:LENGth` on page 115

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately.

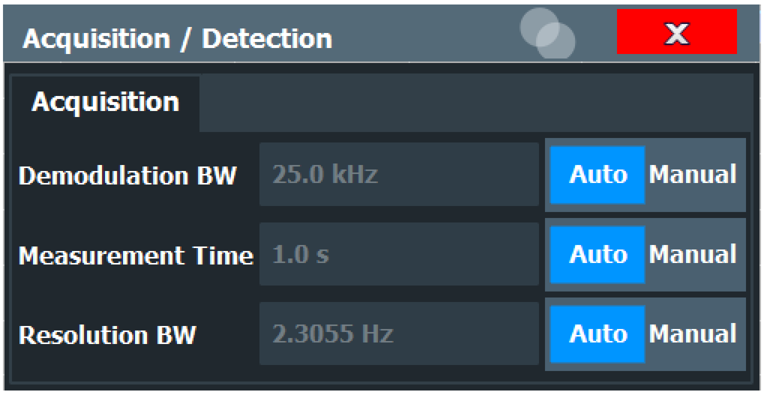
Note that the trigger pulse level is always opposite to the constant signal level defined by the output Level setting. For example, for "Level" = "High", a constant high signal is output to the connector until you select the "Send Trigger" function. Then, a low pulse is sent.

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

Remote command:
`OUTPut:TRIGger<tp>:PULSe:IMMediate` on page 115

5.4 Data acquisition and detection

Access: "Overview" > "Data Acquisition"



Demodulation Bandwidth

The R&S FSW Avionics (VOR/ILS) measurements application captures I/Q data using digital filters with quasi-rectangular amplitude responses. The demodulation bandwidth defines the width of the filter's flat passband.

For more information, see Chapter 3.3.1, "Demodulation bandwidth", on page 26.

Depending on the selected DBW mode, the value is either determined automatically or can be defined manually.

"Auto mode" (Default) The DBW is determined automatically by the R&S FSW Avionics (VOR/ILS) measurements application.
For ILS measurements: 12.5 kHz
For VOR measurements: 25 kHz

"Manual mode" The user-defined DBW is used. For a list of available demodulation bandwidths, see Available demodulation bandwidths and measurement times for ILS measurements and Table 3-2.

Remote command:
`[SENSe:]ADEMod:BWIDth:DEModulation` on page 116
`[SENSe:]ADEMod:BWIDth:DEModulation:AUTO` on page 116

Measurement Time

Defines the net, settled measurement length; internally, the R&S FSW Avionics (VOR/ILS) measurements application captures data slightly longer to allow for all filters to settle.

"Auto" (Default:) The required time (1 s) is determined by the R&S FSW Avionics (VOR/ILS) measurements application. The currently used measurement time is indicated for reference only

"Manual" The measurement time is defined manually; enter the measurement time in seconds
For a list of available measurement times depending on the Demodulation Bandwidth, see Table 3-1 and Table 3-2.

Remote command:
[SENSe<ip>:]SWEep:TIME on page 117
[SENSe<ip>:]SWEep:TIME:AUTO on page 118

RBW
Defines the resolution bandwidth for Modulation Spectrum results. The available RBW values depend on the Demodulation Bandwidth and the Measurement Time.

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

"Auto mode" (Default) The RBW is determined automatically depending on the Demodulation Bandwidth and the Measurement Time.

"Manual mode" The user-defined RBW is used.

Remote command:
[SENSe:]ADEMod:SPECtrum:BWIDth[:RESolution] on page 117
[SENSe:]ADEMod:SPECtrum:BWIDth[:RESolution]:AUTO on page 117

5.5 Sweep settings

Access: [SWEEP]

The sweep settings define how often data from the input signal is acquired and then evaluated.

Continuous Sweep / Run Cont
While the measurement is running, "Continuous Sweep" and [RUN CONT] 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, "Continuous Sweep" only controls the sweep mode for the currently selected channel. However, the sweep mode only takes effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly.
Furthermore, [RUN CONT] controls the Sequencer, not individual sweeps. [RUN CONT] starts the Sequencer in continuous mode.

For details on the Sequencer, see the FSW base unit user manual.

Remote command:
INITiate<n>:CONTinuous on page 122

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

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

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

For details on the Sequencer, see the FSW base unit user manual.

Remote command:
`INITiate<n>[:IMMediate]` on page 122

Measurement Time
Defines the net, settled measurement length; internally, the R&S FSW Avionics (VOR/ILS) measurements application captures data slightly longer to allow for all filters to settle.

"Auto" (Default:) The required time (1 s) is determined by the R&S FSW Avionics (VOR/ILS) measurements application. The currently used measurement time is indicated for reference only

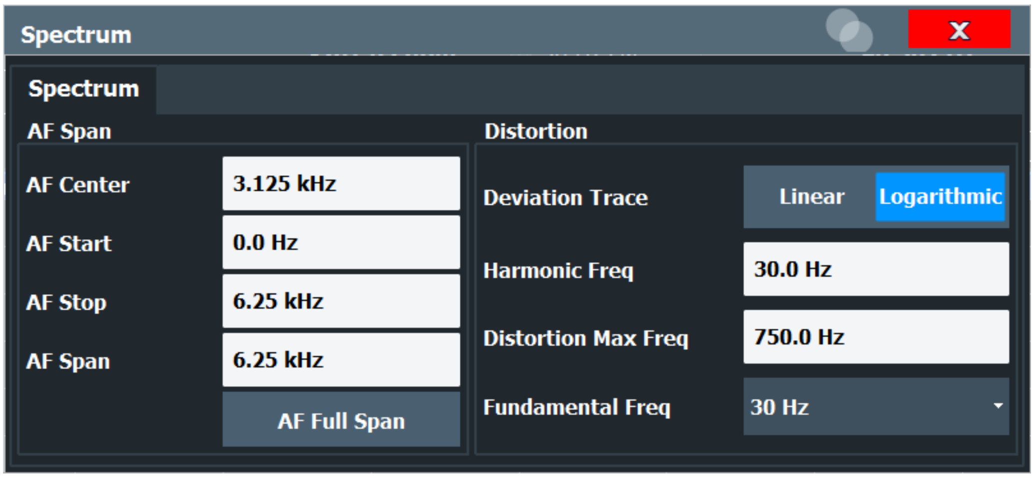
"Manual" The measurement time is defined manually; enter the measurement time in seconds
For a list of available measurement times depending on the Demodulation Bandwidth, see Table 3-1 and Table 3-2.

Remote command:
`[SENSe<ip>:]SWEep:TIME` on page 117
`[SENSe<ip>:]SWEep:TIME:AUTO` on page 118

5.6 Demodulation spectrum

Access: [MEAS CONFIG] > "Spectrum"

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



AF Span

Defines the frequency range to be demodulated in the Modulation Spectrum.

AF Center ← AF Span

Defines the center frequency of the demodulated data to evaluate in the Modulation Spectrum.

Remote command:

`[SENSe:]ADEMod:AF:CENTer` on page 119

AF Start ← AF Span

Defines the start frequency of the demodulated data to evaluate in the Modulation Spectrum.

Remote command:

`[SENSe:]ADEMod:AF:STARt` on page 120

AF Stop ← AF Span

Defines the stop frequency of the demodulated data to evaluate in the Modulation Spectrum display.

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

Remote command:

`[SENSe:]ADEMod:AF:STOP` on page 120

AF Span ← AF Span

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

Remote command:
`[SENSe:]ADEMod:AF:SPAN` on page 119
`[SENSe:]ADEMod:AF:SPAN:FULL` on page 120

AF Full Span ← AF Span

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

Remote command:
`[SENSe:]ADEMod:AF:SPAN:FULL` on page 120

Distortion

Configures the optional harmonic distortion measurement.

Deviation Trace ← Distortion

Switches the scaling mode for the deviation trace in the Modulation Spectrum between linear and logarithmic.

Note: this setting only affects the graphical results, not the numerical results.

"Linear" Scaling in percent

"Logarithmic" (Default:) Scaling in dB

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

Harmonic Frequency ← Distortion

Defines the frequency at which the harmonic distortion is measured.

Tip: the fixed "H1" marker in the Modulation Spectrum display indicates the distortion at the given frequency relative to the modulation at the set Fundamental Frequency.

Remote command:
`CALCulate<n>:AVIonics:SHD:FREQuency` on page 152

Distortion Max Frequency ← Distortion

Defines the upper frequency limit for most total harmonic distortion measurements. Only harmonics frequencies not exceeding this value are included in the THD calculation. The maximum allowed value is half the defined Demodulation Bandwidth.

The setting has no effect on K2 and K3 or FM distortion results.

The following table shows the maximum frequencies included in the THD calculations for different signal components.

Table 5-1: Maximum frequencies included in the THD calculations

Signal component	Maximum frequency included in THD
ILS	
90 Hz AM	"Distortion Max Frequency"
150 Hz AM	"Distortion Max Frequency"

Signal component	Maximum frequency included in THD
90/150 Hz AM	"Distortion Max Frequency"
Voice / Ident	0.5 * Demodulation Bandwidth
VOR	
30 Hz AM	"Distortion Max Frequency"
9.96 kHz AM	0.5 * Demodulation Bandwidth
30 Hz FM	min ("Distortion Max Frequency", 5*30 Hz)
Voice / Ident	8.16 kHz

Remote command:
`CALCulate<n>:AVIonics:THD:FREQuency:UPPer` on page 154

Fundamental Frequency ← Distortion

Defines the reference for the harmonic distortion measurement; the modulation depth measured at the Harmonic Frequency is set in relation to the modulation depth of the selected fundamental frequency.

Table 5-2: Used reference values depending on selected frequency

Setting	Reference value	Remote command
ILS		
"90 Hz"	Modulation depth at nominal 90 Hz	`CALC:AVI:THD:FREQ:FUND '90'`
"150 Hz"	Modulation depth at nominal 150 Hz	`CALC:AVI:THD:FREQ:FUND '150'`
"90 Hz & 150 Hz"	Average of the modulation depth values at nominal 90 Hz and nominal 150 Hz	`CALC:AVI:THD:FREQ:FUND '90_150'`
"Identifica-tion"	Modulation depth at the currently estimated identification frequency	`CALC:AVI:THD:FREQ:FUND 'ID'`
VOR		
"30 Hz"	Modulation depth at nominal 30 Hz	`CALC:AVI:THD:FREQ:FUND '30'`
"9.96 kHz"	Modulation depth at nominal 9960 Hz (inte-gration in specific bandwidth, see "THD" on page 40)	`CALC:AVI:THD:FREQ:FUND '9960'`
"Identifica-tion"	Modulation depth at the currently estimated identification frequency	`CALC:AVI:THD:FREQ:FUND 'ID'`

Remote command:
`CALCulate<n>:AVIonics:THD:FREQuency:FUNDament` on page 154

6 Analysis

General result settings concerning the trace, markers, diagrams etc. can be configured in the R&S FSW Avionics (VOR/ILS) measurements application.

6.1 Display configuration

Access: "Overview" > "Display Config"

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the R&S FSW Avionics (VOR/ILS) measurements application are displayed in the evaluation bar in SmartGrid mode.

Drag one or more evaluations to the display area and configure the layout as required.

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

Up to 16 evaluation methods can be displayed simultaneously in separate windows. The VOR/ILS evaluation methods are described in Chapter 4, "Measurements and result displays", on page 29.

For details on working with the SmartGrid, see the FSW Getting Started manual.

6.2 Result configuration

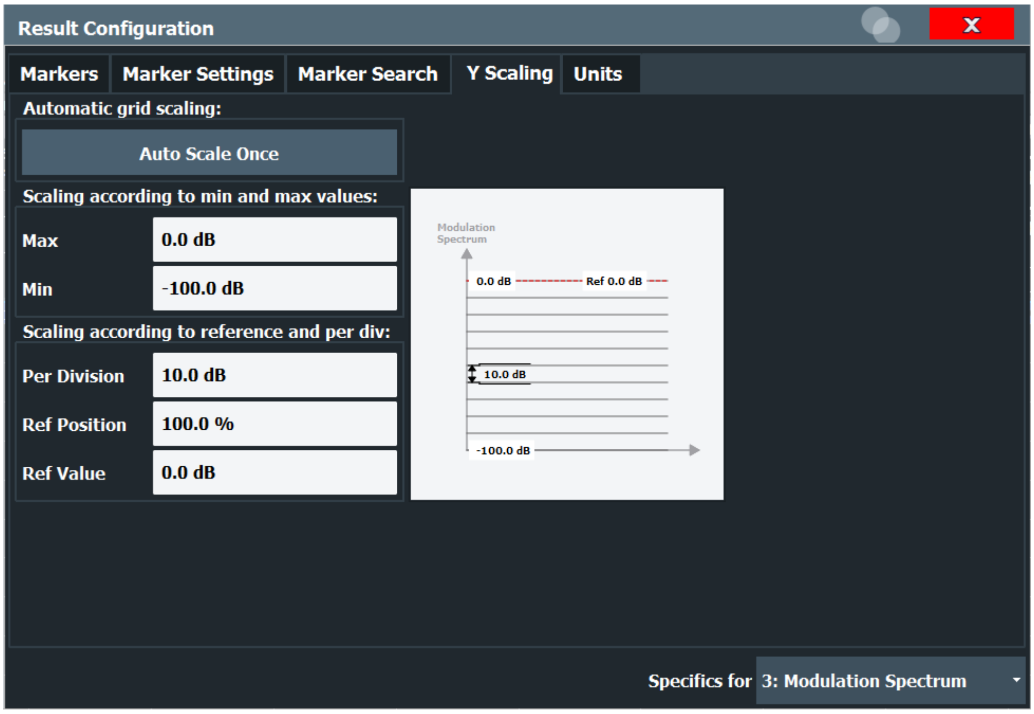
Access: [MEAS CONFIG] > "Result Config"

Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window (see "Specific Settings for" on page 45).

6.2.1 Y-Scaling

Access: [MEAS CONFIG] > "Result Config" > "Y Scaling" tab

The scaling for the vertical axis is highly configurable, using either absolute or relative values.



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>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 131

Absolute Scaling (Min/Max Values)

Define the scaling using absolute minimum and maximum values.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 132
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum` on page 133

Relative Scaling

Defines the scaling relative to a reference value, with a specified value range per division.

Per Division ← Relative Scaling
Defines the value range to be displayed per division of the diagram (1/10 of total range).

Note: The value defined per division refers to the default display of ten divisions on the y-axis. If the window is reduced in height, for example, not all divisions are displayed. In this case, the range per division is increased 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>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision` on page 132

Ref Position ← Relative Scaling
Defines the position of the reference value in percent of the total y-axis range.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition` on page 132

Ref Value ← Relative Scaling
Defines the reference value to be displayed at the specified reference position.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue` on page 133

6.2.2 Units

Some parameters can be provided in different units.

Distortion
Switches units between dB and percent for the total harmonic distortion (THD), K2 and K3 results in the Distortion Summary and Result Summary and the corresponding remote commands.

Remote command:
`UNIT<n>:THD` on page 134

ILS DDM
Determines the unit for ILS DDM results (relevant for ILS measurements only, see also "ILS DDM" on page 37).

"unitless" Absolute results

"percent" Relative results

Remote command:
`UNIT<n>:DDM` on page 133

Deviation Trace

Switches the scaling mode for the deviation trace in the Modulation Spectrum between linear and logarithmic.

Note: this setting only affects the graphical results, not the numerical results.

"Linear" Scaling in percent

"Logarithmic" (Default:) Scaling in dB

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

VOR Phase

Only relevant for VOR measurements: Switches between a phase display in *from* or *to* notation.

For details, see Chapter 3.3.3, "Phase notation in VOR measurements", on page 28.

Remote command:
`UNIT<n>:VORDirection` on page 134

6.3 Markers

Access: [MKR]

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

Fixed markers (H1, F1, F2)

Two fixed markers (H1, F1) are always active and displayed in the Modulation Spectrum result display and the marker table. F1 indicates the currently selected Fundamental Frequency for distortion measurement, as well as the measured power level. A third marker, F2, is set to a second fundamental frequency for ILS measurements on the 90 Hz + 150 Hz components only. H1 indicates the currently selected frequency for distortion measurement (see Harmonic Frequency) and the power measured at that frequency.

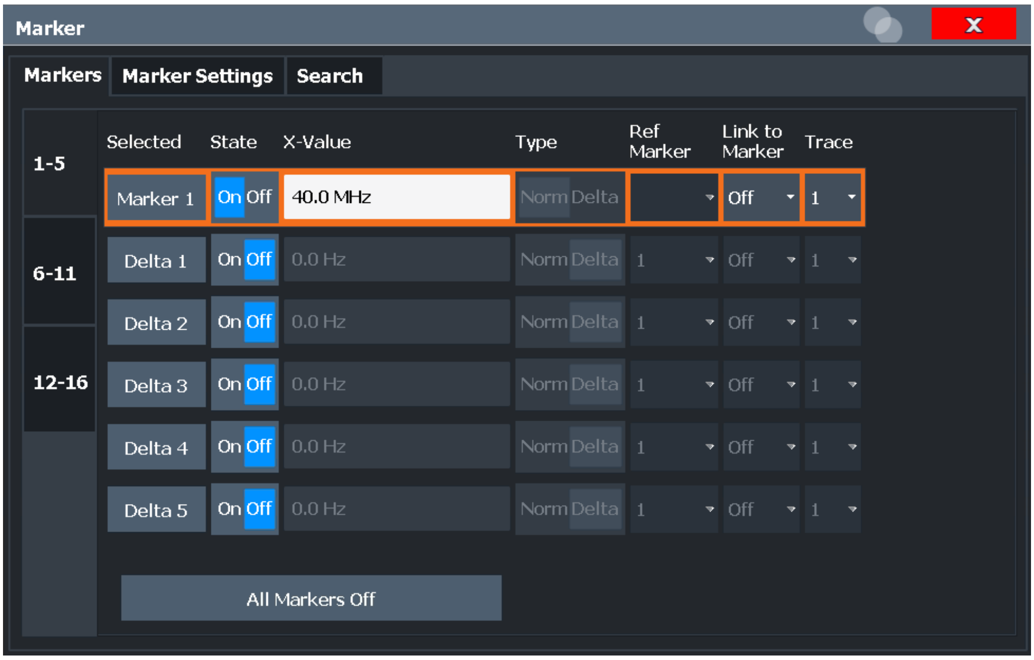
The distortion at this frequency (measured as the power in relation to the power at the fundamental frequency) is indicated as an additional marker result ("Dist") in the Modulation Spectrum.

As opposed to common markers, H1, F1 and F2 markers cannot be repositioned manually, for example by dragging them on the screen. Their position is automatically defined by the Harmonic Frequency and Fundamental Frequency settings, respectively (see "Distortion" on page 68). These markers cannot be deactivated or configured.

Due to these special markers, only 13 regular markers are configurable in the R&S FSW Avionics (VOR/ILS) measurements application.

6.3.1 Individual marker settings

Up to 14 markers or delta markers can be activated for each window simultaneously. Initial marker setup is performed using the "Marker" dialog box.



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

Marker 1 / Marker 2 / Marker 3 / Marker 4

"Marker X" activates the corresponding marker and opens an edit dialog box to enter the marker position ("X-value"). Pressing the softkey again deactivates the selected marker.

Marker 1 is always the default reference marker for relative measurements. If activated, markers 2 to 4 are delta markers that refer to marker 1. These markers can be converted into markers with absolute value display using the "Marker Type" function.

If normal marker 1 is the active marker, pressing "Mkr Type" switches on an additional delta marker 1.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 138
`CALCulate<n>:MARKer<m>:X` on page 139
`CALCulate<n>:MARKer<m>:Y?` on page 146
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 136
`CALCulate<n>:DELTamarker<m>:X` on page 137
`CALCulate<n>:DELTamarker<m>:X:RELative?` on page 145
`CALCulate<n>:DELTamarker<m>:Y?` on page 146

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

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

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 138
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 136

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

To create a delta marker in a fixed distance to another marker, define the distance as the x-value for the delta marker. Then link the delta marker to another marker using the Linking to Another Marker function.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 139
`CALCulate<n>:DELTamarker<m>:X` on page 137

Marker Type
Toggles the marker type.

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

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

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

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

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 138
CALCulate<n>:DELTamarker<m>[:STATe] on page 136

Reference Marker

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

Remote command:
CALCulate<n>:DELTamarker<m>:MREFerence on page 135

Linking to Another Marker

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

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

For linked delta markers, the x-value of the delta marker is 0 Hz by default. To create a delta marker in a fixed distance to another marker, define the distance as the x-value for the linked delta marker.

Remote command:
CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> on page 138
CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> on page 137
CALCulate<n>:DELTamarker<m>:LINK on page 135

Assigning the Marker to a Trace

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

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

Remote command:
CALCulate<n>:MARKer<m>:TRACe on page 139

Select Marker

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

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 138
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 136

All Markers Off

Deactivates all markers in one step.

Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 137

Fixed markers (H1, F1, F2)

Two fixed markers (H1, F1) are always active and displayed in the Modulation Spectrum result display and the "Marker Table". F1 indicates the currently selected Fundamental Frequency for distortion measurement, as well as the measured power level. A third marker, F2, is set to a second fundamental frequency for ILS measurements on the 90 Hz + 150 Hz components only. H1 indicates the currently selected frequency for distortion measurement (see Harmonic Frequency) and the power measured at that frequency.

The distortion at this frequency (measured as the power in relation to the power at the fundamental frequency) is indicated as an additional marker result ("Dist") in the Modulation Spectrum.

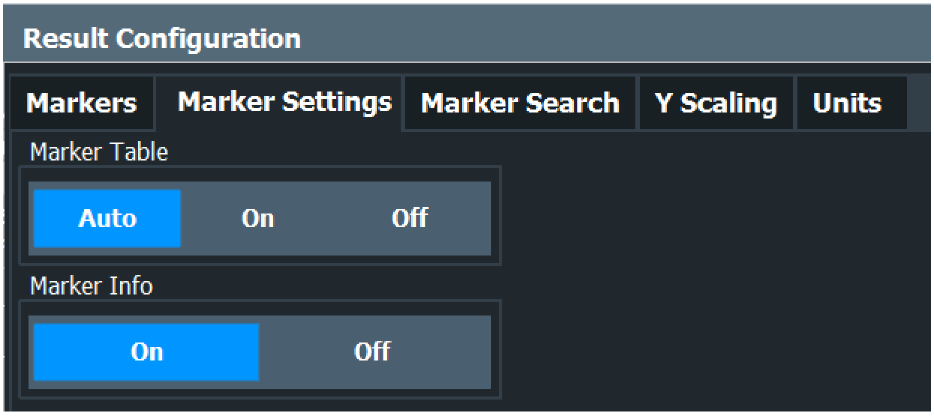
As opposed to common markers, H1, F1 and F2 markers cannot be repositioned manually, for example by dragging them on the screen. Their position is automatically defined by the Harmonic Frequency and Fundamental Frequency settings, respectively (see "Distortion" on page 68). These markers cannot be deactivated or configured.

Remote command:
`CALCulate<n>:AVIonics:SHD:RESult?` on page 153
`CALCulate<n>:AVIonics:SHD:FREQuency` on page 152
`CALCulate<n>:AVIonics:THD:FREQuency:FUNDament` on page 154

6.3.2 General marker settings

Access: "Overview" > "Analysis" > "Marker" > "Marker Settings"

Or: [MKR] > "Marker Config" > "Marker Settings" tab



Marker Table Display

Defines how the marker information is displayed.

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

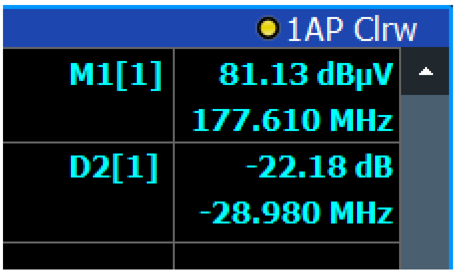
"Off" No separate marker table is displayed.
If Marker Info is active, the marker information is displayed within the diagram area.

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

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 140

Marker Info

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



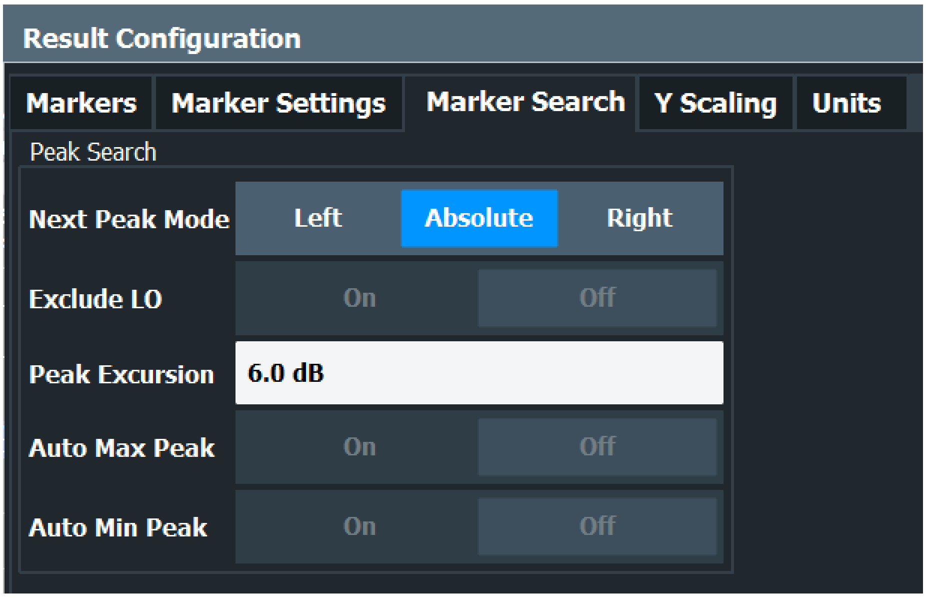
Remote command:
`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 140

6.3.3 Marker search settings

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

Access: [MKR ->] > "Search Config"

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



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

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

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

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

Remote command:
Chapter 9.6.3.3, "Positioning the marker", on page 141

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

Remote command:
`CALCulate<n>:MARKer<m>:PEXCursion` on page 140

6.3.4 Marker positioning functions

Access: [MKR ->]

The following functions set the currently selected marker to the result of a peak search.

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

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 142
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 144

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

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:NEXT` on page 141
`CALCulate<n>:MARKer<m>:MAXimum:RIGHt` on page 142
`CALCulate<n>:MARKer<m>:MAXimum:LEFT` on page 141
`CALCulate<n>:DELTamarker<m>:MAXimum:NEXT` on page 143
`CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt` on page 144
`CALCulate<n>:DELTamarker<m>:MAXimum:LEFT` on page 143

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

Remote command:
`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 142
`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 145

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

Remote command:
`CALCulate<n>:MARKer<m>:MINimum:NEXT` on page 142
`CALCulate<n>:MARKer<m>:MINimum:LEFT` on page 142
`CALCulate<n>:MARKer<m>:MINimum:RIGHt` on page 143
`CALCulate<n>:DELTamarker<m>:MINimum:NEXT` on page 144
`CALCulate<n>:DELTamarker<m>:MINimum:LEFT` on page 144
`CALCulate<n>:DELTamarker<m>:MINimum:RIGHt` on page 145

6.4 Export functions

Access: "Save" > "Export"

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

See the FSW User Manual for a description of the standard functions.

Export table to ASCII File
Opens a file selection dialog box and saves the selected result table in ASCII format (`.DAT`) to the specified file and directory.

Note: To store the measurement results for **all** traces and tables in **all** windows, use the Export Trace to ASCII File command in the "Save/Recall" > "Export" menu.
(See also "Trace Export Configuration" on page 82)

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Remote command:
`MMEMory:STORe<n>:TABLe` on page 157

Table Export Configuration
Table results can be exported to an ASCII file for further evaluation in other (external) applications.

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

Remote command:
FORMat:DEXPort:HEADer on page 159

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

Remote command:
FORMat:DEXPort:DSEParator on page 159

Export Table to ASCII File ← Table Export Configuration
Opens a file selection dialog box and saves the selected result table in ASCII format (**.DAT**) to the specified file and directory.

See "Export table to ASCII File" on page 81.

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

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

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Remote command:
MMEMory:STORe<n>:TRACe on page 158

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

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

Remote command:
FORMat:DEXPort:HEADer on page 159

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

Remote command:
FORMat:DEXPort:DSEParator on page 159

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

See "Export Trace to ASCII File" on page 82.

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

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

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

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

Remote command:
not supported

7 How to perform VOR/ILS measurements

The following step-by-step instructions demonstrate how to perform an VOR/ILS measurement with the R&S FSW Avionics (VOR/ILS) measurements application.

1. Press [MODE] on the front panel and select the "Avionics" application.
2. Press "MEAS" and select the required measurement type (ILS/VOR).
3. Select "Overview" to display the "Overview" for a VOR/ILS measurement.
4. Select "Input/Frontend" and switch to the "Frequency" tab.
5. Define the center frequency and any known frequency offset.
6. Select the "Amplitude" tab and define the appropriate reference level to avoid overload and underload. The bargraph in the Signal Summary is a useful indicator whether the selected value is suitable or not. The bar should cover as much of the graph as possible.
7. Select "Data Acquisition" and define the frequency range ("Demodulation BW") and duration ("Measurement Time") of the measurement.
   Make sure the bandwidth covers all relevant parts of the signal, but no more. If you are interested in the identifier, the measurement time must be long enough to capture the entire IDENT component (several seconds).
8. Select "Display Config" and select the displays that are of interest to you (up to 6). Arrange them on the display to suit your preferences.
9. Press [ESC] to exit the display configuration.
10. Stop the continuous sweep and start a new sweep with the new configuration (e.g. using [RUN SINGLE]).

    The characteristic signal parameters and distortion results are displayed.
11. Select "Spectrum" from the main "Avionics" menu to obtain the distortion for a particular frequency.
    a) Define the frequency ("Harmonic Freq") at which the distortion is to be calculated.
    b) Define the fundamental frequency to be used as a reference for the distortion measurement.

    The distortion at the selected frequency is indicated in the marker area of the "Modulation Spectrum" display ("DIST").
12. Select "Result Config" from the main "Avionics" menu to change any units for the result displays.

8 Optimizing and troubleshooting the measurement

If the results do not meet your expectations, try the following methods to optimize the measurement or solve problems.

Problem: No identification signal results at all in ILS Result Summary
A demodulation bandwidth of 800 Hz does not allow for identification signals to be demodulated. Select a larger demodulation bandwidth (see Chapter 5.4, "Data acquisition and detection", on page 63).

Explanation: The maximum AF frequency that can be analyzed is 0.5 * Demodulation BW = 400 Hz (for carrier offset = 0 Hz and DBW = 800 Hz). However, the identification/voice signal is 300 Hz to 4000 Hz, typically 1020 Hz.

Problem: Identification signal results are unstable or missing in the Result Summary
Possible Solutions:
- Turn off Morse coding of the identification signal in your DUT (making the signal a continuous tone)
- Increase the measurement time of the R&S FSW Avionics (VOR/ILS) measurements application to make sure at least one ON period is included, even in the worst case
- Synchronize the R&S FSW Avionics (VOR/ILS) measurements application and the DUT's Morse coding using an external trigger on the FSW.

Problem: No Morse coding results
Possible Solution: Increase the measurement time of the R&S FSW Avionics (VOR/ILS) measurements application. It should be at least the repetition cycle time of the Morse signal plus the time required to transmit two characters.

If time cannot be increased: Lower the demodulation bandwidth

Problem: Modulation Spectrum display shows picket fence effect around identification signal
Possible Solution: Turn off Morse coding of the identification signal in your DUT (making the signal a continuous tone), or turn off the identification signal in your DUT altogether.

Problem: Modulation Spectrum display does not resolve the signal components
Possible Solution: Make sure the RBW is small enough to distinguish all components. If possible, use the RBW auto mode (see "RBW" on page 65).

Problem: Modulation Spectrum display shows strange distortion products (VOR measurement)
Possible Solution: Could be FM to AM conversion, caused by FM signals or FM-like distortion products falling onto the application's digital filter's slope. Increase the Demodulation BW so that the critical frequencies fall into the filter's flat passband. Also check the measured carrier offset and adjust the carrier frequency setting either in the R&S FSW Avionics (VOR/ILS) measurements application or on the DUT.

Problem: Values in Result Summary or Signal Summary not accurate enough
Possible Solutions:
- Increase the measurement time.
- Adjust the reference level.
  Use an external reference frequency, if possible.
  (See the Reference Frequency Settings chapter in the FSW User Manual).

Problem: identification code not as expected
That is OK if DUT and R&S FSW Avionics (VOR/ILS) measurements application are not synchronized. Sending "MUC" can give you "C MU" or "UC MU" or "UC MU", etc.

Possible Solution: Increase the measurement time to get the complete code word, .e.g "UC MUC MU".

Problem: Missing results in Distortion Summary
K2, K3, and THD of a signal can only be measured if its modulation depth was detected to be high enough to trust the estimated frequency.

Possible Solutions:
- In your DUT, turn on the missing signal or increase its modulation depth.
- The THD result cannot be calculated if the Distortion Max Frequency parameter is smaller than 2 times the fundamental frequency. Increase the Distortion Max Frequency.

Note that the AF Span defined for the Modulation Spectrum result display has no effect on the THD, K2 and K3 results.

Problem: K2 and K3 cannot be calculated
Possible Solution:

K2 and K3 do not regard the Distortion Max Frequency parameter, but cannot be calculated if the span of the Modulation Spectrum display ends earlier than 2 or 3 times the fundamental frequency, respectively. Increase the demodulation bandwidth.

Note that the AF Span defined for the Modulation Spectrum result display has no effect on the THD, K2 and K3 results.

9 Remote commands to perform VOR/ILS measurements

The following commands are required to perform measurements in the R&S FSW Avionics (VOR/ILS) measurements application in a remote environment. It is assumed that the FSW has already been set up for remote operation in a network as described in the FSW User Manual.

Common Suffixes

In the R&S FSW Avionics (VOR/ILS) measurements application, the following common suffixes are used in remote commands:

Table 9-1: Common suffixes used in remote commands in the R&S FSW Avionics (VOR/ILS) measurements application

Suffix	Value range	Description
<m>	1 to 13	Marker
<n>	1 to 16	Window (**in the currently selected channel**)
<t>	1 to 6	Trace
	1 to 8	Limit line

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

In particular, this includes:

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

The following tasks specific to the R&S FSW Avionics (VOR/ILS) measurements application are described here:

9.1 Introduction

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

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

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

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

Remote command examples

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

9.1.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

- *Command usage*
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- *Parameter usage*
  If not specified otherwise, a parameter can be used to set a value, and it is the result of a query.
  Parameters required only for setting are indicated as "Setting parameters".
  Parameters required only to refine a query are indicated as "Query parameters".
  Parameters that are only returned as the result of a query are indicated as "Return values".
- *Conformity*
  Commands that are taken from the SCPI standard are indicated as "SCPI confirmed". All commands used by the FSW follow the SCPI syntax rules.
- *Asynchronous commands*
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an "Asynchronous command".
- *Reset values (*RST)*

Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as "*RST" values, if available.

- *Default unit*
  The default unit is used for numeric values if no other unit is provided with the parameter.
- *Manual operation*
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

9.1.2 Long and short form

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

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

Example:

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

9.1.3 Numeric suffixes

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

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

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

Example:

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

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

9.1.4 Optional keywords

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

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

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

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

With a numeric suffix in the optional keyword:

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

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

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

9.1.5 Alternative keywords

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

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

9.1.6 SCPI parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters can have different forms of values.

9.1.6.1 Numeric values

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

Example:

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

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

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

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

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

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

Querying numeric values

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

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

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

Sometimes, numeric values are returned as text.

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

9.1.6.2 Boolean

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

Querying Boolean parameters

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

Example:

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

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

9.1.6.3 Character data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information, see Chapter 9.1.2, "Long and short form", on page 90.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

9.1.6.4 Character strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELete 'Spectrum'`

9.1.6.5 Block data

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

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. The data bytes follow. During the transmission of these data bytes, all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires an `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

9.2 Activating VOR/ILS measurements

VOR/ILS measurements require a special application on the FSW. A measurement is started immediately with the default settings.

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

Adds a measurement channel. You can configure up to 10 measurement channels at the same time (depending on available memory).

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 95.

<ChannelName> String containing the name of the channel.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.

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

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

Replaces a channel with another one.

Setting parameters:

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

<ChannelType> Channel type of the new channel.
For a list of available channel types, see `INSTrument:LIST?` on page 95.

<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 95).
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named "IQAnalyzer2" by a new channel of type "IQ Analyzer" named "IQAnalyzer".

Usage: Setting only

INSTrument:DELete <ChannelName>

Deletes a channel.

If you delete the last channel, the default "Spectrum" channel is activated.

Setting parameters:

<ChannelName> String containing the name of the channel you want to delete.
A channel must exist to delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Setting only

INSTrument:LIST?

Queries all active channels. The query is useful to obtain the names of the existing channels, which are required to replace or delete the channels.

Return values:

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

Example: `INST:LIST?`
Result for 3 channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

Table 9-2: Available channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> parameter	Default Channel name*)
Spectrum	SANALYZER	Spectrum
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
802.11ad (R&S FSW-K95)	WIGIG	802.11ad
802.11ay (R&S FSW-K97)	EDMG	802.11ay EDMG
Amplifier Measurements (R&S FSW-K18)	AMPLifier	Amplifier
AM/FM/PM Modulation Analysis (R&S FSW-K7)	ADEM	Analog Demod
Avionics (R&S FSW-K15)	AVIonics	Avionics
Bluetooth (R&S FSW-K8)	BTO	Bluetooth
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
DOCSIS 3.1 (R&S FSW-K192/193)	DOCSis	DOCSIS 3.1
Fast Spur Search (R&S FSW-K50)	SPUR	Spurious
GSM (R&S FSW-K10)	GSM	GSM
*) If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> parameter	Default Channel name*)
HRP UWB (R&S FSW-K149)	UWB	HRP UWB
I/Q Analyzer	IQ	IQ Analyzer
LTE (R&S FSW-K10x)	LTE	LTE
Multi-Carrier "Group Delay" (R&S FSW-K17)	MCGD	MC "Group Delay"
NB-IoT (R&S FSW-K106)	NIOT	NB-IoT
Noise (R&S FSW-K30)	NOISE	Noise
5G NR (R&S FSW-K144)	NR5G	5G NR
OFDM VSA (R&S FSW-K96)	OFDMVSA	OFDM VSA
OneWeb (R&S FSW-K201)	OWEB	OneWeb
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
Pulse (R&S FSW-K6)	PULSE	Pulse
"Real-Time Spectrum"	RTIM	"Real-Time Spectrum"
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
Transient Analysis (R&S FSW-K60)	TA	Transient Analysis
Verizon 5GTF Measurement Application (V5GTF, R&S FSW-K118)	V5GT	V5GT
VSA (R&S FSW-K70)	DDEM	VSA
WLAN (R&S FSW-K91)	WLAN	WLAN
*) 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>

Renames a channel.

Setting parameters:

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

<ChannelName2> String containing the new channel name.
Note that you cannot assign an existing channel name to a new channel. If you do, an error occurs.
Channel names can have a maximum of 31 characters, and must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

Example:
```
INST:REN 'IQAnalyzer2','IQAnalyzer3'
```
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

See also `INSTrument:CREate[:NEW]` on page 94.

For a list of available channel types see `INSTrument:LIST?` on page 95.

Parameters:

<ChannelType> **AVI**
R&S FSW Avionics (VOR/ILS) measurements application, FSW–K15

Example: `INST:SEL AVI`

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

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

Usage: Event

Manual operation: See "Preset Channel" on page 44

9.3 Selecting the measurement type

CALCulate<n>:AVIonics[:STANdard] <Standard>

Defines the standard for which the signal parameters are measured.

For details on the standards and the corresponding measurements see Chapter 4, "Measurements and result displays", on page 29 and Chapter 3.1, "General information on ILS and VOR/DVOR", on page 14.

Suffix:

<n> 1..n
irrelevant

Parameters:

<Standard> VOR | ILS
*RST: VOR

Example: `CALC:AVI:STAN ILS`

Manual operation: See "Select Measurement" on page 45

9.4 Configuring VOR/ILS measurements

9.4.1 Input source settings

INPut:ATTenuation:PROTection:RESet

Resets the attenuator and reconnects the RF input with the input mixer for the FSW after an overload condition occurred and the protection mechanism intervened. The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

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

Example: `INP:ATT:PROT:RES`

INPut:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

Parameters:

<ConnType>

RF
RF input connector

RFPRobe
Active RF probe

*RST: RF

Example: `INP:CONN RF`
Selects input from the RF input connector.

Manual operation: See "Input Connector" on page 48

INPut:COUPling <CouplingType>

Selects the coupling type of the RF input.

Parameters:

<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Manual operation: See "Input Coupling" on page 47

INPut:DPATh <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:

<DirectPath> AUTO | OFF

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

Example: `INP:DPAT OFF`

Manual operation: See "Direct Path" on page 47

INPut:FILE:PATH <FileName>[, <AnalysisBW>]

Selects the I/Q data file to be used as input for further measurements.

The I/Q data file must be in one of the following supported formats:

- `.iq.tar`
- `.iqw`
- `.csv`
- `.mat`
- `.wv`
- `.aid`

Only a single data stream or channel can be used as input, even if multiple streams or channels are stored in the file.

For some file formats that do not provide the sample rate and measurement time or record length, you must define these parameters manually. Otherwise the traces are not visible in the result displays.

Parameters:

<FileName> String containing the path and name of the source file.
The file type is determined by the file extension. If no file extension is provided, the file type is assumed to be `.iq.tar`.
For `.mat` files, Matlab® v4 is assumed.

<AnalysisBW> Optionally: The analysis bandwidth to be used by the measurement. The bandwidth must be smaller than or equal to the bandwidth of the data that was stored in the file.
Default unit: HZ

Example:
```
INP:FILE:PATH 'C:\R_S\Instr\user\data.iq.tar'
```
Uses I/Q data from the specified file as input.

Example:
```
//Load an IQW file
INP:SEL:FIQ
INP:FILE:PATH 'C:\R_S\Instr\user\data.iqw'
//Define the sample rate
TRAC:IQ:SRAT 10MHz
//Define the measurement time
SENSe:SWEep:TIME  0.001001
//Start the measurement
INIT:IMM
```

Manual operation: See "Select I/Q data file" on page 49

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 FSW to measure the harmonics for a DUT, for example.

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-preselector, if available.)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

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

Manual operation: See "High Pass Filter 1 to 3 GHz" on page 48

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

Enables or disables the YIG filter.

Parameters:

<State> ON | OFF | 0 | 1

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

Manual operation: See "YIG-Preselector" on page 48

INPut:IMPedance <Impedance>

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

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω
Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See "Impedance" on page 47

INPut:SELect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the FSW.

For FSW85 models with two RF input connectors, you must select the input connector to configure first using `INPut:TYPE`.

Parameters:

<Source>

RF
Radio Frequency ("RF INPUT" connector)

FIQ
I/Q data file
Not available for Input2.

*RST: RF

Example: `INP:TYPE INP1`
For FSW85 models with two RF input connectors: selects the 1.00 mm RF input connector for configuration.
`INP:SEL RF`

Manual operation: See "Radio Frequency State" on page 46
See "I/Q Input File State" on page 49

INPut:TYPE <Input>

The command selects the input path.

Parameters:
<Input>

INPUT1
Selects RF input 1.
1 mm [RF Input] connector

INPUT2
Selects RF input 2.
For FSW85 models with two RF input connectors:
1.85 mm [RF2 Input] connector
For all other models: not available

*RST: INPUT1

Example: //Select input path
`INP:TYPE INPUT1`

Manual operation: See "Radio Frequency State" on page 46

TRACe:IQ:FILE:REPetition:COUNt <RepetitionCount>

Determines how often the data stream is repeatedly copied in the I/Q data memory. If the available memory is not sufficient for the specified number of repetitions, the largest possible number of complete data streams is used.

Parameters:
<RepetitionCount> integer

Example: `TRAC:IQ:FILE:REP:COUN 3`

Manual operation: See "File Repetitions" on page 50

9.4.2 Configuring the outputs

DIAGnostic:SERVice:NSOurce <State>

Turns the 28 V supply of the BNC connector labeled [noise source control] on the FSW on and off.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source Control" on page 56

9.4.3 Frontend configuration

The following commands are required to configure frequency and amplitude settings, which represent the "frontend" of the measurement setup.

9.4.3.1 Frequency

[SENSe:]FREQuency:CENTer <Frequency>

Defines the center frequency.

Parameters:

<Frequency> For the allowed range and f_{max}, refer to the specifications document.

*RST: fmax/2
Default unit: Hz

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

Manual operation: See "Center Frequency" on page 50

[SENSe:]FREQuency:CENTer:STEP <StepSize>

Defines the center frequency step size.

Parameters:

<StepSize> For f_{max}, refer to the specifications document.

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

Example: //Set the center frequency to 110 MHz.

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Center Frequency Stepsize" on page 51

[SENSe:]FREQuency:OFFSet <Offset>

Defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Parameters:

<Offset> Range: -1 THz to 1 THz
*RST: 0 Hz
Default unit: HZ

Example: `FREQ:OFFS 1GHZ`

Manual operation: See "Frequency Offset" on page 51

9.4.3.2 Amplitude settings

The following commands are required to configure the amplitude settings in a remote environment.

Useful commands for amplitude settings described elsewhere:

- INPut:COUPling on page 99
- INPut:IMPedance on page 101
- DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum on page 132
- DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum on page 133

Remote commands exclusive to amplitude settings:

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

Defines the reference level (for all traces in all windows).

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

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

<ReferenceLevel> The unit is variable.

Range: see specifications document
*RST: 0 dBm
Default unit: DBM

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

Manual operation: See "Reference Level" on page 52

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

Defines a reference level offset (for all traces in all windows).

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:

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

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

Manual operation: See "Shifting the Display (Offset)" on page 52

INPut:EGAin[:STATe] <State>

Before this command can be used, the external preamplifier must be connected to the FSW. See the preamplifier's documentation for details.

When activated, the FSW automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results.

Note that when an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For FSW85 models with two RF inputs, you must enable correction from the external preamplifier for each input individually. Correction cannot be enabled for both inputs at the same time.

When deactivated, no compensation is performed even if an external preamplifier remains connected.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
No data correction is performed based on the external preamplifier

ON | 1
Performs data corrections based on the external preamplifier

*RST: 0

Example: `INP:EGA ON`

Manual operation: See "Ext. PA Correction" on page 54

INPut:GAIN:STATe <State>

Turns the internal preamplifier on and off. It requires the optional preamplifier hardware.

Note that if an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

For FSW85 models, no preamplifier is available.

If option R&S FSW-B22 is installed, the preamplifier is only active below 7 GHz.

If option R&S FSW-B24 is installed, the preamplifier is active for all frequencies.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 15
```
Switches on 15 dB preamplification.

Manual operation: See "Preamplifier" on page 54

INPut:GAIN[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 106).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain>

For all FSW models except for FSW85, the following settings are available:
15 dB and 30 dB
All other values are rounded to the nearest of these two.
30 dB
For older FSW43/FSW50/FSW67 models, the input signal is always ampilfied by about 30 dB when the preamplifier is active.
For FSW85 models, no preamplifier is available.

Default unit: DB

Example:

```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```

Switches on 30 dB preamplification.

Manual operation: See "Preamplifier" on page 54

9.4.3.3 Configuring the attenuation

INPut:ATTenuation <Attenuation>

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 specifications document
Increment: 5 dB (with optional electr. attenuator: 1 dB)
*RST: 10 dB (AUTO is set to ON)
Default unit: DB

Example:

```
INP:ATT 30dB
```

Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Manual operation: See "Attenuation Mode / Value" on page 53

INPut:ATTenuation:AUTO <State>

Couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the FSW 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.

Manual operation: See "Attenuation Mode / Value" on page 53

INPut:EATT <Attenuation>

Defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut:EATT:AUTO` on page 108).

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> attenuation in dB

Range: see specifications document
Increment: 1 dB
*RST: 0 dB (OFF)
Default unit: DB

Example: `INP:EATT:AUTO OFF`
`INP:EATT 10 dB`

Manual operation: See "Using Electronic Attenuation" on page 53

INPut:EATT:AUTO <State>

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Example: `INP:EATT:AUTO OFF`

Manual operation: See "Using Electronic Attenuation" on page 53

INPut:EATT:STATe <State>

Turns the electronic attenuator on and off.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual operation: See "Using Electronic Attenuation" on page 53

9.4.4 Triggering measurements

Useful commands for triggering described elsewhere:

- `[SENSe:]FREQuency:CENTer` on page 103

Remote commands exclusive to triggering:

9.4.4.1 Configuring the triggering conditions

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See "Drop-Out Time" on page 61

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

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

Parameters:

<Offset>
*RST: 0 s
Default unit: S

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Offset" on page 61

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

Defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period> Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example: `TRIG:SOUR EXT`
Sets an external trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 61

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB
Default unit: DB

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 61

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

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 front panel)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:

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

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 61

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

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 specifications document.
*RST: -20 dBm
Default unit: DBM

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

Manual operation: See "Trigger Level" on page 61

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

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. If defined, a reference level offset is also considered.

Parameters:

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

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

Manual operation: See "Trigger Level" on page 61

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

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 specifications document.

*RST: -20 dBm
Default unit: DBM

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

TRIGger[:SEQuence]:RFPower:HOLDoff <Time>

Parameters:

<Time> Default unit: S

TRIGger[:SEQuence]:SLOPe <Type>

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Slope" on page 61

TRIGger[:SEQuence]:SOURce <Source>

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 that this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the "Trigger Input" connector.

EXT2
Trigger signal from the "Trigger Input/Output" connector.
For FSW85 models, Trigger 2 is not available due to the second RF input connector on the front panel. The trigger signal is taken from the "Trigger Input/Output" connector on the rear panel.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the "TRIGGER 3 INPUT/ OUTPUT" connector.
Note: Connector must be configured for "Input".

*RST: IMMediate

Example:

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

Manual operation:

See "Trigger Source" on page 59
See "Free Run" on page 59
See "External Trigger 1/2/3" on page 59
See "IF Power" on page 60
See "RF Power" on page 60
See "I/Q Power" on page 61

9.4.4.2 Configuring the trigger output

The following commands are required to send the trigger signal to one of the variable "TRIGGER INPUT/OUTPUT" connectors on the FSW.

OUTPut:TRIGger<tp>:DIRection <Direction>

Selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:

<tp> Selects the used trigger port.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear panel)

Parameters:

<Direction> INPut | OUTPut

INPut
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 2/3" on page 56

OUTPut:TRIGger<tp>:LEVel <Level>

Defines the level of the (TTL compatible) signal generated at the trigger output.

Works only if you have selected a user-defined output with `OUTPut:TRIGger<tp>:OTYPe`.

Suffix:

<tp> 1..n
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:

<Level>

HIGH
5 V

LOW
0 V

*RST: LOW

Example: `OUTP:TRIG2:LEV HIGH`

Manual operation: See "Level" on page 57

OUTPut:TRIGger<tp>:OTYPe <OutputType>

Selects the type of signal generated at the trigger output.

Suffix:

<tp> 1..n
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:

<OutputType>

DEVice
Sends a trigger signal when the FSW 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<tp>:LEVel`.

*RST: DEVice

Manual operation: See "Output Type" on page 57

OUTPut:TRIGger<tp>:PULSe:IMMediate

Generates a pulse at the trigger output.

Suffix:

<tp> 1..n
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Manual operation: See "Send Trigger" on page 57

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

Defines the length of the pulse generated at the trigger output.

Suffix:

<tp> Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
(Not available for FSW85 models with two RF input connectors.)
3 = trigger port 3 (rear)

Parameters:

<Length> Pulse length in seconds.

Default unit: S

Example: `OUTP:TRIG2:PULS:LENG 0.02`

Manual operation: See "Pulse Length" on page 57

9.4.5 Data acquisition

[SENSe:]ADEMod:BANDwidth:DEModulation <DemodBWManual>
[SENSe:]ADEMod:BWIDth:DEModulation <DemodBWManual>

Defines the demodulation bandwidth manually.

For `ADEM:BWID:DEM:AUTO ON`, the query returns the currently used DBW.

Parameters:

<DemodBWManual> <numeric value>

For a list of available DBW values see Available demodulation bandwidths and measurement times for ILS measurements and Available demodulation bandwidths and measurement times for VOR measurements

*RST: ON

Example:

```
ADEM:BWID:DEM:AUTO OFF
ADEM:BWID:DEM 50KHZ
```

Manual operation: See "Demodulation Bandwidth" on page 64

[SENSe:]ADEMod:BANDwidth:DEModulation:AUTO <DemodBWAuto>
[SENSe:]ADEMod:BWIDth:DEModulation:AUTO <DemodBWAuto>

Defines whether the demodulation bandwidth is determined automatically or not.

Parameters:

<DemodBWAuto> ON | OFF | 1 | 0

ON | 1
The DBW is determined automatically by the R&S FSW Avionics (VOR/ILS) measurements application.
For ILS measurements: 12.5 kHz
For VOR measurements: 25 kHz

OFF | 0
The DBW defined by the `[SENSe:]ADEMod:BWIDth:DEModulation` command is used.

*RST: 1

Example: `ADEM:BWID:DEM:AUTO OFF`
`ADEM:BWID:DEM 50KHZ`

Manual operation: See "Demodulation Bandwidth" on page 64

[SENSe:]ADEMod:SPECtrum:BANDwidth[:RESolution] <Frequency>
[SENSe:]ADEMod:SPECtrum:BWIDth[:RESolution] <Frequency>

Sets the resolution bandwidth for "Modulation Spectrum" results. If the available measurement time is not sufficient for the given bandwidth, the measurement time is set to is maximum and the resolution bandwidth is enlarged to the resulting bandwidth.

The query returns the currently used RBW for `SENS:ADEM:SPEC:BWID:AUTO ON`

Parameters:
<Frequency> The available RBW values depend on the Demodulation Bandwidth and the Measurement Time.

Default unit: HZ

Example: `SENS:ADEM:SPEC:BWID:AUTO OFF`
`SENS:ADEM:SPEC:BWID 2.5HZ`

Manual operation: See "RBW" on page 65

[SENSe:]ADEMod:SPECtrum:BANDwidth[:RESolution]:AUTO <DemodResBWAuto>
[SENSe:]ADEMod:SPECtrum:BWIDth[:RESolution]:AUTO <DemodResBWAuto>

Defines whether the resolution bandwidth for Modulation Spectrum results is determined automatically or not.

Parameters:
<DemodResBWAuto> ON | OFF | 1 | 0

ON | 1
The RBW is determined automatically.

OFF | 0
The RBW is defined by the `[SENSe:]ADEMod:SPECtrum:BWIDth[:RESolution]` command.

*RST: 1

Example: `SENS:ADEM:SPEC:BWID:AUTO OFF`
`SENS:ADEM:SPEC:BWID 2.5HZ`

Manual operation: See "RBW" on page 65

[SENSe<ip>:]SWEep:TIME <Time>

Defines the net, settled measurement length; internally, the R&S FSW Avionics (VOR/ILS) measurements application captures data slightly longer to allow for all filters to settle.

For `SWE:TIME:AUTO ON`, the query returns the currently used measurement time.

Suffix:
<ip> 1..n

Parameters:
<Time> The available measurement times depend on the Demodulation Bandwidth, see Available demodulation bandwidths and measurement times for ILS measurements and Available demodulation bandwidths and measurement times for VOR measurements.

*RST: 1 s
Default unit: S

Example:
```
SWE:TIME:AUTO OFF
SENSe:SWEep:TIME 10s
```

Manual operation: See "Measurement Time" on page 64

[SENSe<ip>:]SWEep:TIME:AUTO <State>

Defines whether the measurement time is determined automatically or not.

Suffix:
<ip> 1..n

Parameters:
<State> ON | OFF | 1 | 0

The available measurement times depend on the Demodulation Bandwidth, see Available demodulation bandwidths and measurement times for ILS measurements and Available demodulation bandwidths and measurement times for VOR measurements.

ON | 1
The required time (1 s) is determined by the R&S FSW Avionics (VOR/ILS) measurements application.

OFF | 0
The required time is defined by the `[SENSe<ip>:]SWEep:TIME` command.

*RST: 1

Example:
```
SWE:TIME:AUTO OFF
SENSe:SWEep:TIME 10s
```

Manual operation: See "Measurement Time" on page 64

9.4.6 Configuring the demodulation spectrum

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

DISPlay[:WINDow<n>]:TRACe<t>:Y:SPACing <Spacing>

Switches the scaling mode for the deviation trace in the Modulation Spectrum between linear and logarithmic.

Note: this setting only has an effect on the graphical results, not on the numerical results.

Suffix:

<n> 1..n

<t> 1..n
irrelevant

Parameters:

<Spacing> LINear | LOGarithmic

LINear
Scaling in percent

LOGarithmic
Scaling in dB

*RST: LOGarithmic

Manual operation: See "Deviation Trace" on page 68

[SENSe:]ADEMod:AF:CENTer <Frequency>

Defines the center frequency of the demodulated data to evaluate in the Modulation Spectrum display.

Parameters:

<Frequency> Default unit: HZ

Manual operation: See "AF Center" on page 67

[SENSe:]ADEMod:AF:SPAN <Bandwidth>

Defines the span of the demodulated data to evaluate in the Modulation Spectrum display.

Parameters:

<Bandwidth> Range: 0 to DBW/2
Default unit: HZ

Manual operation: See "AF Span" on page 68

[SENSe:]ADEMod:AF:SPAN:FULL

Defines the span of the demodulated data to evaluate in the Modulation Spectrum display to be the maximum span possible (DBW/2).

Example: `ADEM:BAND:DEM 50e3`
Sets the demodulation bandwidth to 50 kHz
`ADEM:AF:SPAN:FULL`
Sets the demodulation bandwidth to 25 kHz, which is the maximum possible bandwidth (=DBW/2)

Usage: Event

Manual operation: See "AF Span" on page 68
See "AF Full Span" on page 68

[SENSe:]ADEMod:AF:STARt <Frequency>

Defines the start frequency of the demodulated data to evaluate in the Modulation Spectrum display.

Parameters:
<Frequency> Range: CF - DBW/2 to AF stop frequency
Default unit: HZ

Manual operation: See "AF Start" on page 67

[SENSe:]ADEMod:AF:STOP <Frequency>

Defines the stop frequency of the demodulated data to evaluate in the Modulation Spectrum display.

Parameters:
<Frequency> Range: AF start frequency to CF + DBW/2
Default unit: HZ

Manual operation: See "AF Stop" on page 67

9.5 Configuring and performing sweeps

When the R&S FSW Avionics (VOR/ILS) measurements application is activated, a continuous sweep is performed automatically. However, you can stop and start a new measurement any time.

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

ABORt

Aborts the measurement in the current channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details on overlapping execution see Remote control via SCPI.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the FSW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event

INITiate<n>:CONMeas

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: Asynchronous command

INITiate<n>:CONTinuous <State>

Controls the measurement mode for an individual 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 Remote control via SCPI.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1 (some applications can differ)

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 65

INITiate<n>[:IMMediate]

Starts a (single) new measurement.

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

For details on synchronization see Remote control via SCPI.

Suffix:
<n> irrelevant

Usage: Asynchronous command

Manual operation: See "Single Sweep / Run Single" on page 65

[SENSe:]SWEep:COUNt <SweepCount>

This command defines the number of measurements that the application uses to average traces.

Currently the R&S FSW Avionics (VOR/ILS) measurements application does not support averaging measurements. Thus, this command has no effect (the `<SweepCount>` parameter is always considered to be `1`).

Parameters:
<SweepCount> *RST: 1

[SENSe:]SWEep:COUNt:CURRent?

Return values:
<CurrentCount>

Usage: Query only

9.6 Analyzing VOR/ILS measurements

9.6.1 Configuring the result display

The commands required to configure the screen display in a remote environment are described here.

9.6.1.1 General window commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat <Format>

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>

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 127).

Suffix:
<n> Window

Parameters:
<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:SIZE LARG`

9.6.1.2 Working with windows in the display

The following commands are required to change the evaluation type and rearrange the screen layout for a channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected channel.

Note that the suffix <n> always refers to the window *in the currently selected channel*.

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

Adds a window to the display in the active channel.

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

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

Query parameters:

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

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

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

Return values:

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

Usage: Query only

Manual operation: See "Signal Summary" on page 30
See "Result Summary" on page 30
See "Distortion Summary" on page 31
See "Modulation Spectrum" on page 32
See "Marker Table" on page 33

Table 9-3: <WindowType> parameter values for the Avionics (VOR/ILS) application

Parameter value	Window type
DSUMmary	"Distortion Summary"
RSUMmary	"Result Summary"
SSUMmary	"Signal Summary"
MSPectrum	"Modulation Spectrum"
MTABle	"Marker Table"

LAYout:CATalog[:WINDow]?

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

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string
Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

Queries the **index** of a particular display window in the active channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:
<WindowName> String containing the name of a window.

Return values:
<WindowIndex> Index number of the window.

Example: `LAY:IDEN:WIND? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Setting parameters:
<WindowName> String containing the name of an existing window that is to be moved.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

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

<Direction> LEFT | RIGHt | ABOVe | BELow | REPLace
Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

Removes a window from the display in the active channel.

Setting parameters:

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

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

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

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel while keeping its position, index and window name.

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

Setting parameters:

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

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 124 for a list of available window types.

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

Usage: Setting only

LAYout:SPLitter <Index1>, <Index2>, <Position>

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 124 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command does not work, but does not return an error.

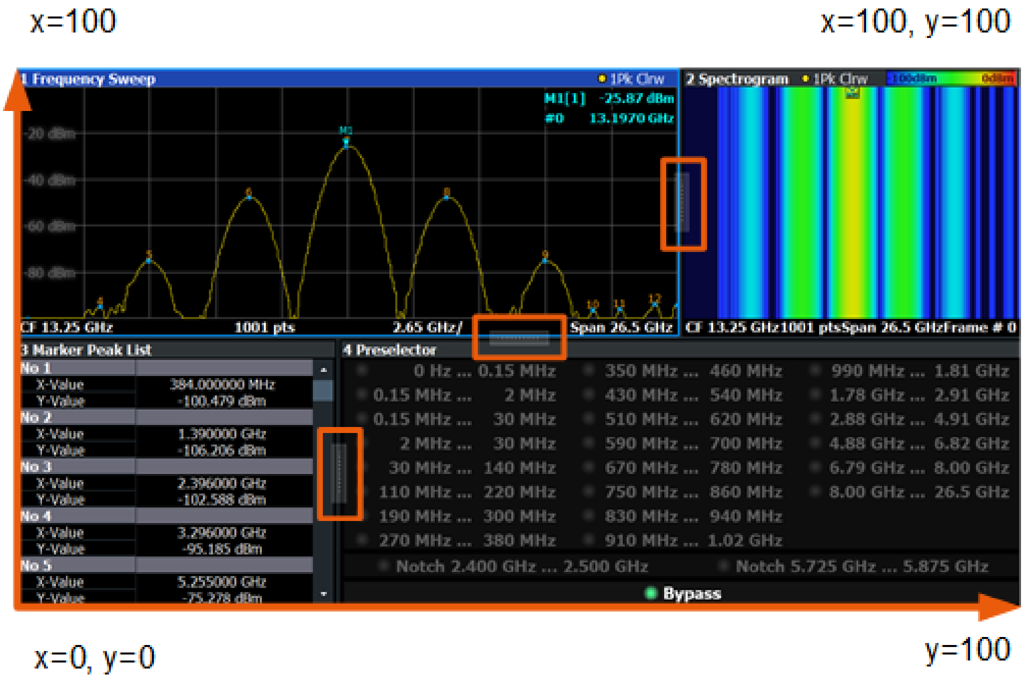


Figure 9-1: SmartGrid coordinates for remote control of the splitters

Setting parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu).
The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See Figure 9-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.
Range: 0 to 100

Example:

```
LAY:SPL 1,3,50
```

Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Table"') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('"Marker Peak List"') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
`LAY:SPL 3,2,70`
`LAY:SPL 4,1,70`
`LAY:SPL 2,1,70`

Usage: Setting only

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

Adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added. Unlike `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

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

Suffix:
<n> Window

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 124 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?

Queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel.

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

Suffix:
<n> Window

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

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

Removes the window specified by the suffix <n> from the display in the active channel.

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

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

Changes the window type of an existing window (specified by the suffix <n>) in the active channel.

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

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

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 124 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

Usage: Setting only

LAYout:WINDow<n>:TYPE <WindowType>

Queries or defines the window type of the window specified by the index <n>. The window type determines which results are displayed. For a list of possible window types, see `LAYout:ADD[:WINDow]?` on page 124.

Note that this command is not available in all applications and measurements.

Suffix:
<n> 1..n
Window

Parameters:
<WindowType>

Example: `LAY:WIND2:TYPE?`

9.6.2 Configuring the Y-Axis scaling and units

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These commands are described here.

Useful commands for configuring scaling described elsewhere:

- `DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 104

Remote commands exclusive to scaling the y-axis

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces).

Suffix:
<n> Window

<t> irrelevant

Manual operation: See "Auto Scale Once" on page 71

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

In spectrum displays, for example, this command is not available.

Suffix:

<n>	Window
<w>	subwindow Not supported by all applications
<t>	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
Default unit: DBM

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Per Division" on page 72

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

Defines the vertical position of the reference level on the display grid (for all traces).

The FSW adjusts the scaling of the y-axis accordingly.

Suffix:

<n>	Window
<w>	subwindow Not supported by all applications
<t>	irrelevant

Example: `DISP:TRAC:Y:RPOS 50PCT`

Manual operation: See "Ref Position" on page 72

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

Defines the maximum value on the y-axis in the specified window.

Suffix:

<n>	Window
<t>	irrelevant

Parameters:

<Max> numeric value

Example: `DISP:WIND2:TRAC:Y:SCAL:MAX 10`

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 71

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

Defines the minimum value on the y-axis in the specified window.

Suffix:

<n> Window

<t> irrelevant

Parameters:

<Min> numeric value

Example: `DISP:WIND2:TRAC:Y:SCAL:MIN -90`

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 71

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:

<n> Window

<t> irrelevant

Parameters:

<Value> numeric value WITHOUT UNIT

Default unit: dBm

Manual operation: See "Ref Value" on page 72

UNIT<n>:DDM <DDMUnit>

Determines the unit for ILS DDM results (relevant for ILS measurements only).

Suffix:

<n> 1..n
irrelevant

Parameters:

<DDMUnit> UNITless | PCT

UNITless
Absolute results

PCT
Relative results

*RST: UNITless

Example: `UNIT:DDM UNIT`

Manual operation: See "ILS DDM" on page 72

UNIT<n>:THD <THDUnit>

Switches units between dB and percent for the total harmonic distortion (THD), K2 and K3 results in the Distortion Summary and Result Summary and the corresponding remote commands.

Suffix:

<n> 1..n
irrelevant

Parameters:

<THDUnit> DB | PCT
*RST: PCT

Example: `UNIT:THD DB`

Manual operation: See "Distortion" on page 72

UNIT<n>:VORDirection <VORDirection>

Only relevant for VOR measurements: Switches between a phase display in *from* or *to* notation.

For details see Chapter 3.3.3, "Phase notation in VOR measurements", on page 28.

Suffix:

<n> 1..n
irrelevant

Parameters:

<VORDirection> FROM | TO
*RST: FROM

Example: `UNIT:VORD TO`

Manual operation: See "VOR Phase" on page 73

9.6.3 Working with markers

9.6.3.1 Individual marker settings

CALCulate<n>:DELTamarker<m>:AOFF

Turns off *all* delta markers.

Suffix:

<n>	Window
<m>	irrelevant

Example: `CALC:DELT:AOFF`
Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

Links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Suffix:

<n>	Window
<m>	Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2:LINK ON`

Manual operation: See "Linking to Another Marker" on page 76

CALCulate<n>:DELTamarker<m>:MREFerence <Reference>

Selects a reference marker for a delta marker other than marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<Reference> **D1**
Selects the deltamarker 1 as the reference.

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 76

CALCulate<n>:DELTamarker<m>[:STATe] <State>

Turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74
See "Marker State" on page 75
See "Marker Type" on page 75
See "Select Marker" on page 76

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

Selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<n> Window

<m> Marker

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:DELTamarker<m>:X <Position>

Moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:

<n> Window

<m> Marker

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74
See "Marker Position X-value" on page 75

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

Links the delta source marker <ms> to any active destination marker <md> (normal or delta marker).

Suffix:

<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT4:LINK:TO:MARK2 ON`
Links the delta marker 4 to the marker 2.

Manual operation: See "Linking to Another Marker" on page 76

CALCulate<n>:MARKer<m>:AOFF

Turns off all markers.

Suffix:

<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Manual operation: See "All Markers Off" on page 77

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

Links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:
<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See "Linking to Another Marker" on page 76

CALCulate<n>:MARKer<m>[:STATe] <State>

Turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74
See "Marker State" on page 75
See "Marker Type" on page 75
See "Select Marker" on page 76

CALCulate<n>:MARKer<m>:TRACe <Trace>

Selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<n>	Window
<m>	Marker

Parameters:
<Trace>

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See "Assigning the Marker to a Trace" on page 76

CALCulate<n>:MARKer<m>:X <Position>

Moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Note that the markers 14, 15 and 16 are used for the fixed markers H1, F1, and F2 (see "Fixed markers (H1, F1, F2)" on page 73) and cannot be positioned manually. For these markers, this command can be used as a query only.

Suffix:

<n>	Window
<m>	Marker

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.
Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 33
See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74
See "Marker Position X-value" on page 75

9.6.3.2 General marker settings

CALCulate<n>:MARKer<m>:PEXCursion <Excursion>

Defines the peak excursion (for *all* markers in *all* windows).

The peak excursion sets the requirements for a peak to be detected during a peak search.

The unit depends on the measurement.

Suffix:

<n> irrelevant

<m> irrelevant

Manual operation: See "Peak Excursion" on page 79

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

Turns the marker information in all diagrams on and off.

Suffix:

<n> irrelevant

Parameters:

<State>

ON | 1
Displays the marker information in the diagrams.

OFF | 0
Hides the marker information in the diagrams.

*RST: 1

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Marker Info" on page 78

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

Turns the marker table on and off.

Suffix:

<n> irrelevant

Parameters:

<DisplayMode>

ON | 1
Turns on the marker table.

OFF | 0
Turns off the marker table.

AUTO
Turns on the marker table if 3 or more markers are active.
*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 78

9.6.3.3 Positioning the marker

This chapter contains remote commands necessary to position the marker on a trace.

Positioning normal markers

The following commands position markers on the trace.

CALCulate<n>:MARKer<m>:MAXimum:LEFT

Moves a marker to the next positive peak.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 80

CALCulate<n>:MARKer<m>:MAXimum:NEXT

Moves a marker to the next positive peak.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 80

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

Moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:

<n> Window

<m> Marker

Manual operation: See "Peak Search" on page 80

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

Moves a marker to the next positive peak.

The search includes only measurement values to the right of the current marker position.

Suffix:

<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 80

CALCulate<n>:MARKer<m>:MINimum:LEFT

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:

<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 80

CALCulate<n>:MARKer<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

Suffix:

<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 80

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

Moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 80

CALCulate<n>:MARKer<m>:MINimum:RIGHt

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 80

Positioning delta markers

The following commands position delta markers on the trace.

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

Moves a delta marker to the next positive peak value.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 80

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

Moves a marker to the next positive peak value.

Suffix:
<n> 1..n
Window

<m> 1..n
Marker

Manual operation: See "Search Next Peak" on page 80

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

Moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Peak Search" on page 80

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

Moves a delta marker to the next positive peak value on the trace.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 80

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 80

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 80

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

Moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 80

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 80

9.6.3.4 Retrieving marker results

The following commands are used to retrieve the results of markers.

CALCulate<n>:DELTamarker<m>:X:RELative?

Queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Suffix:
<n> Window

<m> Marker

Return values:
<Position> Position of the delta marker in relation to the reference marker.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

Manual operation: See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74

CALCulate<n>:DELTamarker<m>:Y?

Queries the result at the position of the specified delta marker.

Suffix:
<n> 1..n

<m> 1..n

Return values:
<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.
Default unit: DBM

Usage: Query only

Manual operation: See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74

CALCulate<n>:MARKer<m>:Y?

Queries the result at the position of the specified marker.

Suffix:
<n> 1..n

<m> 1..n

Return values:
<Result> Default unit: DBM

Usage: Query only

Manual operation: See "Marker Table" on page 33
See "Marker 1 / Marker 2 / Marker 3 / Marker 4" on page 74

9.7 Retrieving results

9.7.1 Retrieving numeric results

CALCulate<n>:AVIonics:AM:CODE?

Queries the Morse code of the demodulated identifier.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Return values:
<VORILSMorseCode> **'N/A'**
No identifier detected

<string>
Demodulated identifier code

Example: `CALC:AVI:AM:CODE?`
Result:
`"MUC"`

Usage: Query only

Manual operation: See "Ident Code" on page 36

CALCulate<n>:AVIonics:AM:FREQuency? <FundFreqIdent>

Queries the measured AF frequency for the specified fundamental frequency.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Query parameters:
<FundFreqIdent> '30' | '90' | '150' | '90+150' | '9960' | 'ID'

'30'
30 Hz AM rotational signal

'90'
90 Hz ILS component

'150'
150 Hz ILS component

'90+150'
90 Hz and the 150 Hz components, taking the phase between the components into account.

'9960'
9.96 kHz subcarrier

'ID'
Identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS/VOR signal components

Example: `CALC:AVI:AM? '90+150'`

Usage: Query only

Manual operation:
See "90 Hz AM frequency" on page 35
See "150 Hz AM frequency" on page 35
See "Voice / IDENT AM frequency" on page 36
See "30 Hz AM frequency" on page 38
See "9.96 kHz AM frequency" on page 39
See "VOICE / IDENT AM frequency" on page 39

CALCulate<n>:AVIonics:AM[:DEPTh]? <FundFreqIdent>

Queries the amplitude modulation depth result for the specified signal component.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Query parameters:
<FundFreqIdent> '30' | '90' | '150' | '90+150' | '9960' | 'ID'

signal component, defined by its fundamental frequency

'30'
30 Hz AM rotational signal

'90'
90 Hz ILS component

'150'
150 Hz ILS component

'90+150'
90 Hz and the 150 Hz components, taking the phase between the components into account.

'9960'
9.96 kHz subcarrier

'ID'
Identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS/VOR signal components

Example: `CALC:AVI:AM? '90+150'`

Usage: Query only

Manual operation:
See "90 Hz AM depth" on page 35
See "150 Hz AM depth" on page 35
See "90+150 Hz AM depth" on page 36
See "Voice / IDENT AM depth" on page 36
See "30 Hz AM depth" on page 38
See "9.96 kHz AM depth" on page 39
See "VOICE / IDENT AM depth" on page 39

CALCulate<n>:AVIonics:CARRier[:RESult]?

Queries the result of the RF level measurement.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Return values:
<Value> Default unit: dBm

Example: `CALC:AVI:CARR?`

Usage: Query only

Manual operation:
See "Signal Summary" on page 30
See "RF Level" on page 34

CALCulate<n>:AVIonics:DDM?

Queries the result of the ILS DDM measurement.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Return values:

<Value> Difference in depth of modulation (DDM) between 90 Hz and 150 Hz AM signal ($m_{90\,Hz} - m_{150\,Hz}$)
The unit depends on the `UNIT<n>:DDM` command.

Example: `CALC:AVI:DDM?`

Usage: Query only

Manual operation: See "ILS DDM" on page 37

CALCulate<n>:AVIonics:FERRor[:RESult]?

Queries the carrier offset.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:

<n> 1..n
irrelevant

Return values:

<Value> Difference between measured frequency and frequency setting; Positive value if the signal's carrier frequency is higher than expected

Example: `CALC:AVI:FERRor?`

Usage: Query only

Manual operation: See "Signal Summary" on page 30
See "Carrier Offset" on page 34

CALCulate<n>:AVIonics:FM:FREQuency?

Queries the frequency (typically 30 Hz) of the signal that was used to modulate the carrier at typically 9960 Hz (VOR only).

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:

<n> 1..n
irrelevant

Return values:

<Value>

Example: `CALC:AVI:FM:FREQ?`

Usage: Query only

Manual operation: See "30 Hz FM frequency" on page 39

CALCulate<n>:AVIonics:FM[:DEViation]?

Queries the frequency deviation (typically 480 Hz) used to modulate the carrier at typically 9960 Hz with the 30 Hz FM signal (typically 30 Hz frequency).

(VOR measurements only).

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Return values:
<Value>

Example: `CALC:AVI:FM?`

Usage: Query only

Manual operation: See "30 Hz FM depth" on page 39

CALCulate<n>:AVIonics:PHASe?

Queries the result of the ILS or VOR phase measurement.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Return values:
<Value> ILS: Phase angle measurement between 90 Hz and 150 Hz AM signal (90 Hz = reference signal); measurement range: ±60 degrees
VOR: Phase angle measurement between 30 Hz AM & 30 Hz FM demodulated signal
Note the effect of the `UNIT<n>:VORDirection` command on the results!

Default unit: deg

Example: `CALC:AVI:PHAS?`

Usage: Query only

Manual operation: See "90+150 Hz AM phase" on page 36
See "VOR Phase" on page 40

CALCulate<n>:AVIonics:RFFRequency[:RESult]?

Queries the result of the RF frequency counter measurement.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:

<n>	1..n irrelevant

Return values:

<Value>	Measured RF frequency Default unit: Hz
Example:	`CALC:AVI:RFFR?`
Usage:	Query only
Manual operation:	See "Signal Summary" on page 30 See "RF Frequency" on page 34

CALCulate<n>:AVIonics:SDM?

Queries the ILS Sum in Depth of Modulation (SDM) result.

Suffix:

<n>	1..n irrelevant

Return values:

<Value>	Arithmetic sum of the modulation depth of the 90 Hz and the 150 Hz components without any influence of the phase between the components. Default unit: %
Example:	`CALC:AVI:SDM?`
Usage:	Query only
Manual operation:	See "SDM" on page 37

CALCulate<n>:AVIonics:SHD:FREQuency <Frequency>

Defines the frequency for which a harmonic distortion measurement is required. The fixed marker H1 is positioned at this frequency (see "Fixed markers (H1, F1, F2)" on page 77).

For details see Chapter 4.2, "Avionics parameters", on page 34.

Tip: The result of this harmonic distortion measurement is provided using the `CALCulate<n>:AVIonics:SHD:RESult?` command.

Suffix:

<n>	1..n irrelevant

Parameters:

<Frequency>	arbitrary frequency, need not be a fixed fundamental frequency Default unit: HZ
Example:	`CALC:AVI:SHD:FREQ 100HZ`

Manual operation: See "Modulation Spectrum" on page 32
See "Marker Table" on page 33
See "H1" on page 41
See "Harmonic Frequency" on page 68
See "Fixed markers (H1, F1, F2)" on page 77

CALCulate<n>:AVIonics:SHD:RESult?

Queries the result of the harmonic distortion measurement performed at the position of the marker H1 (defined by `CALCulate<n>:AVIonics:SHD:FREQuency` on page 152).

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n
irrelevant

Return values:
<Value> Distortion measured at the frequency specified by `CALCulate<n>:AVIonics:SHD:FREQuency` in relation to the modulation measured at the fundamental frequency (`CALCulate<n>:AVIonics:THD:FREQuency:FUNDament`) in percent

Range: 0 to 100
Default unit: percent

Example:
```
CALC:AVI:THD:FREQ:FUND '90'
CALC:AVI:SHD:FREQ 100HZ
CALC:AVI:SHD:RES?
```

Usage: Query only

Manual operation: See "Modulation Spectrum" on page 32
See "Marker Table" on page 33
See "DIST" on page 41
See "Fixed markers (H1, F1, F2)" on page 77

CALCulate<n>:AVIonics:SHD[:STATe] <State>

Is maintained for compatibility reasons only, the harmonic distortion measurement is always active.

Suffix:
<n> 1..n
Window

Parameters:
<State> ON | 1

Manual operation: See "Modulation Spectrum" on page 32
See "Marker Table" on page 33

CALCulate<n>:AVIonics:THD:FREQuency:FUNDament <FundFreqIdent>

Selects the fundamental frequency of the harmonic distortion measurement.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:

<n> 1..n
irrelevant

Parameters:

<FundFreqIdent> '30' | '30FM' | '90' | '150' | '90+150' | '9960' | 'ID'

fundamental frequency

'30'
30 Hz AM rotational signal

'30FM'
30 Hz FM reference signal (VOR measurements only)

'90'
90 Hz ILS component

'150'
150 Hz ILS component

'90+150'
90 Hz and the 150 Hz components, taking the phase between the components into account.

'9960'
9.96 kHz subcarrier

'ID'
Identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS/VOR signal components

Example: `CALC:AVI:THD:FREQ:FUND 'ID'`

Manual operation: See "F1, (F2)" on page 41
See "Fundamental Frequency" on page 69
See "Fixed markers (H1, F1, F2)" on page 77

CALCulate<n>:AVIonics:THD:FREQuency:UPPer <Frequency>

Defines the upper frequency limit for most total harmonic distortion measurements. Only harmonics frequencies not exceeding this value are included in the THD calculation.

The setting has no effect on K2 and K3 or FM distortion results.

Suffix:

<n> 1..n
irrelevant

Parameters:

<Frequency> The maximum allowed value is half the defined demodulation bandwidth (see [SENSe:]ADEMod:BWIDth:DEModulation on page 116). The maximum frequencies included in the THD calculations for different signal components is indicated in Table 5-1.

Default unit: HZ

Example: `CALC:AVI:THD:FREQ::UPP 1 KHz`

Manual operation: See "Distortion Max Frequency" on page 68

CALCulate<n>:AVIonics:THD:K<m>? <FundFreqIdent>

Queries the relative amplitude of an AF signal's second (K2) or third (K3) harmonic for the specified signal component.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:

<n> 1..n
irrelevant

<m> 1..n

Query parameters:

<FundFreqIdent> '30' | '30FM' | '90' | '150' | '90+150' | '9960' | 'ID'

signal component, defined by its fundamental frequency

'30'
30 Hz AM rotational signal

'30FM'
30 Hz FM reference signal (VOR measurements only)

'90'
90 Hz ILS component

'150'
150 Hz ILS component

'90+150'
90 Hz and the 150 Hz components, taking the phase between the components into account.

'9960'
9.96 kHz subcarrier

'ID'
Identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS/VOR signal components

Example: `CALC:AVI:THD:K2? '90+150'`

Usage: Query only

Manual operation: See "K2" on page 37
See "K3" on page 37
See "K2" on page 40
See "K3" on page 40

CALCulate<n>:AVIonics:THD[:RESult]? <FundFreqIdent>

Queries the total harmonic distortion (THD) for the specified fundamental frequency.

For details see Chapter 4.2, "Avionics parameters", on page 34.

Suffix:
<n> 1..n

Query parameters:
<FundFreqIdent> '30' | '30FM' | '90' | '150' | '90+150' | '9960' | 'ID'

fundamental frequency

'30'
30 Hz AM rotational signal

'30FM'
30 Hz FM reference signal (VOR measurements only)

'90'
90 Hz ILS component

'150'
150 Hz ILS component

'90+150'
90 Hz and the 150 Hz components, taking the phase between the components into account.

'9960'
9.96 kHz subcarrier

'ID'
Identifier signal and speech band (300 Hz to 4 kHz) without influence by the actual ILS/VOR signal components

Example: `CALC:AVI:THD? '90+150'`

Usage: Query only

Manual operation: See "90 Hz AM THD" on page 35
See "150 Hz AM THD" on page 35
See "90+150 Hz AM THD" on page 36
See "Voice / IDENT AM THD" on page 36
See "THD total" on page 37
See "30 Hz AM THD" on page 39
See "9.96 kHz AM THD" on page 39
See "30 Hz FM THD" on page 39
See "VOICE / IDENT AM THD" on page 40
See "THD" on page 40

9.7.2 Trace results

Trace results can be exported to a file.

For more commands concerning data and results storage see the FSW User Manual.

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

Suffix:

<n> 1..n

Query parameters:

<Trace> TRACe1

The measured power levels at each frequency in the modulation spectrum.

Usage: Query only

Manual operation: See "Modulation Spectrum" on page 32

MMEMory:COMMent <Comment>

Defines a comment for the stored settings.

Parameters:

<Comment> String containing the comment.

Example:

```
MMEMory:COMMent "ACP measurement with Standard
Tetra from 23.05."
MMEMory::MMEMory:STORe1:STATe 1, "ACP_T"
```

As a result, in the selection list for recall settings, the comment `"ACP measurement with Standard Tetra from 23.05."` is added to the ACP entry.

MMEMory:STORe<n>:TABLe <Columns>, <FileName>

Exports result table data from the specified window to an ASCii file (`.DAT`).

Secure User Mode

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Suffix:
<n> Window

Setting parameters:
<Columns> Columns to be stored in file

SELected
Export only the selected (visible) table columns

ALL
Export all table columns (all possible measured parameters)

*RST: SEL

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TABL SEL,'TEST.DAT'`
Stores the selected columns from the result table in window 1 in the file `TEST.DAT`.

Usage: Setting only

Manual operation: See "Export table to ASCII File" on page 81

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

Exports trace data from the specified window to an ASCII file.

Secure User Mode

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

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

For details, see "Protecting Data Using the Secure User Mode" in the "Data Management" section of the FSW base unit user manual.

Suffix:
<n> Window

Parameters:
<Trace> Number of the trace to be stored

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR1:TRAC 1,'C:\TEST.ASC'`
Stores trace 1 from window 1 in the file `TEST.ASC`.

Manual operation: See "Export Trace to ASCII File" on page 82

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example: `FORM:DEXP:DSEP POIN`
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 82

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Manual operation: See "Include Instrument & Measurement Settings" on page 81

FORMat:DEXPort:TRACes <Selection>

Selects the data to be included in a data export file (see `MMEMory:STORe<n>:TRACe` on page 158).

Parameters:

<Selection> SINGle | ALL

SINGle
Only a single trace is selected for export, namely the one specified by the `MMEMory:STORe<n>:TRACe` command.

ALL
Selects all active traces and result tables (e.g. "Result Summary", marker peak list etc.) in the current application for export to an ASCII file.
The <trace> parameter for the `MMEMory:STORe<n>:TRACe` command is ignored.

*RST: SINGle

9.8 Status reporting system

The status reporting system stores all information on the current operating state of the instrument, e.g. information on errors or limit violations which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

In this section, only the status registers/bits specific to the R&S FSW Avionics (VOR/ILS) measurements application are described.

For details on the common FSW status registers refer to the description of remote control basics in the FSW User Manual.

*RST does not influence the status registers.

Description of the Status Registers

In addition to the registers provided by the base system, the following registers are used in the R&S FSW Avionics (VOR/ILS) measurements application:

- `STATus:QUEStionable:SYNC<n>` - contains application-specific information about synchronization errors or errors during burst detection.

The `STATus:QUEStionable` register "sums up" the information from all subregisters (e.g. bit 11 sums up the information for all `STATus:QUEStionable:SYNC` registers). For some subregisters, there may be separate registers for each active channel. Thus, if a status bit in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific subregisters. In this case, you must check the subregister of each channel to determine which channel caused the error. By default, querying the status of a subregister always returns the result for the currently selected channel.

The commands to query the contents of the following status registers are described in Chapter 9.8.2, "Querying the status registers", on page 161.

9.8.1 STATus:QUEStionable:SYNC<n> register

This register contains application-specific information about synchronization errors or errors during burst detection for each window in each VOR/ILS channel. It can be queried with commands `STATus:QUEStionable:SYNC:CONDition?` on page 161 and `STATus:QUEStionable:SYNC[:EVENt]?` on page 162.

Table 9-4: Status error bits in STATus:QUEStionable:SYNC register for R&S FSW Avionics (VOR/ILS) measurements application

Bit	Definition
0	
1	
2	Demod failed This bit is set if the input signal at the FSW is invalid.
3 to 14	Not used.
15	This bit is always 0.

9.8.2 Querying the status registers

The following commands query the contents of the individual status registers.

STATus:QUEStionable:FREQuency:CONDition?
STATus:QUEStionable:LIMit<n>:CONDition?
STATus:QUEStionable:LMARgin<n>:CONDition?
STATus:QUEStionable:POWer:CONDition?
STATus:QUEStionable:SYNC:CONDition? <ChannelName>

Reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:QUEStionable:FREQuency[:EVENt]?
STATus:QUEStionable:LIMit<n>[:EVENt]?
STATus:QUEStionable:LMARgin<n>[:EVENt]?
STATus:QUEStionable:POWer[:EVENt]?
STATus:QUEStionable:SYNC[:EVENt]? <ChannelName>

Reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

STATus:QUEStionable:FREQuency:ENABle <Enable>
STATus:QUEStionable:LIMit<n>:ENABle <Enable>
STATus:QUEStionable:LMARgin<n>:ENABle <Enable>
STATus:QUEStionable:POWer:ENABle <Enable>
STATus:QUEStionable:SYNC:ENABle <BitDefinition>, <ChannelName>

Controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:QUEStionable:FREQuency:NTRansition <NTransition>
STATus:QUEStionable:LIMit<n>:NTRansition <NTransition>
STATus:QUEStionable:LMARgin<n>:NTRansition <NTransition>
STATus:QUEStionable:POWer:NTRansition <NTransition>
STATus:QUEStionable:SYNC:NTRansition <BitDefinition>[,<ChannelName>]

Controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

STATus:QUEStionable:FREQuency:PTRansition <PTransition>
STATus:QUEStionable:LIMit<n>:PTRansition <PTransition>
STATus:QUEStionable:LMARgin<n>:PTRansition <PTransition>
STATus:QUEStionable:POWer:PTRansition <PTransition>
STATus:QUEStionable:SYNC:PTRansition <BitDefinition>[,<ChannelName>]

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

9.9 Programming examples: performing VOR/ILS measurements

These examples demonstrate how to perform VOR/ILS measurements in a remote environment.

9.9.1 Programming example: performing an ILS measurement

This example demonstrates how to perform an ILS measurement in a remote environment.

The following prerequisites are assumed concerning the input signal:

- ILS localizer signal with a carrier frequency of 108.1 MHz, level of -10 dBm
- DDM, SDM, phase between 90 Hz and 150 Hz signal irrelevant
- IDENT signal: On, morse coding on, repetition rate of 7 seconds or shorter, standard-conform timing

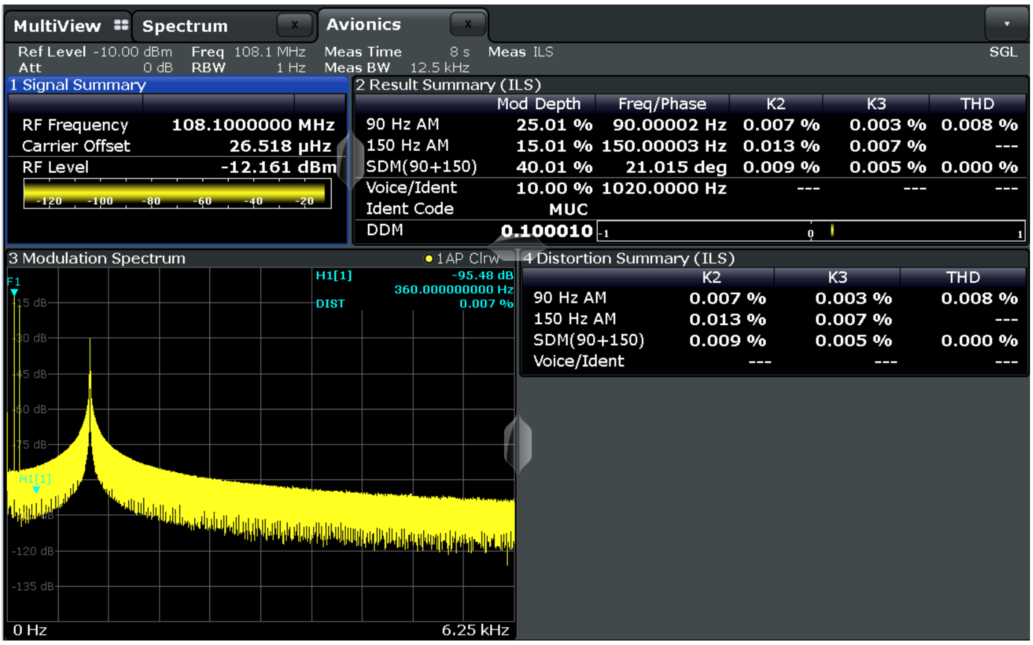


Figure 9-2: Results of the remote ILS measurement

```
//-----------Preparing the instrument ------------
//Reset the instrument
*RST
//Activate the Avionics measurement application
INST:SEL AVI
//Select the ILS measurement
CALC:AVI:STAN ILS

//-----------Configuring the measurement ------------
//Configure the center frequency and reference level
FREQ:CENT 108MHZ
DISP:TRAC:Y:SCAL:RLEV -10DBM

//Define a demod BW of 12.5 kHz and a meas time of 8 s.
ADEM:BWID:DEM:AUTO OFF
ADEM:BWID:DEM 12500
SWE:TIME:AUTO OFF
SWE:TIME 8S
//Query the resulting RBW
ADEM:SPEC:BWID?
//Result: 1.0 Hz

//Display the distortion summary in addition to the 3 default windows:
//1: top left:    Signal Summary      2: top right:    Result Summary
//3: bottom left: Modulation Spectrum 4: bottom right: Distortion Summary
LAY:ADD:WIND? '3',RIGH,DSUM
//Result: '4' (window name)
```

```
//--------------Performing the Measurement-----
//Select single sweep mode
INIT:CONT OFF

//Initiate a new measurement and wait until the sweep has finished
INIT;*WAI

//---------------Retrieving Results-------------

//Query the morse code of the demodulated identifier
CALC:AVI:AM:CODE?
//Query the AM frequency of the identifier signal
CALC:AVI:AM:FREQ? 'ID'
//Query the amplitude mod. depth of 90 HZ AM component
CALC:AVI:AM:DEPT? '90'
//Query the phase angle between 90 HZ AM & 150 Hz AM signals
CALC:AVI:PHAS?
//Query the difference in mod.depth between 90 HZ AM & 150 Hz AM signals (ILS DDM)
CALC:AVI:DDM?
//Set the maximum frequency to be used for calculating THD results
CALC:AVI:THD:FREQ:UPP 271
//Query the total harmonic distortion of the 90 Hz AM component
CALC:AVI:THD? '90'

//Calculate the distortion for the fourth harmonic of the 90 Hz AM component
//Note: It is recommended that you turn off the IDENT signal for accurate results
//Set the marker H1 (harmonic frequency) to 4*90 = 360 Hz
CALC:AVI:SHD:FREQ 360HZ
//Set the fundamental frequency to 90 Hz
CALC:AVI:THD:FREQ:FUND '90'
//Query the distortion
CALC:AVI:SHD:RES?
```

9.9.2 Programming example: performing a VOR measurement

This example demonstrates how to perform a VOR measurement in a remote environment.

The following prerequisites are assumed concerning the input signal:

- VOR signal with a carrier frequency of 108.1 MHz, level of -10 dBm
- The azimuth and individual modulation depths are irrelevant
- IDENT signal: On, morse coding on, repetition rate of 7 seconds or shorter, standard-conform timing

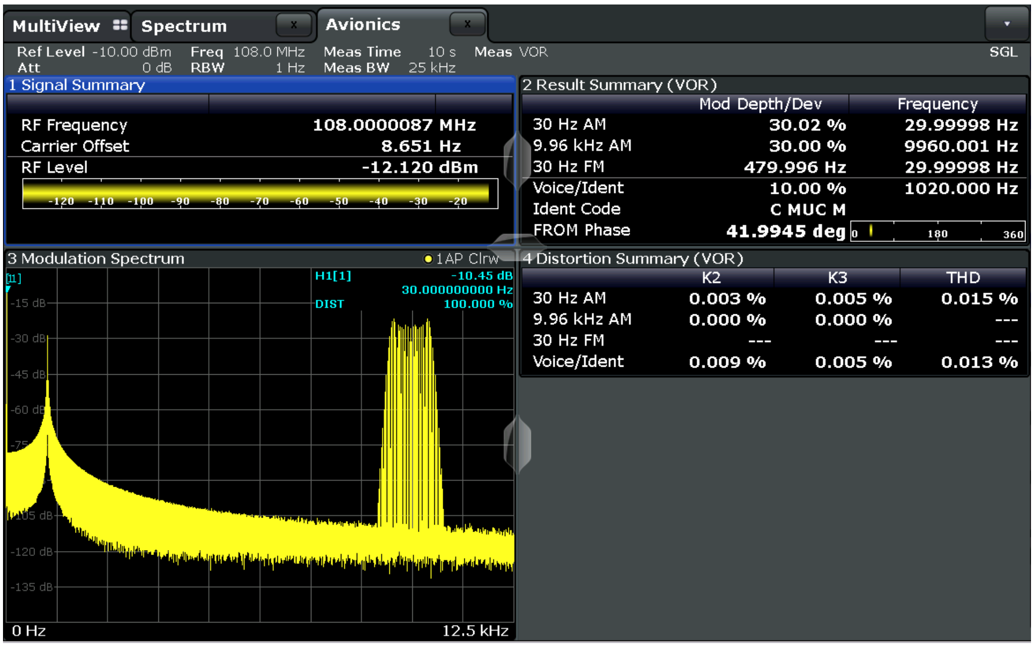


Figure 9-3: Results of the remote VOR measurement

```
//-----------Preparing the instrument ------------
//Reset the instrument
*RST
//Activate the Avionics measurement application
INST:SEL AVI
//Select the VOR measurement
CALC:AVI:STAN VOR

//-----------Configuring the measurement ------------
//Configure the center frequency and reference level
FREQ:CENT 108MHZ
DISP:TRAC:Y:SCAL:RLEV -10DBM

//Define a demod BW of 25 kHz and a meas time of 10 s.
ADEM:BWID:DEM:AUTO OFF
ADEM:BWID:DEM 25000
SWE:TIME:AUTO OFF
SWE:TIME 10S
//Query the resulting RBW
ADEM:SPEC:BWID?
//Result: 1.0 Hz

//Display the distortion summary in addition to the 3 default windows:
//1: top left:    Signal Summary      2: top right:    Result Summary
//3: bottom left: Modulation Spectrum 4: bottom right: Distortion Summary
LAY:ADD:WIND? '3',RIGH,DSUM
//Result: '4' (window name)
```

```
//--------------Performing the Measurement-----
//Select single sweep mode
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished
INIT;*WAI

//---------------Retrieving Results-------------

//Query the morse code of the demodulated identifier
CALC:AVI:AM:CODE?
//Query the AM frequency of the identifier signal
CALC:AVI:AM:FREQ? 'ID'
//Query the amplitude mod. depth of 30 HZ AM component
CALC:AVI:AM:DEPT? '30'
//Query the phase angle between 30 HZ AM and 30 Hz FM signals (VOR phase)
CALC:AVI:PHAS?

// get the carrier frequency error
CALC:AVI:FERR?
// get the measured RF level
CALC:AVI:CARR:RES?


//---------------Exporting Trace Results-------------
//Retrieve trace data for modulation spectrum (window 3)
TRAC3:DATA? TRACe1
TRAC3:DATA:X? TRACe1

//Export entire distortion summary table (window 4) to an ASCII file
MMEM:STOR:TABL ALL,'C:\R_S\Instr\user\AllResults.dat'

//Store captured I/Q data to an iq-tar file
MMEM:STOR:IQ:COMM 'I/Q data for VOR measurement'
MMEM:STOR:IQ:STAT 1,'C:\R_S\Instr\user\VORTestdata.iq.tar'
```

Annex

A Abbreviations

The following abbreviations are used throughout this documentation:

Abbreviation	Description
ADC	Analog to digital converter
AF signal	Audio frequency signal. Signal used to modulate a carrier (its amplitude or frequency or phase)
AM	Amplitude modulation
BP	Band pass (filter)
CF	Center frequency
DBW	Demodulation bandwidth
DUT	Device under test
FFT	Fast Fourier transform
FM	Frequency modulation
IF	Intermediate frequency
ILS	Instrument landing system
K2, K3	The Total Harmonic Distortion figure restricted up to 2nd or 3rd harmonic; also referred to as THD2 or THD3, respectively
LP	Low pass (filter)
NCO	Numerically controlled oscillator
THD	Total harmonic distortion
VOR	VHF omnidirectional range

List of Commands (Avionics)

Index

I

K

L

M

N

O

P