R&S®FS-K15
VOR/ILS Avionics Measurements
Software Manual

1302.0942.42 – 04

ROHDE&SCHWARZ

Test and Measurement

Software Manual

PAD-T-M: 3574.3259.02/01.00/CI/1/EN

Muehldorfstr. 15, 81671 Munich, Germany
Phone: +49 89 41 29 - 0
Fax: +49 89 41 29 12 164
E-mail: info@rohde-schwarz.com
Internet: http://www.rohde-schwarz.com

The following abbreviations are used throughout this manual:
R&S®FS-K15 is abbreviated as R&S FS-K15

Contents

1 Installation and Enabling

1.1 Installation

Application Firmware R&S FS-K15 is part of the basic firmware of the base unit. The application is available starting with the following minimum firmware version of the instruments:

Instrument type	Firmware version
R&S FSMR	4.26
R&S FSU	4.31
R&S FSQ	4.35

If the firmware has to be updated, start the update of the firmware by SETUP → NEXT → FIRMWARE UPDATE.

1.2 Enabling

Application Firmware R&S FS-K15 is enabled in the SETUP → GENERAL SETUP menu by entering a keyword. The keyword is supplied together with the application firmware. After enabling the application firmware a performance verification test is required to check the measurement accuracy.

If the application firmware is installed at the factory, it will already be enabled and tested against the specifications.

SETUP menu:

GENERAL SETUP

The GENERAL SETUP softkey opens a submenu in which the general instrument parameters can be set up. In addition to the configuration of the digital interfaces (IECBUS, COM), the date and time may be entered.

OPTIONS

The OPTIONS softkey opens a submenu in which you can enter the keywords for the application firmware. The existing applications are displayed in a table that opens when you enter the submenu.

INSTALL OPTION

The INSTALL OPTION softkey enables entry of the keyword for application firmware.

If the keyword is valid, the message OPTION KEY OK is displayed and the application firmware is entered in the FIRMWARE OPTIONS table.

If an invalid keyword is entered, OPTION KEY INVALID is displayed.

1.3 General information about ILS and VOR/DVOR

1.3.1 ILS (Instrument Landing System)

Through the globally standardized ILS an aircraft on a defined glidepath receives highly accurate position information in reference to the glidepath during landing. This landing path is described by the intersection of a vertical glideslope level and a horizontal localizer plane.

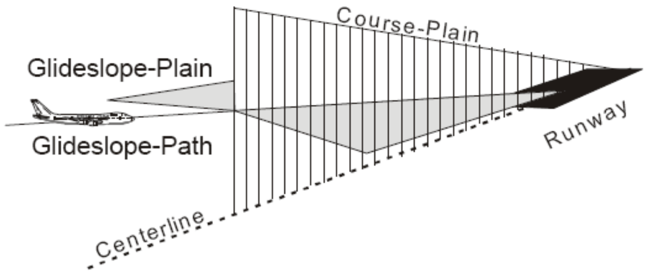


Figure 1-1: Basics of the ILS landing

The ILS frequency range covers 108 to 118.MHz for the LLZ (localizer) and 320 to 340 MHz for the GS (Glideslope). The ILS is based on the interpretation of two amplitude modulated coherent carrier signals, each of which is emitted through an antenna array. If the aircraft is on the landing line both signals are received with the same modulations depth. If the aircraft deviates from the landing line, either the 90 Hz- or the 150 Hz-components predominates after the AM demodulation. The ILS-interpretation is done by measuring the modulation depth of both emitted signals, the difference allows the calculation of the DDM (Difference in Depth of Modulation).

DDM = m(x90) – m(x150)

The ICAO (International Civil Aviation Organization) prescribes the way in which the DDM values must be generated for different distances from the runway threshold. According to this the corresponding antenna diagrams of the landing course transmitter LLZ (Localizer) and the glide path transmitter GS (Glideslope) are calibrated.

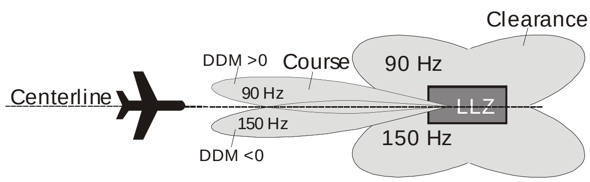


Figure 1-2: Basic antenna diagrams of the ILS localizer

1.3.2 VOR (VHF Omni directional Radio Range)

VOR is a radio navigation system for short and medium distance navigation. VOR transmitter systems work in the VHF range from 108 to 118 MHz. The VOR radio navigation aid supplies the aircraft with directional information, angle information relative to the magnetic north from the site of the beacon. The range covered by a VOR station is ideally a circle around the VOR station with a radius depending on the flight altitude.

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 transmits with a rotating antenna. From the rotation a sinewave AM modulated 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. In order to determine the radial the phase difference to a reference phase must be measured. Because this reference phase must be independent of the rotation of the antenna it is modulated with a frequency deviation of 480 Hz in FM onto a secondary carrier with 9,96 kHz and emitted over a separate antenna with round characteristic.

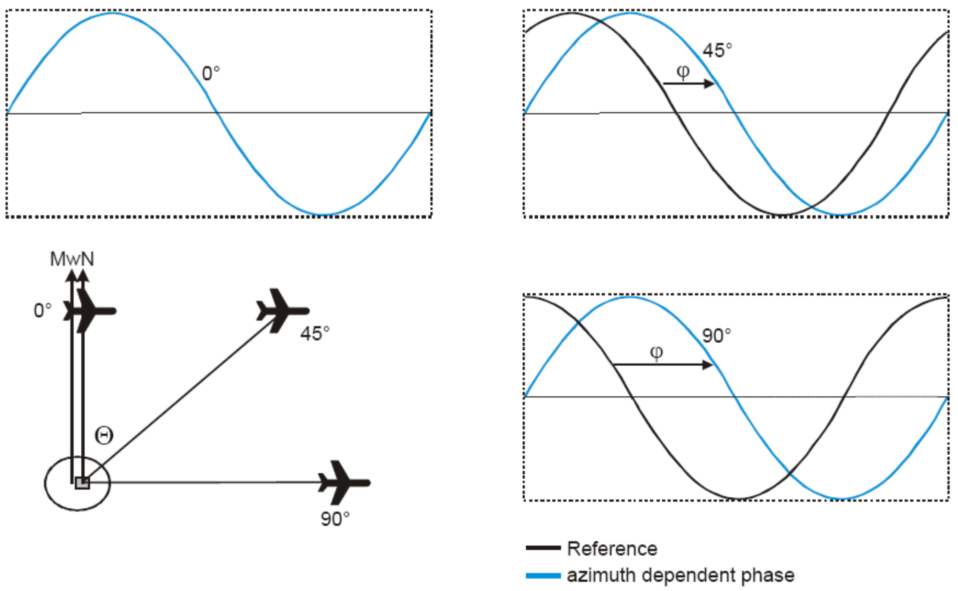


Figure 1-3: Basics of the VOR phase angles (φ) depending on the azimuth angle (Θ)

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 or speech in the usual AF from 300 Hz to 3.3 kHz can be transmitted on the VOR carrier. Often the voice channel of a VOR station is used for the transmission of ATIS (Automatic Terminal Information Service) messages. The spectrum of a VOR signal is therefore composed of the carrier and three modulated components.

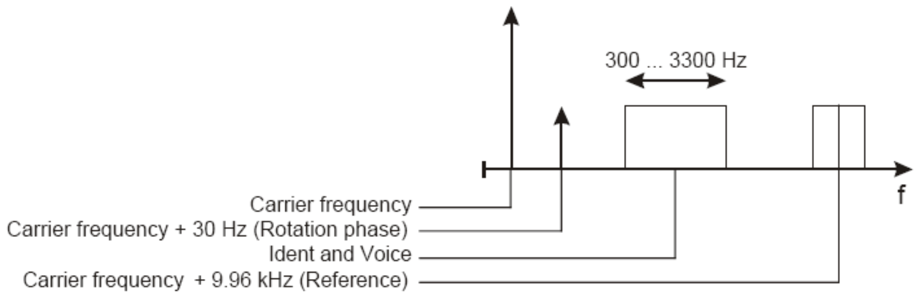


Figure 1-4: Example of the VOR Spectrum

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.

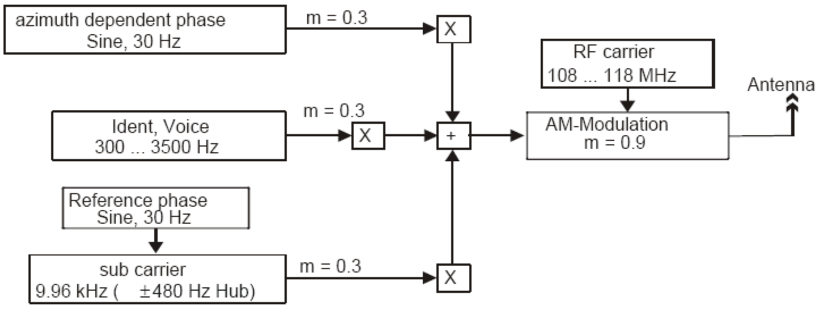


Figure 1-5: Basics of the VOR signal generation

1.3.3 DVOR (Doppler VHF Omni directional Range)

A DVOR beacon transmits like a VOR a RF signal in which the two phase angles are coded from whose difference the receiver can calculate it´s position in reference to the DVOR. In contrast to the VOR the meaning of the reference and azimuth depending phase is interchanged. This means that the reference phase is no longer emitted in FM through the secondary carrier, but rather 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 frx increases when there is radial relative movement of a receiver with a speed vx towards the transmitter, and correspondingly 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 (carrier + 9,96 kHz) is distributed using an electronic multiplexer on the circularly arranged antenna, such that the transmission signal seems to revolve at 30 Hz in the circle.

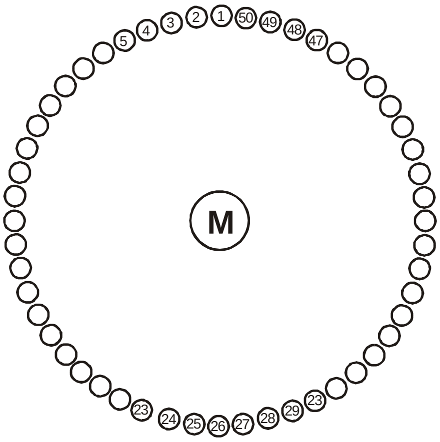


Figure 1-6: Basics of a DVOR system

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 a FM on the receiver, because one sideband component always increases in frequency because of 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.

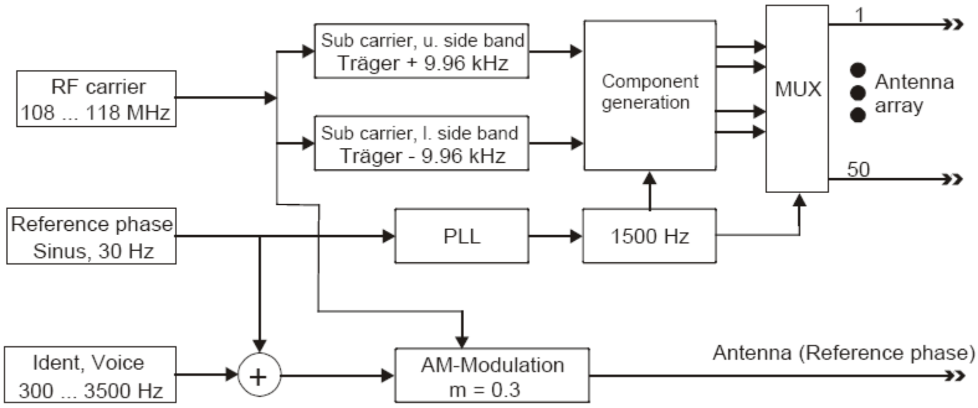


Figure 1-7: Basics of the DVOR signal generation

1.4 Description of the Avionics Measurement Demodulator

The following chapter describe the functions of the Avionics measurement demodulator. In the case of functions identical to those of the base unit, reference is made to the relevant chapter in the base unit manual.

The digital signal processing used in the analyzer mode for digital IF filters are also ideally suited for demodulating VOR and ILS navigation aid signals.

By sampling (digitization) already at the IF and digital downconversion to the baseband (I/Q), the demodulator achieves maximum accuracy and temperature stability. There is no evidence of typical errors of an analog downconversion and demodulation like AM ⇔ FM conversion, deviation error, frequency response or frequency drift at DC coupling. Only the characteristics of the analog IF filter ahead of the A/D converter needs to be taken into consideration.

1.4.1 Circuit Description - Block Diagrams

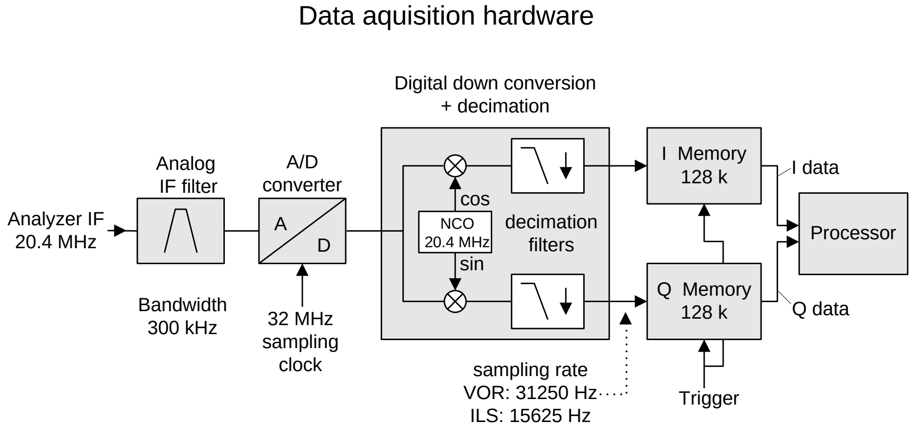


Figure 1-8: Block diagram of analyzer signal processing

Figure 1-8 shows the analyzer's hardware from the IF to the processor. The IF filter is the resolution filter of the spectrum analyzer, with a bandwidth range from 300 kHz to 10 MHz for ILS and VOR measurement. The A/D converter samples the IF (20.4 MHz) at 32 MHz.

Lowpass filtering and reduction of the sampling rate follow the downconversion to the complex baseband. The decimation depends on the selected demodulation bandwidth. The output sampling rate is set in powers of 2 between 800 Hz and 31.250 kHz. Useless oversampling at narrow bandwidths is avoided, saving computing time and increasing the maximum recording time.

The I/Q data is stored in memories each comprising 512 k words in case of FSU, FSQ and FSMR. The hardware triggering (external, IF power) controls the memory.

1.4.2 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.

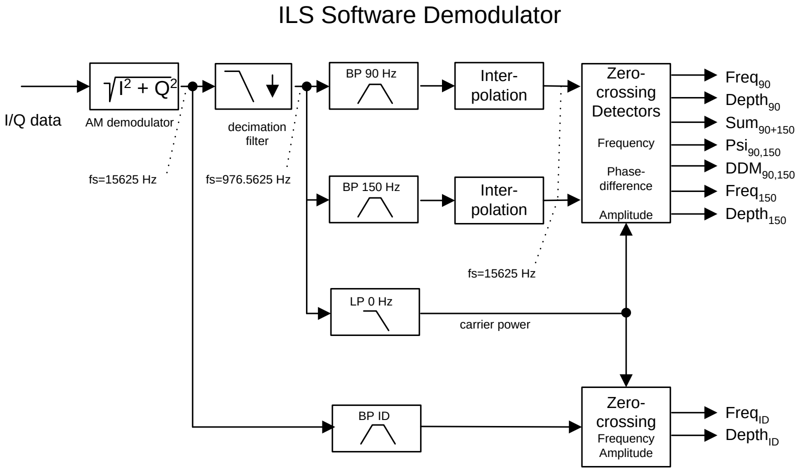


Figure 1-9: Block diagram of ILS software demodulator

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

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

1.4.2.1 AM Modulation Depth

To obtain the AM depth the mean carrier power must be calculated by an lowpass filter. Since modulation depths are computed by using the RMS method, the averaging length is crucial and must be multiples of the period length. Thus zero crossing detector results are used to derive the appropriate averaging lengths. In this way the following AM depths and their derivates are computed

- 90 Hz / 150 Hz
- 300 Hz -4KHz (Identification/Voice)
- DDM Difference in Depths of Modulation (90 Hz and 150 Hz)
- SDM Sum of Depths of Modulation (90 Hz and 150 Hz)
- Sum90/150 Hz (vectorial) sum amplitude of the 90 and 150 Hz signals (peak-to-peak method, no RMS)

1.4.2.2 AF frequencies

Interpolated results of the zero crossing detectors are used to determine the frequencies of the AM signal components 90 Hz, 150 Hz and 1020 Hz (Identification).

1.4.2.3 Phase angle 90/150 Hz

The phase angle is computed by the differences of the interpolated results of the 90/150 Hz zero crossing detectors. Since the frequencies having a ratio of 3 to 5, phase angles exceeding ± 60° will lead to ambiguous results.

1.4.3 VOR demodulator

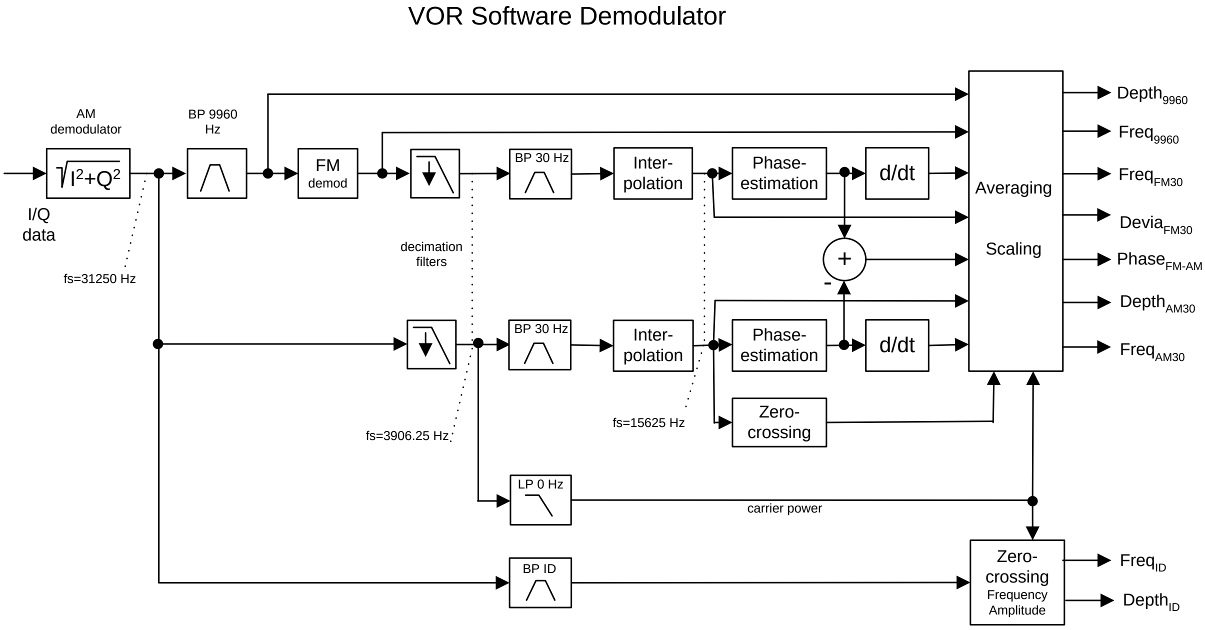


Figure 1-10: Block diagram of VOR software demodulator

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 – 4 kHz)
- FM component (9960 ± 700 Hz)

This is done by means of bandpass filters covering the given frequency ranges. However, like in the case of the ILS demodulator, the low frequency component of 30 Hz must be computed on an downsampled version of the AM demodulated signal in order to obtain the required selectivity with a reasonable filter order.

The separated FM component is passed through a FM demodulator. To obtain the 30 Hz reference-signal the FM demodulator output is processed with the same procedure as the AM 30 Hz rotational-component (downsampling, 30 Hz bandpass filter and interpolation). FM deviation is computed using the RMS value of the 30 Hz reference signal.

Both signals, the 30 Hz reference and the rotational signal are fed to a phase estimation procedure for the azimuth processing.

1.4.3.1 AM Modulation Depth

To obtain the AM depth the mean carrier power must be calculated by an lowpass filter. Since modulation depths are computed by using the RMS method, the averaging length is crucial an must be multiple of the period length. Thus zero crossing detector result of the AM 30 Hz rotational component is used to derive the appropriate averaging length. Note that the precision as specified in the FS-K15 data sheet will be guaranteed only if the AM 30 Hz rotational component can be identified properly.

The following AM depths are computed:

- 30 Hz (Rotational-signal)
- 300 Hz – 4KHz (Identification/Voice)
- 9960 Hz (FM)

1.4.3.2 Azimuth (Phase difference at 30 Hz)

In order to meet the resolution requirements the phase of the 30 Hz rotational- (AM) and reference- (FM) components are computed by means of an Hilbert transform based phase estimation algorithm. The azimuth is obtained by the difference of both estimator results and the frequency results are obtained from the differential phase.

1.4.3.3 AF frequencies

In the VOR demodulator the AF frequencies are computed using different methods:

- 30 Hz Rotational-signal (AM), differential of the phase estimator result
- 30 Hz Reference-signal (FM), differential of the phase estimator result
- 1020 Hz (Identification), interpolated results of the zero crossing detector
- 9960 Hz (FM carrier frequency), mean value for the FM demodulator output

1.5 Further Characteristics

1.5.1 IF Bandwidth

The analog IF filter improves the selectivity, but also may cause signal distortion. The filter is negligible if the IF bandwidth is wider than the highest modulation frequency.

In general, the IF bandwidth should be set to auto coupling.

1.5.2 Demodulation Bandwidth

Digital filters determine the demodulation bandwidth. This is not the 3 dB bandwidth but the useful bandwidth which is distortion-free with regard to phase and amplitude.

Therefore the following automated settings are applied:

- ILS: demodulation bandwidth set to 12.5 kHz, in order to capture the full identifier signal
- VOR: demodulation bandwidth set to 25 kHz, in order to capture the 9.96 kHz signal
- DIST demodulation bandwidth set to same value as selected demodulator (ILS or VOR)

If the demodulation bandwidth setting is changed, some demodulation results may not be available due to bandwidth limitations. In case of harmonic distortion measurement the highest measured harmonic signal may be limited due to the demodulation bandwidth.

In general, the demodulation bandwidth should be set to auto coupling.

1.5.3 Stability of Measurement Results

Stability of the mean-squares method involved for of computation of the modulation depths and Azimuth estimation rely on a sufficient length for the averaging.

This is achieved if at least five periods of the 30 Hz basic modulation frequency are recorded. To this time the summed filter settling times must, be added, thus a minimum recording time of 400 ms is needed to meet the required precision.

Note, that the precision as specified in FS-K15 data sheet will be guaranteed only if the AM 30 Hz rotational component can be identified properly in the VOR analysis case.

Due to rounding effects of the phase estimation algorithm, the systematic error is limited to 10E-8 for the Azimuth- and frequency results.

2 Configuration of the Avionics Demodulator

2.1 Getting Started

Before measurements, you must adjust the instrument settings to the properties of the device under test. The following procedure is recommended:

1. Set the spectrum analyzer to its default state.
   – Press the PRESET button.
     The device is now in its default state. If the instrument is not in the spectrum analyzer mode, the mode has to be changed to the spectrum analyzer mode: Press the SPECTRUM hotkey.
2. Activate measurements with avionics demodulator.
   – Press the AVIONICS hotkey.
     Measurements with the avionics demodulator will be activated and the menu with the settings for the avionics demodulator will be opened.
3. Set the frequency
   – In the default setting, the frequency of the avionics demodulator is coupled with the center frequency of the analyzer, i.e. when the center frequency of the analyzer is set (FREQ button), the avionics demodulator is automatically set to the frequency to be measured.
4. Set the measurement mode.
   – In the avionics demodulator main menu, press the VOR softkey for measurements in the VOR standard (VHF Omnidirectional Radio Range), or press the ILS softkey for measurements in the ILS standard (Instrument Landing System)
5. Set the unit
   – Press the SETTINGS softkey to select the harmonic distortion readings in % or dB values.

Additional setting options are described in the following reference section of the manual.

2.2 Test Setup for Measurements

NOTICE

Instrument damage caused by disregarding the following precautions

Before the instrument is put into operation, make sure the following are done:

- The ventilation openings are unobstructed.
- No signal voltage levels exceed permitted limits.

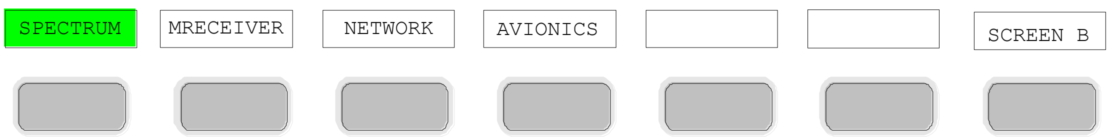
The instrument outputs are not overloaded or improperly connected

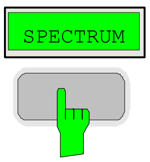
This chapter describes the basic settings for the analyzer for measurements. Before measurements can be started, the analyzer must be correctly configured and powered as described in Chapter 1 of the operating manual for the base unit. Furthermore, Application Firmware R&S FS-K15 must be enabled. Chapter 1 of this manual describes how to install and enable the application firmware.

2.3 Selecting the Operating Mode – HOTKEY Bar

The base instrument has seven hotkeys below the display for fast mode selection. These hotkeys can be differently assigned depending on the available instrument options and instrument modes.

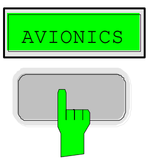
The keys after instrument preset: (in spectrum analysis mode, further keys may be available).





The SPECTRUM hotkey sets the instrument to spectrum analysis mode.

`Remote: INST:SEL SAN`



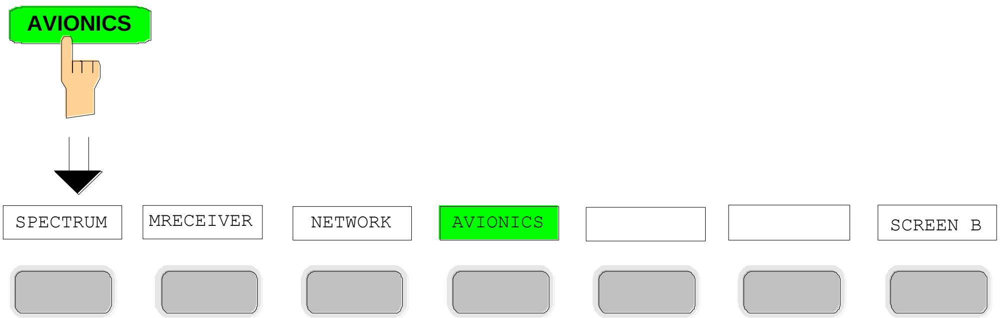
The AVIONICS hotkey sets the instrument to avionics demodulation mode.

`Remote: INST:SEL AVI`

The operating manual of the base instrument or of the other options describes the meaning of the other keys.

2.4 Avionics Demodulator Mode

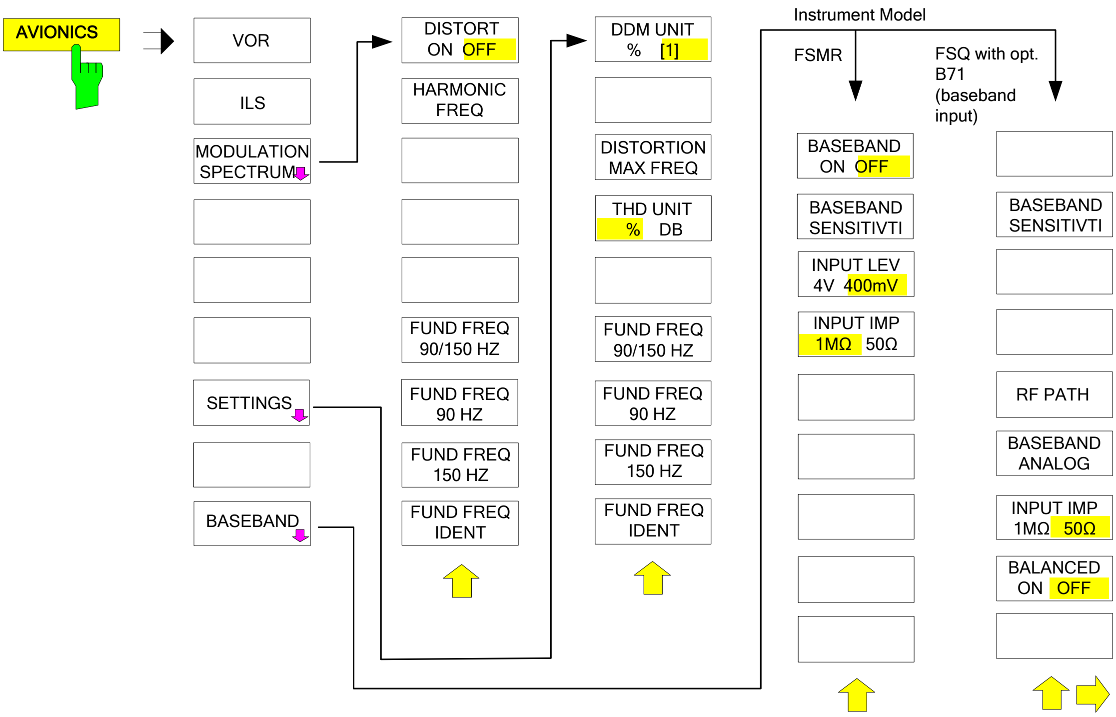
The application firmware R&S FS-K15 (avionics demodulation measurements) is activated with the AVIONICS hotkey.



The AVIONICS hotkey allows the access to the avionics measurement capabilities (VOR/ILS) of the instrument.

A softkey menu suitable for the currently selected operating mode is simultaneously displayed and allows the setting of the measurement parameters.

Simultaneously, the VOR demodulator is activated (default after Preset).



The softkeys visible in the BASEBAND submenu depend on the instrument type. The BASEBAND submenu is only available in the R&S FSMR and R&S FSQ equipped with baseband inputs (option R&S FSQ-B71).

The individual settings are explained in the following menus.

The main measurement functions of the avionics demodulator are:

- VOR VOR Measurements
- ILS ILS Measurements
- MODULATION SPECTRUM Modulation Distortion measurements

In the avionics demodulator mode the base instrument is equipped with a high performance avionics demodulator. In order to display the measurement results the screen is divided in two halves.

The frequency setting, the frequency counter result and the RF or baseband input level is displayed in the upper half of the screen. The measurement results of the avionics demodulator are displayed in a table in the lower half of the screen. The modulation spectrum can be displayed in the lower half as a trace.

Signal parameters such as modulation depth and frequency deviation can be determined.

2.5 Result Display – RF level and frequency counter result

The upper screen shows the level readings and the frequency settings and frequency counter result.

Example for upper screen:

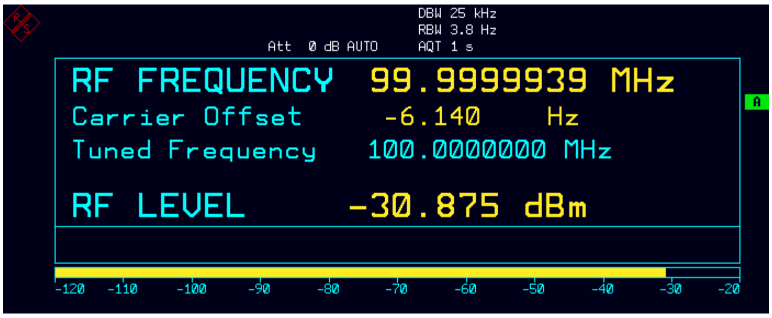


Figure 2-1: RF Level measurement display

Screen description:

- RF frequency Result from the frequency counter
- Carrier Offset Frequency offset between measured frequency and tuned frequency
- Tuned Frequency RF Frequency setting
- RF level RF level reading (Baseband input level in case of baseband operation)
- Bargraph for visual information about the input level

Status information flags for Power Splitter, Auto Tune, Average, AutoLevel etc.:

ATT	Setting of the RF attenuator. Manual or Coupled to Reference level
AQT	This is the measurement time or capture time.
RBW	Display of actual resolution bandwidth for distortion measurement
AUTO TUNE	Enhancement label for Autotune = ON.
AUTOL	Enhancement label for level Autorange.

EVEL
SPLITTER Enhancement label for Power Splitter Sensor head. The insertion loss of the splitter will be taken into account in the RF level reading

The individual measured values are read out with the following commands:

RF frequency	`CALC:AVI:RFFR:RES?`
Carrier Offset	`CALC:AVI:FERR:RES?`
RF level	`CALC:AVI:CARR:RES?`

2.6 Avionics Demodulator Main Menu

The AVIONICS hotkey opens the menu for setting the VOR/ILS demodulator functions.

VOR The VOR softkey switches the VOR demodulator on. The VOR demodulator default setting is OFF. When the AVIONICS mode is selected after preset, the demodulator is switched on automatically.

Remote: `CALC:AVI:STAN VOR`

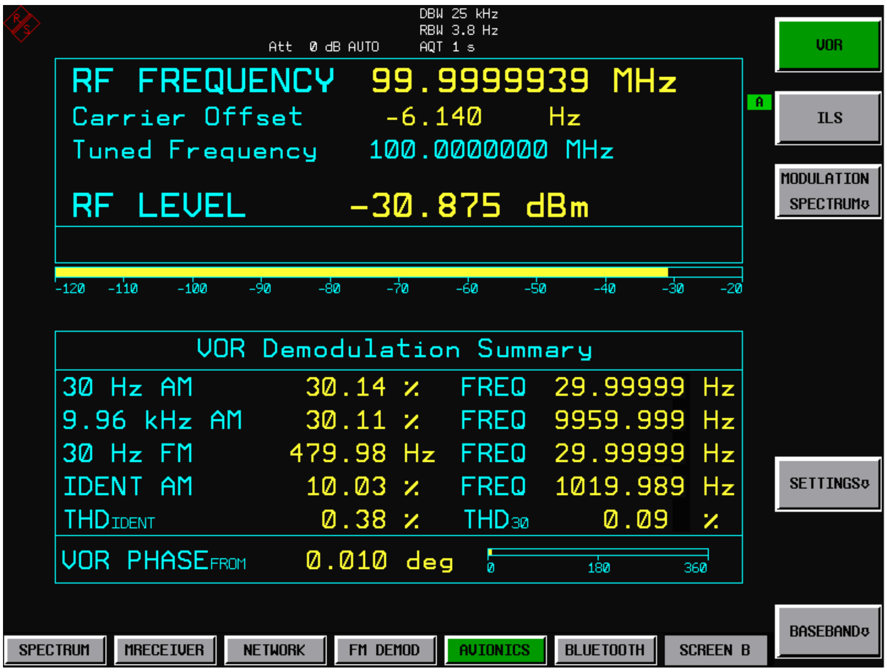


Figure 2-2: VOR measurement display

The settings of the spectrum analyzer active before the demodulator is switched on will be restored when the demodulator is switched off. The center frequency setting is coupled between the operating modes.
The trace operating mode and detector are restored (the VOR/ILS demodulator has separate trace settings).

Screen description:

30 Hz AM	Selective modulation depth and AF frequency measurement of VOR 30 Hz signal component.
9.96 kHz AM	Selective modulation depth and AF frequency measurement of frequency modulated VOR 9960 Hz signal component.
IDENT AM	Modulation depth and frequency measurement of Identifier signal and speech band 300 Hz to 4 kHz without influence by the actual VOR signal component.
30 Hz FM	Frequency deviation and AF frequency measurement at the frequency modulated VOR 9960 Hz signal component.
THD Ident	Distortion measurement at the identifier signal component.
THD 30	Distortion measurement at the 30 Hz AM signal component.
VOR Phase	Phase measurement between 30 Hz AM signal and 30 Hz FM demodulated signal (= reference signal), measurement range 0 to 360 degree.

The individual measured values are read out with the following commands:

30 Hz AM Depth	CALC:AVI:AM:DEPT? ‘30’
30 Hz AM Frequency	CALC:AVI:AM:FREQ? ‘30’
9.96 kHz AM Depth	CALC:AVI:AM:DEPT? ‘9960’
9.96 kHz AM Freq.	CALC:AVI:AM:FREQ? ‘9960’
IDENT AM depth	CALC:AVI:AM:DEPT? ‘ID’
IDENT AM Frequency	CALC:AVI:AM:FREQ? ‘ID’
30 Hz FM deviation	CALC:AVI:FM:DEV?
30 Hz FM Frequency	CALC:AVI:FM:FREQ?
THD Ident	CALC:AVI:THD:RES? 'ID'
THD 30	CALC:AVI:THD:RES? '30'
VOR Phase	CALC:AVI:PHAS?

ILS The ILS softkey switches the ILS demodulator on.

`Remote: CALC:AVI:STAN ILS`

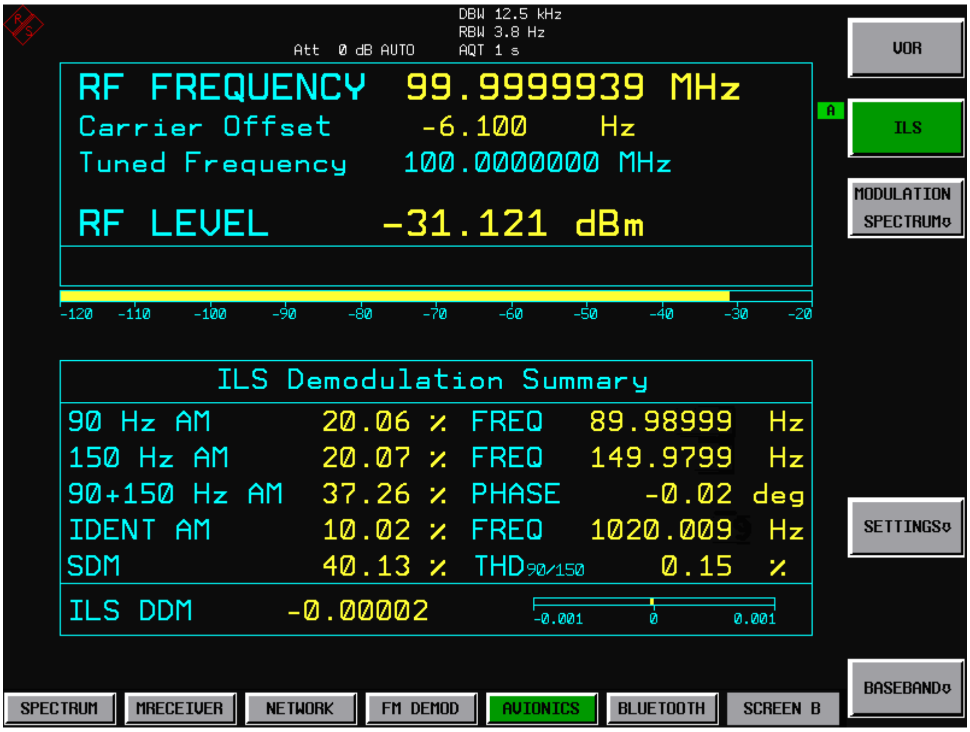


Figure 2-3: ILS measurement display

The settings of the spectrum analyzer active before the demodulator is switched on will be restored when the demodulator is switched off. The center frequency setting is transferred between the operating modes.
Similarly, the trace operating mode and detector are restored (the VOR/ILS demodulator has separate trace settings).

Screen description:

90 Hz AM	Selective modulation depth and AF frequency measurement of 90 Hz ILS signal component.
150 Hz AM	Selective modulation depth and AF frequency measurement of 150 Hz ILS signal component.
ILS Phase	Phase angle measurement between 90 Hz and 150 Hz AM signal (90 Hz = reference signal), measurement range ±60 degree.
90+150 Hz AM	Total modulation depth of the 90 Hz and the 150 Hz components taking the phase between the components into account.
IDENT AM	Modulation depth and frequency measurement of Identifier signal and speech band 300 Hz to 4 kHz without influence by the actual ILS signal components.
SDM	Selective measurement of the sum-modulation depth (SDM = Sum in Depth of Modulation); arithmetic sum of the modulation depth of the 90 Hz and the 150 Hz components without any influence of the phase between the components.
THD Ident	Distortion measurement at the identifier signal component.
DDM	DDM (= difference in depth of modulation) between 90 Hz and 150 Hz AM signal (m90 Hz – m150 Hz).

The individual measured values are read out with the following commands:

90 Hz AM depth	CALC:AVI:AM:DEPT? ‘90’
90 Hz AM Frequency	CALC:AVI:AM:FREQ? ‘90’
150 Hz AM depth	CALC:AVI:AM:DEPT? ‘150’
150 Hz AM Frequency	CALC:AVI:AM:FREQ? ‘150’
90+150 Hz AM depth	CALC:AVI:AM:DEPTh? ‘90+150’
ILS Phase	CALC:AVI:PHAS?
IDENT AM depth	CALC:AVI:AM:DEPT? ‘ID’
IDENT AM Frequency	CALC:AVI:AM:FREQ? ‘ID’
SDM	CALC:AVI:SDM?
THD	CALC:AVI:THD:RES? ‘’
DDM	CALC:AVI:DDM?

MODULATION SPECTRUM

The MODULATION SPECTRUM softkey opens the submenu for the distortion meter operation and selects the display of the AF spectrum. The AF spectrum is calculated from the ILS signal or the VOR signal depending on the mode which was active before selecting the distortion/spectrum measurement.

Remote:: CALC:FEED 'XTIM:SPEC'

To switch back to the demodulation summary screen:

`Remote: CALC:FEED 'XTIM:AMS'`

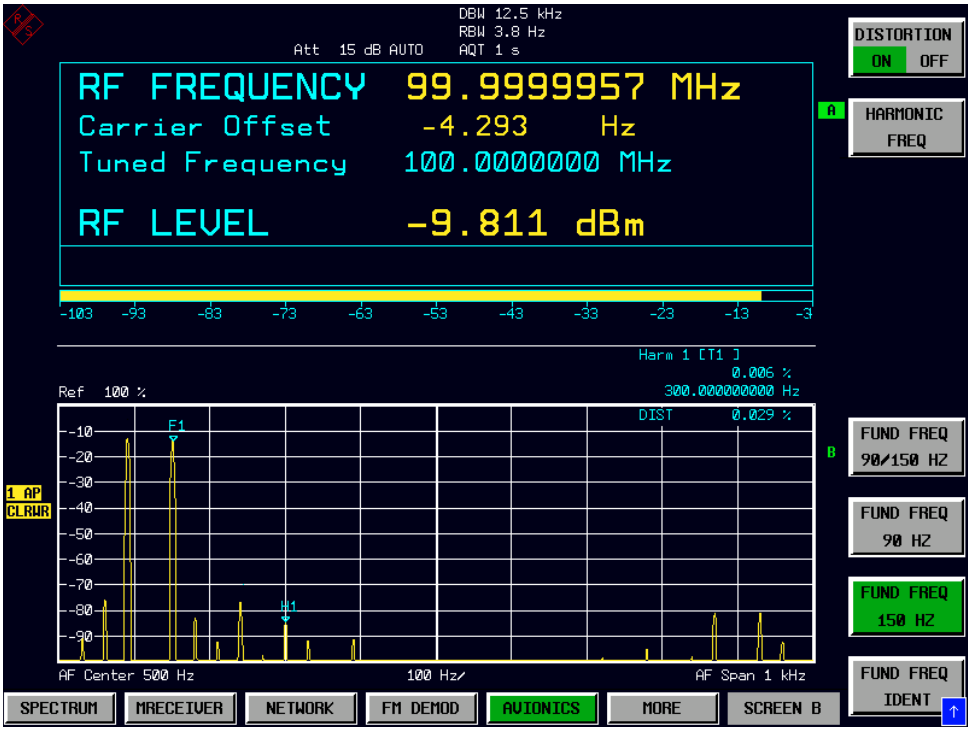


Figure 2-4: Distortion measurement display

Similarly to the spectrum analyzer operation, the markers can be used for selective harmonic measurements on any arbitrary frequencies within the audio spectrum range. The spectrum is limited to the half of the demodulation bandwidth setting (default: 12.5 kHz in ILS mode and 25 kHz in VOR mode).

Screen description:

DIST Distortion measurement at the selected signal component.

The measured value are read out with the following command:

`Remote: CALC:AVI:SHD:RES?`

DISTORTION ON OFF

The DISTORTION ON OFF softkey activates the harmonic distortion measurement.

`Remote: CALC:AVI:SHD:STAT ON | OFF`

HARMONIC FREQUENCY

The HARMONIC FREQUENCY softkey sets the measurement frequency of the harmonic distortion measurement. This setting is only taken into account for the distortion reading in the distortion screen.

`Remote: CALC:AVI:SHD:FREQ 300HZ`

The result of the manual distortion measurement is available with the following command:

`Remote: CALC:AVI:SHD:RES?`

FUND FREQ 90/150HZ

The FUND FREQ 90/150HZ softkey sets the reference frequency for the harmonic distortion reading to the 90 Hz and 150 Hz signal. Both modulation tones will be measured and the average level will be used as reference. This allows THD measurements at signals with non-equal tone modulation (DDM not zero). All harmonics at N * 30 Hz will be measured and the distortion result is calculated in % or dB to the average of the 90 Hz and 150 Hz signal level.

`Remote: CALC:AVI:THD:FREQ:FUND '90_150'`

FUND FREQ 90 HZ

The FUND FREQ 90 HZ softkey sets the reference frequency for the harmonic distortion reading to the 90 Hz signal. All harmonics at N * 90 Hz will be measured and the distortion result is calculated in % or dB to the 90 Hz signal level.

`Remote CALC:AVI:THD:FREQ:FUND '90'`

FUND FREQ 150 HZ

The FUND FREQ 150 HZ softkey sets the reference frequency for the harmonic distortion reading to the 150 Hz signal. All harmonics at N * 150 Hz will be measured and the distortion result is calculated in % or dB to the 150 Hz signal level.

`Remote: CALC:AVI:THD:FREQ:FUND '150'`

FUND FREQ IDENT

The FUND FREQ IDENT softkey sets the fundamental frequency for the harmonic distortion reading to the Identifier signal. The THD measurement will use the highest signal in the frequency range from 300 Hz to 4 kHz as the fundamental signal reference.

`Remote: CALC:AVI:THD:FREQ:FUND 'ID'`

SETTINGS

The SETTINGS softkey opens the submenu for setting the measurement parameters of the selected measurement function.

DDM UNIT % [1]

The DDM UNIT %/1 softkey selects between % and unitfree for displaying the DDM measurement results of the ILS demodulator.

`Remote: UNIT:DDM PCT | UNIT`

DISTORTION MAX FREQ The DISTORTION MAX FREQ softkey sets the upper frequency limit of the total harmonic distortion measurement.

Remote: `CALC:AVI:THD:FREQ:UPP`

DIST UNIT %/DB The DIST UNIT %/DB softkey selects between % and dB for displaying the THD measurement results.

Remote: `UNIT:THD PCT`

FUND FREQ 90/150HZ The FUND FREQ 90/150HZ softkey sets the reference frequency for the harmonic distortion reading to the 90 Hz and 150 Hz signal. Both modulation tones will be measured and the average level will be used as reference. This allows THD measurements at signals with non-equal tone modulation (DDM not zero). All harmonics at N * 30 Hz will be measured and the distortion result is calculated in % or dB to the average of the 90 Hz and 150 Hz signal level.

Remote: CALC:AVI:THD:FREQ:FUND '90_150'

FUND FREQ 90 HZ The FUND FREQ 90 HZ softkey sets the reference frequency for the harmonic distortion reading to the 90 Hz signal. All harmonics at N * 90 Hz will be measured and the distortion result is calculated in % or dB to the 90 Hz signal level.

Remote: `CALC:AVI:THD:FREQ:FUND '90'`

FREQ 150 HZ The FUND FREQ 150 HZ softkey sets the reference frequency for the harmonic distortion reading to the 150 Hz signal. All harmonics at N * 150 Hz will be measured and the distortion result is calculated in % or dB to the 150 Hz signal level.

Remote: `CALC:AVI:THD:FREQ:FUND '150'`

FUND FREQ IDENT The FUND FREQ IDENT softkey sets the fundamental frequency for the harmonic distortion reading to the Identifier signal. The THD measurement will use the highest signal in the frequency range from 300 Hz to 4 kHz as the fundamental signal reference.

Remote:`CALC:AVI:THD:FREQ:FUND 'ID'`

BASEBAND FUND FREQ IDENT (present at the RF input of the instrument) the modulation signal at the audio input or the baseband input is analyzed. The input level range is fixed (no autorange). In all VOR/ILS modulation depth measurements the selectively measured voltages are converted into modulation depth and read out in %AM, the sensitivity entered under Baseband Sensitivity in Volöts/100% being used as a reference. This applies also to the ILS measurements DDM, SDM and m(90+150)Hz derived from the 90 and 150 Hz tones modulation depth measurements. When baseband measurements are selected, the RF input is switched off.

The baseband menu is only available when the instrument is equipped with an audio input (R&S FSMR) or with the option baseband inputs (R&S FSQ-B71).

The baseband signal shall be connected to the “I” baseband input on the R&S FSQ.

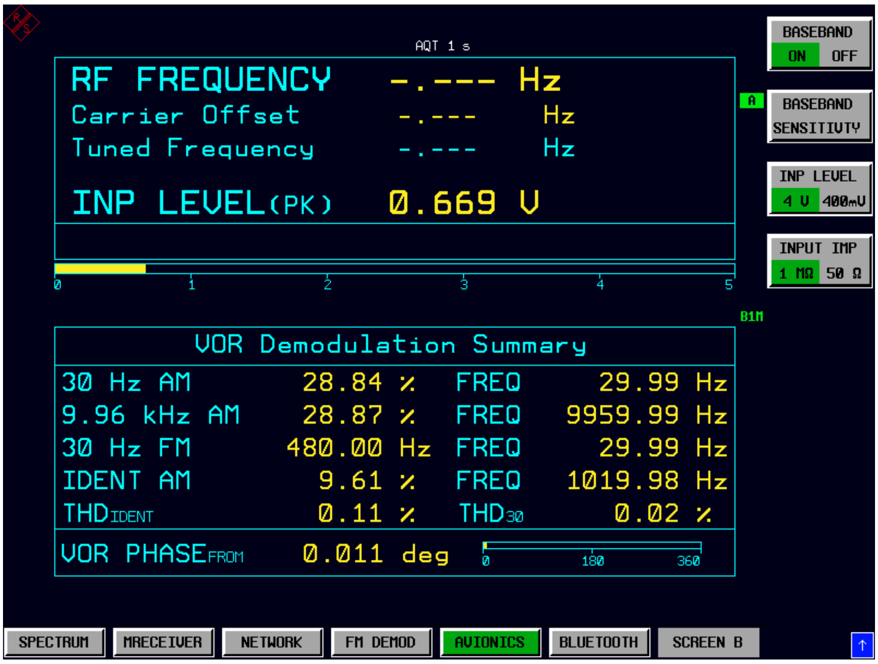


Figure 2-5: Screen display of measurements on the audio input

Screen description:

RF frequency Not available in Baseband mode

Carrier Offset Not available in Baseband mode

Tuned Frequency Not available in Baseband mode

Input level Peak input level of the modulation signal

Bargraph for visual information about input level

The following commands are used for reading out the individual measured value:

Input Level(Pk) CALC:AVI:POW:AC:RES?

R&S FSQ with R&S FSQ-B71	R&S FSMR	

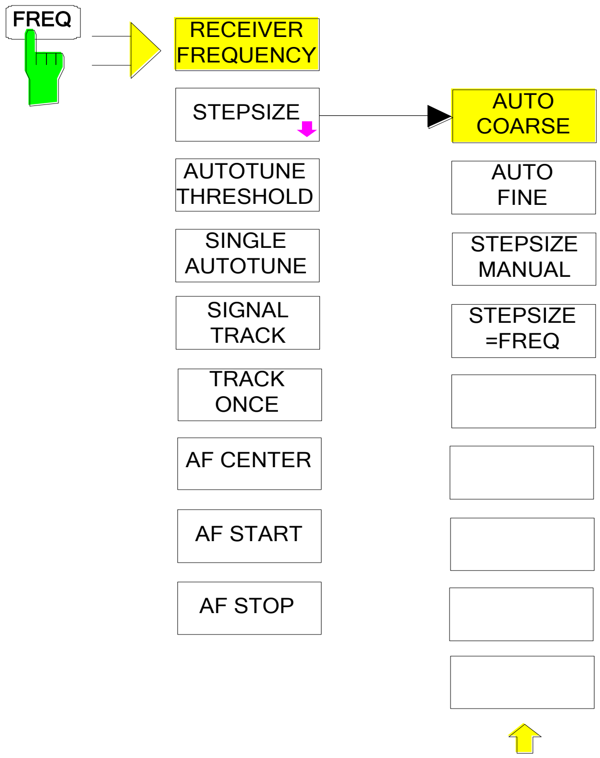
BASEBAND ANALOG	**BASEBAND ON/OFF**	The BASEBAND ON/OFF or BASEBAND ANALOG softkey in the avionics mode switches the audio or baseband input to active.
		`Remote: ON: INP1:SEL AIQ| AUD`
		`Remote: OFF: INP1:SEL RF`

BASEBAND SENSITIVITY	**BASEBAND SENSITIVITY**	The BASEBAND SENSITIVITY softkey enables the entry of the sensitivity of an (external) AM modulator that could be or is driven by the applied baseband signal. The entered sensitivity [Vpeak/100%AM] is used to convert the measured voltages into modulation depth. Default value: 1 V peak voltage corresponds to 100 % AM. `Remote: SENS1:VOLT:AC:SENS 2V`

Use reference level setting in amplitude menu.	**INP LEVEL 4V/400mV**	The INP LEVEL 4V/400mV softkey switches the input voltage range of the audio input between 4 V and 400 mV. In the default setting, the 4 V range is switched on. `Remote: SENS1:VOLT:AC:RANG:UPP 0.4V`
I/Q INPUT 50Ω/1MΩ	**INPUT IMP 50Ω/1MΩ**	The INPUT IMP 50Ω/1MΩ or I/Q INPUT 50Ω/1MΩ softkey switches the input impedance of the audio input between 50 Ω and 1 MΩ. Note: The baseband input impedance on the R&S FSQ depends on the model. Older models offer 50Ω/1kΩ impedance settings. In the default setting, the input impedance is set to 1 MΩ. `Remote: INP1:IMP 50OHM`
BALANCED ON/OFF		The BALANCED ON/OFF softkey switches the baseband input between balanced and unbalanced mode. (only R&S FSQ-B71). In the default setting, the balanced mode is switched on. `Remote: INP1:IQ:BAL ON`

2.7 FREQ Key

The FREQ key opens the RF frequency menu. The menu allows to set the RF frequency tuning mode on the instrument. In the default status the analyzer is set to manual tuning mode and 100 MHz receiver frequency. The keys for the RF frequency variation are not available in the baseband mode.



RECEIVER FREQUENCY

The RECEIVER FREQUENCY softkey activates the window for entering the receiver frequency.

The receiver frequency resolution is 0.1 Hz.

Setting range: 20 Hz ≤ fREC ≤ fmax

`Remote: SENS:FREQ:CENT 300MHz`

STEPSIZE

The STEPSIZE softkey opens a submenu for setting the step size of the receive frequency. The step size can either be coupled to the set frequency or be manually set to a fixed value. The menu softkeys are selection switches, and only one of them at a time can be active.

AUTO AUTO COARSE COARSE

The AUTO COARSE softkey sets the step size of the receive frequency to coarse. In this setting, the fourth position of the set frequency is varied.

`Remote: ---`

AUTO FINE

The AUTO FINE softkey sets the step size of the receive frequency to fine. The seventh position of the set frequency is varied in this setting.

`Remote: ---`

STEPSIZE MANUAL

The STEPSIZE MANUAL softkey activates the window for entering a fixed value for the step size.

`Remote: FREQ:CENT:STEP 50 kHz`

STEPSIZE = FREQ The STEPSIZE = FREQ softkey sets the step size to the receive frequency value. This function is particularly useful for measuring the harmonics of a signal. If the receiver is first tuned to the fundamental, the frequency of another harmonic is set with each frequency variation by using the rotary knob or the STEP keys.

`Remote: ---`

AUTOTUNE THRESHOLD The AUTOTUNE THRESHOLD softkey activates the window for entering the threshold level of the autotune function. This function is only available for instrument models up to a maximum frequency of 26.5 GHz.
The autotune threshold default setting is -40 dBm.
Setting range -50 dBm ≤ Threshold level ≤ 0 dBm

`Remote: SENS:FREQ:CW:AFC:THR <numeric_value>`

SINGLE AUTOTUNE This softkey activates a single automatic signal search.Q

`Remote: SENS:FREQ:CW:AFC ONCE`

SIGNAL TRACK This softkey activates a function to track a drifting signal. If the measured signal frequency is too far away from the tuned center frequency and the level is above the threshold, the center frequency of the receiver will be changed to the new signal frequency.

`Remote: SENS:FREQ:CW:AFC ON`

TRACK ONCE This softkey activates a single frequency setting to align the tuned frequency to the signal. If the measured signal frequency is too far away from the tuned center frequency and the level is above the threshold, the center frequency of the receiver will be changed to the new signal frequency.

```
Remote: SENS:FREQ:CW:AFC ON'
        SENS:FREQ:CW:AFC:STR ONCE
```

AF CENTER The AF CENTER softkey allows the user to select the center frequency within the AF spectrum.

`Remote: SENS:ADEM:AF:CENT 1KHZ`

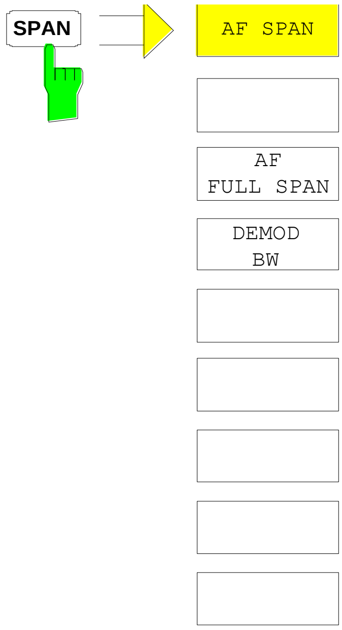
AF START The AF START softkey allows the user to select the start frequency within the AF spectrum.

`Remote: SENS:ADEM:AF:STAR 0HZ`

AF STOP The AF STOP softkey allows the user to select the stop frequency within the AF spectrum.
The maximum AF stop frequency corresponds to half the demodulation bandwidth.

`Remote: SENS:ADEM:AF:STOP 2KHZ`

2.8 SPAN Key



The SPAN menu allows the user to select the frequency range to be displayed.

The Span softkey is only available when the modulation spectrum is active.

AF SPAN

The AF SPAN softkey allows the user to select the frequency range if the modulation spectrum display is active.
Values between the sampling rate/200 and the demodulation bandwidth/2 can be selected.

`Remote:SENS:ADEM:AF:SPAN 2.5 kHz`

AF FULL SPAN

The AF FULL SPAN softkey sets the maximum frequency range if the AF spectrum displays are active.
The maximum frequency range corresponds to half the demodulation bandwidth.

`Remote:SENS:ADEM:AF:SPAN:FULL`

DEMOD BW

The demodulation bandwidth of the avionics demodulator is selected using the DEMOD BW softkey. The demodulation bandwidth determines the sampling rate for recording the signal to be analyzed. The DEMOD BW MANUAL softkey is only available in ILS demodulation mode. The bandwidth can be set to 12.5 kHz, 3.2 kHz and 800 Hz. This function can be used to suppress adjacent transmitters.

`Remote: SENS:BAND:DEM 3.2KHZ`

2.9 AMPT Key

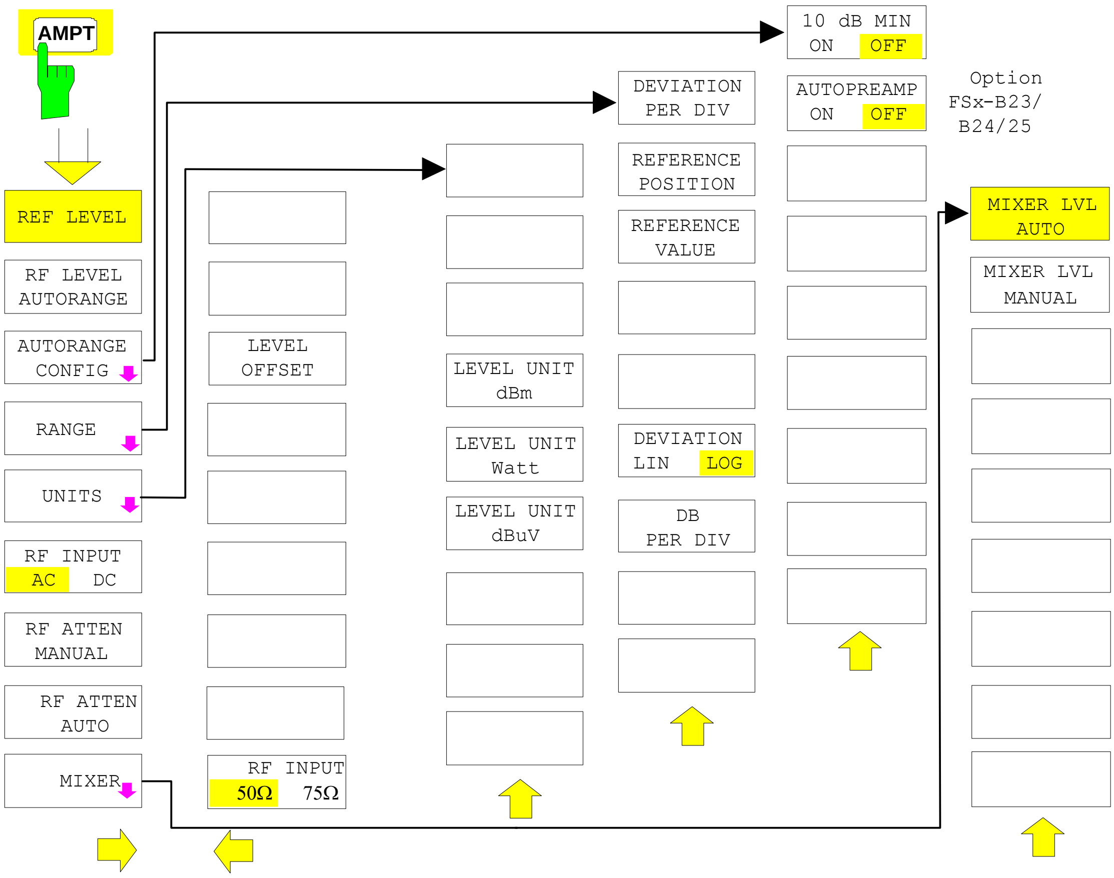
2.9.1 Setting the Level Display and Configuring the RF Input – AMPT Key

The AMPTkey is used to set the reference level, the maximum level and the display range as well as the input impedance and the input attenuation of the RF input.

Further settings regarding the level display RF attenuation, the preamplifier and the autorange function can be made in this menu.

When the instrument is in default status, it is in autorange mode, i.e. the input level is automatically set depending on the measured peak level. In the default setting the measurement time is set to 1s, this allows the auto level routine to find the peak level for modulation frequencies down to 10 Hz.

For special cases, e.g. if a input signal is only temporarily applied, the RF level can also be manually set to a fixed value using the reference level function. This leads to improved measurement speed and saves unwanted switching of the mechanical attenuator. When manual level setting is activated, the current valid setting of the auto level function will be maintained when autorange was active before.



REF LEVEL The REF LEVEL softkey activates the window for entering the reference level. The entry is made in the currently active unit (dBm, dBµV, etc).

Remote: DISP:WIND:TRAC:Y:RLEV -60dBm

The REF LEVEL value defines the clipping level of the A/D converter and must therefore be set greater than or equal to the maximum power of the signal to be analyzed.

RF LEVEL AUTORANGE

The RF LEVEL AUTORANGE softkey activates the autorange function; attenuation, IF gain and, if necessary, preamplification, are automatically matched to the applied RF signal.

Remote:`DISP:WIND:TRAC:Y:RLEV:AUTO ON`

AUTORANGE CONFIG

The AUTORANGE CONFIG softkey opens a submenu for configuring the automatic setting of attenuation and IF gain and, if necessary, preamplification.

10 dB MIN ON/OFF

The 10 dB MIN ON/OFF softkey determines whether or not the 0 dB position of the attenuator is used when setting the insertion manually or automatically.

The default setting is 10 dB MIN OFF.

With 10 dB MIN ON an RF attenuation of at least 10 dB is always switched on in the instrument to ensure specific adjustment.

Even manually, the 0 dB position cannot be switched on.

Remote: `INP:ATT:PROT ON`

AUTO PREAMP ON/OFF

The AUTO PREAMP ON/OFF softkey activates the preamplifier for the autorange function.

ON The autorange function takes the preamplifier into account. The preamplifier is activated only when the attenuation of the attenuator has been reduced to the minimum settable value.

OFF The auto range does not take into account the preamplifier.

The softkey is only available with the R&S FSx-B23/B24/B25 preamplifier option.

Remote: `INP:GAIN:AUTO ON`

RANGE

The RANGE softkey opens a submenu for determining the diagram scaling for the selected measurement.

The softkeys visibility depends on the selected measurement function (only for modulation spectrum).

REFERENCE POSITION

The REFERENCE POSITION softkey defines the position of the reference line.

The entry is in percentage of the diagram height, where 100% corresponds to the top edge of the diagram. The default setting is 100 % (top edge of diagram) for displaying the AF spectrum of the signal.

Remote: `DISP:WIND:TRAC:Y:RPOS 50PCT`

REFERENCE VALUE

The REFERENCE VALUE softkey defines the modulation depth at the at the reference line of the y axis.

The settable value range is 0.0001% to 10000%.

`Remote:DISP:WIND:TRAC:Y:RVAL 100PCT`

DEVIATION LIN/LOG The DEVIATION LIN/LOG softkey switches between logarithmic and linear modulation spectrum display.

`Remote:DISP:WIND:TRAC:Y:SPAC LOG`

DB PER DIV The DB PER DIV softkey allows to scale the modulation depth in the range from 0.1 dB/div to 20 dB/div.

The softkey is not available with linear display.

`Remote: DISP:WIND:TRAC:Y:PDIV 5DB`

UNIT The UNIT softkey opens a submenu from which the desired unit for the y axis can be selected.

The default setting is dBm.

In general, the analyzer measures the signal voltage at the RF input. The level display is calibrated in rms values of an unmodulated sinewave signal. In the default state, the level is displayed at a power of 1 mW (= dBm). Via the known input resistance, conversion to other units is possible. The units dBm, dBμV and W are directly convertible.

`Remote: CALC:UNIT:POW DBM`

dBm The dBm softkey selects the unit dBm for displaying the RF level measurement results.

Watt The Watt softkey selects the unit Watt for displaying the RF level measurement results.

dBuV The dBuV softkey selects the unit dBuV for displaying the RF level measurement results.

RF INPUT AC/DC The RF INPUT AC/DC softkey switches the analyzer input between AC and DC coupling.

> **Note:**
> The softkey is not available in all models.

`Remote: INP:COUP AC`

RF ATTEN MANUAL The RF ATTEN MANUAL softkey activates the window for entering attenuation independently of the reference level.

The attenuation can be altered in 5 dB steps between 0 dB and 75 dB. Other entries are rounded down to the next lowest integral value.

If the specified reference level can no longer be set with the specified RF attenuation, the level is adjusted and the "Limit reached" message is displayed.

> **Note:**
> The 0 dB value cannot be switched on unless the 10 dB MIN function is off. This protects the input mixer from overloading by mistake.

`Remote: INP:ATT 40 DB`

RF ATTEN AUTO

The RF ATTEN AUTO softkey automatically sets the RF attenuation depending on the set reference level.
This ensures that the optimum RF attenuation is always used.
RF ATTEN AUTO is the default setting.

Remote: `INP:ATT:AUTO ON`

MIXER

The MIXER softkey opens a submenu for changing the mixer level on the input mixer.

MIXER LVL AUTO

The MIXER LVL AUTO softkey activates the automatic coupling of the maximum mixer level to the reference level and the RF attenuation.

Remote: `INP:MIX:AUTO ON`

MIXER LVL MANUAL

The MIXER LVL MANUAL softkey activates the window for entering the maximum mixer level that can be achieved with reference levels.

The setting range is 0 dB to -100 dBm with a step size of 1 dB.

Remote: `INP:MIX -25DBM`

RF INPUT 50 Ω / 75 Ω

The RF INPUT 50 Ω / 75 Ω softkey switches the reference impedance for the measured level values between 50 Ω (= default setting) and 75 Ω.

Select the 75 Ω setting if the 50 Ω input impedance is transformed to the next higher impedance by using a 75 Ω matching pad of the RAZ type (= 25 Ω in series with the input impedance of the analyzer). The correction value used is 1.76 dB = 10 log (75 Ω/50 Ω).

All level specifications in this manual refer to the default setting (50 Ω) of the device.

Remote: `INP:IMP 50 OHM`

2.9.2 Setting the Level Display at the Baseband Input – AMPT Key

In Baseband mode the AMPT key allows to set the display range in the modulation spectrum display.

REF LEVEL

The REF LEVEL softkey activates the window for entering the peak reference level.

Remote: `DISP:WIND:TRAC:Y:RLEV 1V`

The REF LEVEL value defines the clipping level of the A/D converter and must therefore be set greater than or equal to the maximum peak voltage of the signal to be analyzed.

RANGE

The RANGE softkey opens a submenu for configuring the Y-axis in the graphical display of the modulation spectrum measurement results.

REFERENCE POSITION

The REFERENCE POSITION softkey defines the position of the reference line.

The entry is in percentage of the diagram height, where 100% corresponds to the top edge of the diagram. The default setting is 100% (top edge of diagram) for displaying the AF spectrum of the signal.

`Remote: DISP:WIND:TRAC:Y:RPOS 50PCT`

REFERENCE VALUE

The REFERENCE VALUE softkey defines the modulation depth at the top edge of the diagram.

The settable value range is 0% to 10000%.

`Remote:DISP:WIND:TRAC:Y:RVAL 100PCT`

DEVIATION LIN/LOG

The DEVIATION LIN/LOG softkey switches between logarithmic and linear modulation spectrum display.

`Remote: DISP:WIND:TRAC:Y:SPAC LOG`

DB PER DIV

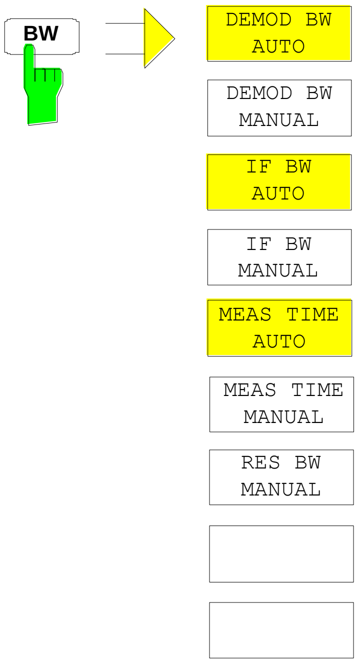
The DB PER DIV softkey allows you to select the modulation depth in the range from 0.1 dB/div to 20 dB/div.

The softkey is not available with linear display.

`Remote: DISP:WIND:TRAC:Y:PDIV 5DB`

2.10 BW Key

2.10.1 Setting the Bandwidths and the Measurement Time – BW Key



The BW menu comprises all functions relating to the band limiting of the analyzed signal.

In the default setting, demodulation bandwidth, IF bandwidth and measurement time are automatically selected depending on the selected operating mode. To obtain optimum measurement results these settings shall not be changed.

DEMOD BW AUTO

The DEMOD BW AUTO softkey activates the automatic setting of the demodulation bandwidth. Depending on the operating mode (VOR, ILS), the demodulation bandwidth is set in such a way that only the smallest possible measurement error occurs within the specified measurement range.

Mode	Demodulation bandwidth
VOR	25 kHz
ILS	12.5 kHz

Remote: `SENS:BAND:DEM:AUTO ON`

DEMOD BW MANUAL

The demodulation bandwidth of the avionics demodulator is selected using the DEMOD BW softkey. The demodulation bandwidth determines the sampling rate for recording the signal to be analyzed. The DEMOD BW MANUAL softkey is only available in ILS demodulation mode. The bandwidth can be set to 12.5 kHz, 3.2 kHz and 800 Hz. This function can be used to suppress adjacent transmitters.

Remote: `SENS:BAND:DEM 12.5 KHZ`

IF BW AUTO

The IF BW AUTO softkey couples the IF bandwidth of the analyzer (i.e. the bandwidth of the analog LC filters) to the selected receive frequency.

Receive frequency	IF bandwidth
≥10 MHz	10 MHz
<10 MHz	500 kHz

Remote: `BAND:RES:AUTO ON`

IF BW MANUAL

The IF BW MANUAL softkey activates the entry of the IF bandwidth (i.e. the bandwidth of the analog filters). Bandwidths from 300 kHz to 10 MHz can be selected.

Note:
Manual setting of the IF bandwidth is usually not required. In case of strong signals close to the test signal the IF bandwidth may be reduced to suppress these signals.

Remote: `SENS:BAND:RES 10 MHZ`

MEAS TIME AUTO

The MEAS TIME AUTO softkey activates automatic coupling of the measurement time.

Mode	Measurement time
VOR	1000 ms
ILS	1000 ms
Distortion	1000 ms

Note:
To obtain a correct result display, at least five periods of the demodulated signal should be monitored. If the modulation frequencies are low, it may be useful to manually prolong the measurement time (= signal monitoring time).

Remote: `SENS:SWE:TIME:AUTO ON`

MEAS TIME MANUAL

The MEAS TIME MANUAL softkey opens the entry field for determining the data acquisition time. The permissible value range depends on the selected demodulation bandwidth:

Note:
To obtain a correct result display, at least five periods of the demodulated signal should be monitored.

Remote: `SENS:SWE:TIME 800 MS`

RES BW MANUAL

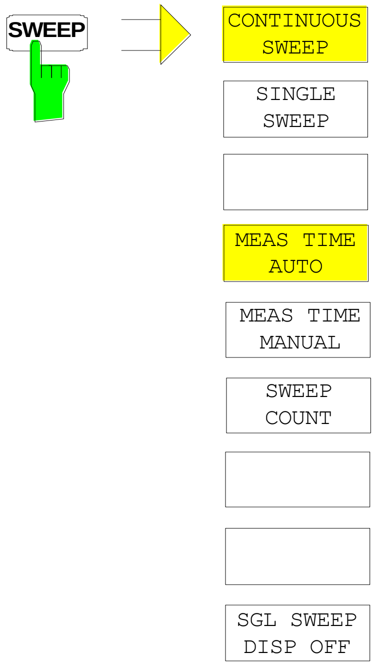
If the spectrum display is active, the RES BW MANUAL softkey selects the resolution bandwidth for the displayed signal. Note that these resolution bandwidths are implemented as FFT filters.

Note:
The softkey is only available if the modulation spectrum result displays is active.

Remote: `SENS:ADEM:SPEC:BAND:RES 10 Hz`

2.11 SWEEP Key

2.11.1 Setting the Sweep – SWEEP/MEAS Keys



The SWEEP key calls a menu in which the sweep mode is defined.

The CONTINUOUS SWEEP, SINGLE SWEEP and SGL SWEEP DISP OFF softkeys are mutually exclusive selection keys.

CONTINUOUS SWEEP

The CONTINUOUS SWEEP softkey sets the continuous sweep, i.e. the sweep occurs continuously in accordance with the trigger setting.

CONTINUOUS SWEEP is the default setting of the instrument.

`Remote: INIT:CONT ON`

SINGLE SWEEP

The SINGLE SWEEP softkey starts an n-times sweep after the trigger event has occurred. The SWEEP COUNT softkey defines the number of sweeps.

If a trace is sampled with TRACE AVERAGE or MAXHOLD, the value set with the SWEEP COUNT softkey defines the number of measurements. If the value is 0, a sweep is performed.

`Remote: INIT:CONT OFF;:INIT`

MEAS TIME AUTO

The MEAS TIME AUTO softkey activates the automatic coupling of measurement time.

Mode	Measurement time
VOR	1000 ms
ILS	1000 ms
Distortion	1000 ms

Note:
To obtain a correct result display, at least five periods of the demodulated signal should be monitored. If the modulation frequencies are low, it may be useful to manually prolong the measurement time (= signal monitoring time).

`Remote: SWE:TIME:AUTO ON`

MEAS TIME MANUAL

The MEAS TIME MANUAL softkey opens the entry field for determining the data acquisition time. The permissible value range depends on the selected demodulation bandwidth:

Demodulation bandwidth	min. measurement time	max. measurement time
25 kHz	600 ms	4.178 s
12.5 kHz	600 ms	8.356 s
3.2 kHz	601 ms	33.4 s
800 Hz	601 ms	133 s

Note:
To obtain a correct result display, at least five periods of the demodulated signal should be monitored.

`Remote: SENS:SWE:TIME 800 MS`

SWEEP COUNT

The SWEEP COUNT softkey activates the window for entering the number of sweeps that the instrument performs after a single sweep has been started. If Trace Average, Max Hold or Min Hold has been activated, the number of averages or maximum value findings is specified as well.

Example:

[TRACE1: MAX HOLD]

[SWEEP: SWEEP COUNT: {10} ENTER]

[SINGLE SWEEP]

The instrument performs the Max Hold function across ten sweeps.

The value range permissible for the sweep count is 0 to 32767. If the sweep count is 0 or 1, a sweep is performed. With trace averaging and if the sweep count is 0, the instrument performs sliding averaging across ten sweeps in continuous sweep mode; if the sweep count is 1, no averaging occurs.

The sweep count is valid for all traces in a diagram.

> **Note:**
> Setting the number of sweeps in the Trace menu is identical with setting them in the Sweep menu.
> In the SINGLE SWEEP setting, the measurement is stopped once the selected number of sweeps has been reached.

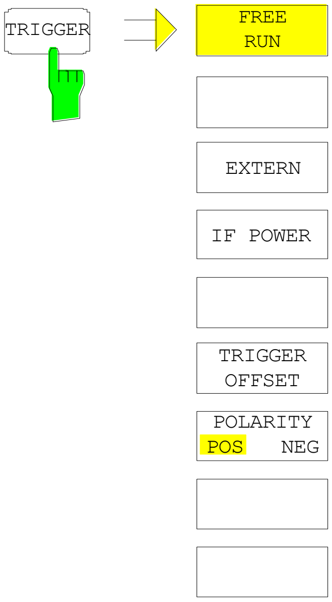
Remote: `SENS:SWE:COUN 64`

SGL SWEEP DISP OFF

The SGL SWEEP DISP OFF softkey starts a sweep and switches off the display during a single sweep. Once the sweep is completed, the display is reactivated and the trace displayed.

Remote: `INIT:DISP OFF;:INIT`

2.12 TRIG Key



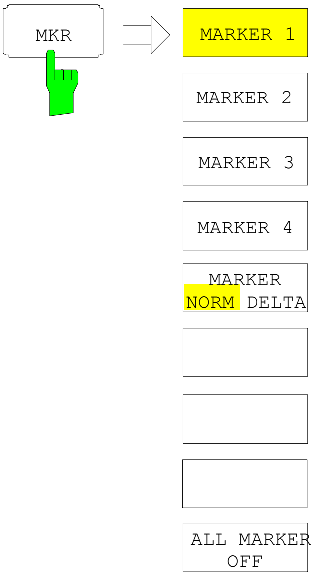
The TRIG key opens a menu for setting the different trigger sources and for selecting the trigger polarity. The active trigger mode is indicated by highlighting the associated softkeys.

To indicate that a trigger mode other than FREE RUN has been set, the TRG enhancement label is displayed on the screen. If two measurement windows are displayed, TRG is indicated next to the window in question.

The available TRIGGER menu functions are identical to those of the base unit.

Video Trigger and Gated Trigger are not available in the avionics mode.

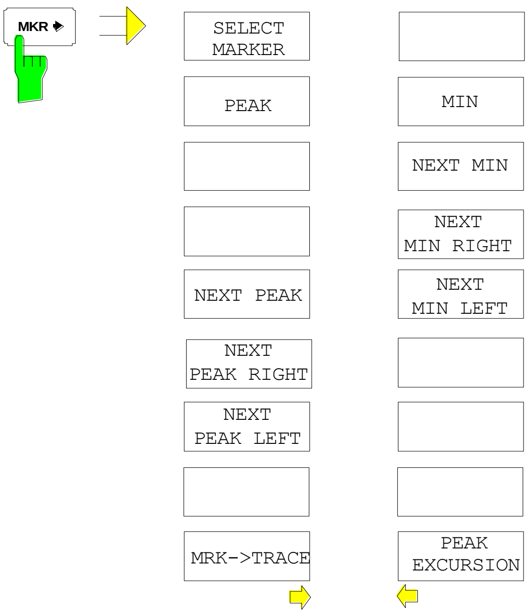
2.13 MKR Key



The available MKR menu functions are identical to those of the base unit.

The MKR menu is only available when the modulation spectrum is active.

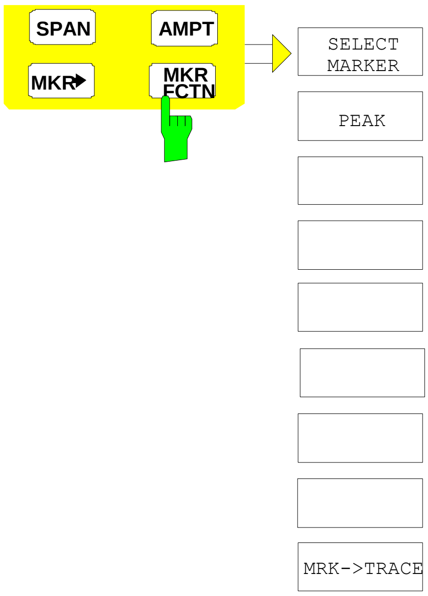
2.14 MKR -> Key



The available MKR ⇒ menu functions are identical to those of the base unit.

The MKR ⇒ menu is only available when the modulation spectrum is active.

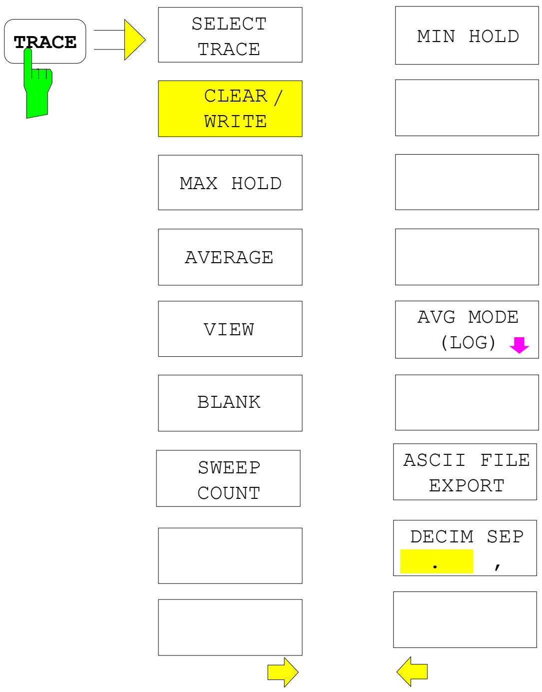
2.15 MKR FCTN Key



The available MKR FCTN menu functions are identical to those of the base unit.

The MKR FCTN menu is only available when the modulation spectrum is active.

2.16 TRACE Key

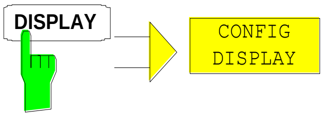


The available TRACE menu functions are identical to those of the base unit.

The function Trace Math and Trace Detector is not available in the avionics demodulator.

The TRACE menu is only available when the modulation spectrum is active.

2.17 DISP Key



The available CONFIG DISPLAY menu functions are identical to those of the base unit.

2.18 Other Keys

The functions of the other keys are identical to those of the base unit. Please refer to the relevant chapters in the operating manual of the base unit.

3 Remote Control Commands

This chapter describes the remote control commands for the application firmware. An alphabetic list following the text of the manual provides a quick overview of the commands.

The commands that also apply to the base unit in the SPECTRUM mode and the system settings are described in the operating manual for the analyzer.

3.1 Common Commands

***OPT?**

OPTION IDENTIFICATION QUERY polls the options contained in the device and returns a list of installed options. The options are separated by commas. The identifier for option R&S FS-K15 is contained in the response string at position 57.

```
Example 0,0, /……/ ,0,0,0,0,0,0,K15,0,0,0,0,0,0,0
```

3.2 CALCulate Subsystem

3.2.1 CALCulate:AVIonics Subsystem

The CALCulate:AVIonics subsystem controls the settings of the instrument for avionics measurements.

CALCulate:AVIonics[:STANdard:]

This command sets the avionics demodulation mode.

Parameters

VOR: VOR demodulation
ILS: ILS demodulation

Example

```
CALC:AVI:STAN VOR
'sets the avionics demodulator mode to VOR
```

Characteristics

*RST value: VOR

SCPI: device-specific

CALCulate:AVIonics:AM[:DEPTh]?

This command queries the results of the AM modulation depth measurement.

Parameters

<string> =

’30’	AM modulation depth VOR 30 Hz
’90’	AM modulation depth ILS 90 Hz.
‘150’	AM modulation depth ILS 150 Hz
’90+150’	AM modulation depth ILS 90+150 Hz
‘9960’	AM modulation depth VOR 9960 Hz
‘ID’	AM modulation depth identifier signal (300 to 4000 Hz)

Example

```
CALC:AVI:AM? ‘150’
‘queries the 150 Hz ILS tone
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:AM:FREQuency?

This command queries the results of the audio frequency counter measurement.

Parameters

<string>::=

’30’	Audio frequency VOR 30 Hz AM component
’90’	Audio frequency ILS 90 Hz AM component.
‘150’	Audio frequency ILS 150 Hz AM component
‘9960’	Audio frequency VOR 9960 Hz AM component
‘ID’	Audio frequency identifier signal (300 to 4000 Hz)

Example

```
CALC:AVI:AM:FREQ? ‘150’
‘queries the 150 Hz ILS tone frequency
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:CARRier[:RESult]?

This command queries the result of the RF level measurement.

Example

```
CALC:AVI:CARR?
‘queries the RF level reading.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics: DDM?

This command queries the result of the ILS DDM measurement.

Parameters

<parameters>

Example

```
CALC:AVI:DDM?
'queries the DDM reading.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:FERRor[:RESult]?

This command queries the result of the RF frequency offset measurement.

Example

```
CALC:AVI:FERR?
'queries the RF frequency offset reading.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:FM[:DEViation]?

This command queries the results of the VOR 9960 Hz FM deviation measurement.

Example

```
CALC:AVI:FM?
'queries the FM deviation
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:FM:FREQuency?

This command queries the audio frequency of the VOR 9960 Hz FM deviation measurement.

Example

```
CALC:AVI:FM:FREQ?
'queries the audio frequency.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:PHASe?

This command queries the results of the ILS or VOR phase measurement.

Example

```
CALC:AVI:PHAS?
'queries the VOR phase (bearing).
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:POWer:AC[:RESult]?

This command queries the result of the audio or baseband input level measurement.

Parameters

<parameters>

Example

```
CALC:AVI:POW:AC?'
queries the input level reading.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:RFFRequency[:RESult]?

This command queries the result of the RF frequency counter measurement.

Example

```
CALC:AVI:RFFR?
'queries the RF frequency reading
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:SDM?

This command queries the result of the ILS SDM measurement.

Example

```
CALC:AVI:SDM?
'queries the SDM reading.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:SHD:FREQuency

This command sets the measurement frequency of the harmonic distortion measurement to a single signal within the audio frequency range.
The limit value fmax is half of the demodulation bandwidth.

Parameters

f_{min} to f_{max}

Example

```
CALC:AVI:SHD:FREQ 1KHZ
'sets the frequency of the distortion measurement to 1 kHz
```

Characteristics

*RST value: 750 Hz

SCPI: device-specific

CALCulate:AVIonics:SHD[:STATe]

This command switches the distortion measurement on.

Parameters

ON | OFF

Example

```
CALC:AVI:SHD ON
'activates the distortion reading of the result
```

Characteristics

*RST value: OFF

SCPI: device-specific

CALCulate:AVIonics:SHD:RESult?

This command queries the result of the selective distortion measurement.

Example

```
CALC:AVI:SHD:RES?
'queries the SHD reading.
```

Characteristics

*RST value: -

SCPI: device-specific

CALCulate:AVIonics:THD:FREQuency:FUNDament

This command selects the fundamental frequency of the harmonic distortion measurement.

Parameters

<string>::=
’90’ fundamental frequency ILS 90 Hz.
‘150’fundamental frequency ILS 150 Hz
’90_150’ fundamental frequency Average of ILS 90 and 150 Hz
‘ID’ fundamental frequency identifier signal (300 to 4000 Hz

Example

```
CALC:AVI:THD:FREQ:FUND ‘90’
‘sets the fundamental frequency of the distortion
measurement to the ILS 90 Hz signal
```

Characteristics

*RST value: 90_150’ Hz

SCPI: device-specific

CALCulate:AVIonics:THD:FREQuency:UPPer

This command sets the maximum frequency of the harmonic distortion measurement.
The limit value fmax is half of the demodulation bandwidth.

Parameters

f_{min} to f_{max}

Example

```
CALC:AVI:THD:FREQ:UPP 1KHZ
‘sets the max. frequency of the distortion measurement to
1 kHz
```

Characteristics

*RST value: 750 Hz

SCPI: device-specific

CALCulate:AVIonics:THD[:RESult]?

This command queries the results of the total harmonic distortion measurement.

Parameters

<string>:
’’ ILS component defined by “CALC:AVI:THD:FREQ:FUND”
‘30’ VOR 30 Hz AM component
‘ID’ VOR Identifier signal (300 to 4000 Hz)

Example

CALC:AVI:THD:RES ’ID’
‘queries the identifier THD measurement

Characteristics

*RST value: 30 Hz

SCPI: device-specific

3.2.2 CALCulate:FEED - Subsystem

The CALCulate:FEED - Subsystem selects the type of evaluation of the measured data. In the avionics demodulator the evaluation is independent of the selected measurement window. The numeric Suffix <1|2> is meaningless and will be ignored.

CALCulate<1|2>:FEED

This command selects the type of evaluation of the measured data.

Parameters

<string>::=
'XTIM:SPECtrum' FFT display of the modulation spectrum.
'XTIM:AMSummary' AM-demodulation results in tables.

Example

```
CALC:FEED ‘XTIM: SPEC’
‘selects the modulation spectrum display
```

Characteristics

*RST value: ‘XTIM:AMSummary’

SCPI: compliant

3.3 DISPlay Subsystem

The DISPLay subsystem controls the selection and presentation of text and graphics information as well as measurement data on the screen.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel

This command defines the reference level in the selected measurement window.
The numeric suffix under TRACe <1...3> is irrelevant.

Parameters

<numeric_value>

Example

```
DISP:WIND:TRAC:Y:RLEV 10 DBM
'sets the reference level to 10 dBm
```

Characteristics

*RST value: -- (AUTO is set to ON)

SCPI: compliant

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel:AUTO

This command enables the referenc level autorange.
The numeric suffix under TRACe <1...3> is irrelevant.

Parameters

ON | OFF

Example

```
DISP:WIND:TRAC:Y:RLEV:AUTO ON
'enables autorange for the reference level.
```

Characteristics

*RST value: ON

SCPI: compliant

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RVALue

This command defines the modulation depth value assigned to the reference position.
The numeric suffix under TRACe <1...3> is irrelevant.

Parameters

<numeric_value>

Example

```
DISP:WIND:TRAC:Y:RVAL 50 PCT
'sets the modulation depth value at the reference position
to 50 %
```

Characteristics

*RST value: 100 %

SCPI: compliant

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RPOSition

This command defines the position of the reference value in the selected measurement window. The numeric suffix in TRACe<1 to 3> is irrelevant.

Parameters

<numeric_value>

Example

```
DISP:WIND:TRAC:Y:RPOS 50 PCT
'sets the reference position to the middle of the grid
scale.
```

Characteristics

*RST value: 100 %

SCPI: compliant

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:PDIVision

This command defines the scaling of the Y axis.
The numeric suffix under TRACe <1...3> is irrelevant.

Parameters

<numeric_value>

Example

DISP:WIND:TRAC:Y:PDIV 1DB
‘sets the grid scale to 1 dB per division.

Characteristics

*RST value: 10 DB

SCPI: compliant

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y:SPACing

This command toggles between linear and logarithmic display in the selected measurement window
The numeric suffix under TRACe <1...3> is irrelevant.

Parameters

<LINear | LOGarithmic>

Example

```
DISP:WIND:TRAC:Y:SPAC LIN
'sets the grid scale to linear.
```

Characteristics

*RST value: LOG

SCPI: compliant

3.4 INITiate Subsystem

The INITiate subsystem is used to control the measurement sequence in the selected measurement window.

INITiate:CONTinuous

This command determines whether the device performs measurements continuously ("Continuous") or only individual measurements ("Single“).
In the spectrum analysis mode, this setting refers to the sweep operation (switchover between Continuous and Single Sweep).

Parameters

ON | OFF

Example

```
INIT:CONT OFF
'switches operation to Single Sweep
```

```
INIT:CONT ON
'switches operation to Continuous Sweep
```

Characteristics

*RST value: ON

SCPI: compliant

INITiate:DISPlay

This command configures the behavior of the display during a single sweep.
The numeric suffix of INITiate is irrelevant with this command .

Parameters

ON means that the display is switched on during the measurement.

OFF means that the display is switched off during the measurement.

Example

```
INIT:CONT OFF
'switches operation to Single Sweep
```

```
INIT:DISP OFF
'Sets the display behavior to OFF
```

```
INIT;*WAI
'Starts the measurement with display OFF
```

Characteristics

*RST value: ON

SCPI: compliant

INITiate[:IMMediate]

This command starts a new measurement sequence in the specified measurement window.
This command starts a new measurement sequence (sweep) in the specified measurement window. A sweep count > 0 or average count > 0 means the number of specified measurements will be restarted. In the case of the trace functions MAXHold, MINHold and AVERage, the previous results are reset when the measurement is restarted.
In the Single Sweep mode, the commands *OPC, *OPC? or *WAI can be used to perform synchronization with the end of the specified number of measurements. In the Continuous Sweep mode, synchronization with the end of the sweep is not possible because the entire measurement "never" actually ends

Parameters

<parameters>

Example

```
INIT:CONT OFF
'switches to Single Sweep mode
```

```
DISP:WIND:TRAC:MODE AVER
'activates Trace Averaging
```

```
SWE:COUN 20
'sets the sweep counter to 20 sweeps
```

```
INIT;*WAI
'starts the measurement by waiting for the end of 20
measurements
```

Characteristics

*RST value: -

SCPI: compliant

This command is an "event" and thus has neither a *RST value nor a query.

3.5 INPut Subsystem

The INPut subsystem controls the input characteristics of the RF inputs of the instrument. The measurement windows are assigned to INPut1 (screen A) and INPut2 (screen B).

INPut<1|2>:ATTenuation

This command programs the input attenuator. To protect the input mixer against damage from overloads, the setting 0 dB can be obtained by entering numerals, not by using the command DEC.
The input attenuation can be set in 5 dB steps between 0 dB and 75 dB.
In the default state, the attenuation set on the step attenuator is coupled to the reference level of the instrument. If the attenuation is programmed directly, the coupling to the reference level is switched off.

Parameters

0 to 75 dB

Example

```
INP:ATT 40dB
'Sets the attenuation on the attenuator to 40 dB and
switches off the coupling to the reference level.
```

Characteristics

*RST value: 10 dB (AUTO is set to ON)

SCPI: conforming

INPut<1|2>:ATTenuation:AUTO

This command automatically couples the input attenuation to the reference level (state ON) or switches the input attenuation to manual entry (state OFF). The minimum input attenuation set with the coupling switched on is 10 dB.

Parameters

ON | OFF

Example

```
INP:ATT:AUTO ON
'Couples the attenuation set on the attenuator to the
reference level.
```

Characteristics

*RST value: ON

SCPI: conforming

INPut<1|2>:ATTenuation:PROTection

This command defines whether the 0 dB position of the attenuator is to be used in manual or automatic adjustment.

Parameters

ON | OFF

Example

```
INP:ATT:PROT ON
```

Characteristics

*RST value: OFF

SCPI: device-specific

INPut:COUPling

This command switches the input coupling of the RF input between AC and DC.

Parameters

AC | DC

Example

`INP:COUP DC`

Characteristics

*RST value: AC

SCPI: conforming

INPut<1|2>:IMPedance

This command sets the nominal input impedance of the instrument. The set impedance is taken into account in all level indications of results.
The setting 75 Ω should be selected, if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the analyzer). The correction value in this case is 1.76 dB = 10 log (75 Ω / 50 Ω).

Parameters

50 | 75 | 1M

Example

`INP:IMP 75`

Characteristics

*RST value: 50 Ω

SCPI: conforming

INPut<1|2>:GAIN:AUTO

This command automatically switches on the preamplifier for low levels. The switchable gain is fixed to 20 dB.

Parameters

ON | OFF

Example

`INP:GAIN ON`

Characteristics

*RST value: OFF

SCPI: conforming

The command is only available with the option electronic attenuator B25, preamplifier B23 and B24.

INPut<1|2>:MIXer[:POWer]

This command defines the desired power at the input mixer of the analyzer. On any change to the reference level the RF attenuation will be adjusted in a way that makes the difference between reference level and RF attenuation come as close to the desired mixer level as possible.

Parameters

<numeric value>

Example

`INP:MIX -30`

Characteristics

*RST value: -25 dBm

SCPI: device-specific

INPut<1|2>:MIXer:AUTO

This command enables/disables the automatic setup of the mixer level.

Parameters

ON | OFF

Example

`INP:MIX:AUTO ON`

Characteristics

*RST value: ON

SCPI: device-specific

INPut<1|2>:SELect

This command switches the audio input – and thus the BASEBAND mode – on (AUDio) or off (RF).

Parameters

AIQ | AUDio | RF

Example

`INP:SEL:AUD`

Characteristics

*RST value: RF

SCPI: conforming

3.6 INSTrument Subsystem

The INSTrument subsystem selects the operating mode of the unit either via text

INSTrument[:SELect

This command switches between the operating modes by means of text parameters.

Parameters

SANalyzer: Spectrum analysis
AVIonics: Avionics demodulator

Example

```
INST SAN
'Switches the instrument to SPECTRUM
```

Characteristics

*RST value: SANalyzer

SCPI: conforming

Changeover to AVIonics is only possible with option avionics demodulator FS-K15 installed.

INSTrument:NSELect

This command switches between the operating modes by means of numbers

Parameters

1: Spectrum analysis

25: Avionics analyzer

Example

```
INST:NSEL 1
'Switches the instrument to SPECTRUM
```

Characteristics

*RST value: 1

SCPI: conforming

Changeover to 25 is only possible with Avionics Analyzer FS-K15 option installed.

3.7 SENSe Subsystem

3.7.1 [SENSe:]ADEMod Subsystem

The purpose of the commands defined below is to set up the spectrum analyzer for the measurement of AM and FM modulated avionics signals in a way that allows to obtain as many measurement results as possible with a single shot measurement.

For that purpose the option K15 is been equipped with a demodulator that is capable of performing both FM and AM demodulation at a time.

Demodulation will be performed offline, that means, on signals previously stored into memory. The I/Q memory available for that purpose is 2 x 128 k samples. The sample rate can be selected in the range of 800 Hz to 25 kHz.

The signal schematic is described in the manual operation mode section of this manual.

[SENSe:]ADEMod:AF:CENTer

This command sets the center frequency for result display AF spectrum.

Parameters

<numeric_value>

Example

```
SENS:ADEM:AF:CENT 2kHz
'Sets the AF center frequency to 2 kHz
```

Characteristics

*RST value: 6.25 kHz

SCPI: compliant

[SENSe:]ADEMod:AF:SPAN

This command sets the maximum span for result display AF spectrum. . The span is limited to half the measurement bandwidth of demodulation bandwidth.

Parameters

<numeric_value>

Example

```
SENS:ADEM:AF:SPAN 2kHz
'Sets the AF span to 2 kHz
```

Characteristics

*RST value: 12.5 kHz

SCPI: compliant

[SENSe:]ADEMod:AF:SPAN:FULL

This command sets the span for result display AF spectrum The maximum span corresponds to half the demodulation bandwidth

Example

```
SENS:ADEM:AF:SPAN:FULL
'Sets the AF span to 12.5 kHz (in case of VOR)
```

Characteristics

*RST value: FULL

SCPI: compliant

[SENSe:]ADEMod:AF:STARt

This command sets the start frequency for result display AF spectrum.

Parameters

<numeric_value>

Example

```
ADEM:AF:STAR 1kHz
'Sets the AF start frequency to 1 kHz
```

Characteristics

*RST value: 0 Hz

SCPI: compliant

[SENSe:]ADEMod:AF:STOP

This command sets the stop frequency for result display AF spectrum..The stop frequency is limited to half the demodulation bandwidth.

Parameters

<numeric_value>

Example

```
ADEM:AF:STOP 1kHz
'Sets the AF stop frequency to 1 kHz
```

Characteristics

*RST value: 12.5 kHz

SCPI: compliant

[SENSe:]ADEMod:SPECtrum:BANDwidth|BWIDth[:RESolution]:

This command sets the resolution bandwidth for spectrum representation that was determined from the analog demodulation data. The recording time required is calculated from bandwidth. If the available recording time is not sufficient for the given bandwidth, the recording time is set to is maximum and the resolution bandwidth is enlarged to the resulting bandwidth.

Parameters

<numeric_value>

Example

```
SENS:ADEM:SPEC:BAND 20Hz
'Sets the RBW to 20 Hz.
```

Characteristics

*RST value: 3.8 Hz

SCPI: compliant

3.7.2 SENSe:BANDwidth Subsystem

This subsystem controls the setting of the instrument's filter bandwidths. Both groups of commands (BANDwidth and BWIDth) perform the same functions. The measurement windows are selected by SENSe1 (screen A) and SENSe2 (screen B).

[SENSe<1|2>:]BANDwidth|BWIDth:DEMod:AUTO

This command activates automatic setting of the demodulation bandwidth. The demodulation bandwidth is set as a function of the operating mode (ILS, VOR) in order to minimize the measurement error in the specified measurement range.

Parameters

ON | OFF

Example

```
SENS:BAND:DEM:AUTO OFF
```

Characteristics

*RST value: ON

SCPI: conforming

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution]

This command defines the receiver IF bandwidth or, in SPECTRUM mode, the analyzer's resolution bandwidth.
Analog resolution filters from 300 kHz to 10 MHz in 1, 3, 10 steps are available. These filters are implemented as 5-circuit LC filters in the range from 300 kHz to 10 MHz.

Parameters

<numeric_value>

Example

```
SENS:BAND 1MHz
'Sets the resolution bandwidth to 1 MHz
```

Characteristics

*RST value: - (AUTO is set to ON)

SCPI: conforming

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution]:AUTO

This command either automatically couples the resolution bandwidth of the instrument to the span or cancels the coupling. The automatic coupling adapts the resolution bandwidth to the currently set frequency according to the relationship between frequency and resolution bandwidth.

Parameters

ON | OFF

Example

SENS:BAND:AUTO OFF
'Switches off the coupling of the resolution bandwidth to the span.

Characteristics

*RST value: ON

SCPI: conforming

[SENSe<1|2>:]BANDwidth|BWIDth:DEMod

This command defines the demodulation bandwidth of the instrument for analog demodulation. The required sampling rate is automatically set depending on the selected demodulation bandwidth. The available demodulation bandwidths are determined by the selected standard (ILS, VOR).

Parameters

<numerical value>

Example

```
SENS:BAND:DEM 12.6kHz
```

Characteristics

*RST value: - (AUTO is set to ON)

SCPI: conforming

3.7.3 SENSe:FREQuency Subsystem

The SENSe:FREQuency subsystem defines the frequency-axis of the active display. The frequency-axis can either be defined via the start/stop frequency or via the center frequency and span. The measurement windows are selected by SENSe1 (screen A) and SENSe2 (screen B).

[SENSe<1|2>:]FREQuency:CENTer

This command defines the center frequency of the analyzer or the measuring frequency for span = 0.

Parameters

0 to fmax

Example

```
SENS:FREQ:CENT 100MHz
```

Characteristics

*RST value: fmax /2 with fmax = maximum frequency of the analyzer

SCPI: conforming

[SENSe<1|2>:]FREQuency:CENTer:STEP

This command defines the step width of the center frequency.

Parameters

0 to fmax

Example

```
SENS:FREQ:CENT:STEP 100MHz
```

Characteristics

*RST value: - (AUTO 0.1 x SPAN is switched on)

SCPI: conforming

[SENSe<1|2>:]FREQuency:CW:AFC

This command defines the center frequency tracking and the single signal search.

Parameters

<ONCE | ON>

Example

```
SENS:FREQ:CENT:AFC ONCE
'Starts a single signal search.
```

Characteristics

*RST value: -

SCPI: conforming

3.7.4 SENSe:SWEep Subsystem

This subsystem controls the sweep parameters. The measurement windows are selected by SENSe1 (screen A) and SENSe2 (screen B).

[SENSe<1|2>:]SWEep:COUNt

This command defines the number of sweeps started with single sweep, which are used for calculating the average or maximum value. In average mode, the value 0 defines a continuous averaging of measurement data over 10 sweeps.

Parameters

0 to 32767

Example

```
SENS:SWE:COUN 64
'Sets the number of sweeps to 64.

SENS:INIT:CONT OFF
'Switches to single-sweep mode.

SENS:INIT;*WAI
'Starts a sweep and waits for its end.
```

Characteristics

*RST value: 0

SCPI: conforming

[SENSe<1|2>:]SWEep:TIME

This command defines the measurement time. The available time values are different in the operating modes and depend on the selected demodulation bandwidth (400ms to 800s with DemodBW = 800 Hz).

Parameters

600ms... 133s

Example

```
SENS:SWE:TIME 10s
```

Characteristics

*RST value: - (AUTO is set to ON)

SCPI: conforming

[SENSe<1|2>:]SWEep:TIME:AUTO

This command controls the automatic coupling of the sweep time to the bandwidth settings.

Parameters

ON | OFF

Example

```
SENS:SWE:TIME:AUTO ON
'Switches on the coupling to bandwidths
```

Characteristics

*RST value: ON

SCPI: conforming

3.7.5 SENSe:VOLTage Subsystem

The Unit subsystem is used to switch the basic measurement unit of setting parameters. In split-screen display, a distinction is made between UNIT1 (SCREEN A) and UNIT2 (SCREEN B).

[SENSe:]VOLTage:AC:RANGe[:UPPer]

This command selects 4 V or 400 mV as the input voltage range for the audio input.

Parameters

<numeric_value>

Example

```
SENS:VOLT:AC:RANG 0.4 V
'Selects 400 mV as the input voltage range.
```

Characteristics

*RST value: 4 V

SCPI: compliant

[SENSe:]VOLTage:AC:SENSitivity

This command selects the input voltage for 100% modulation depth at the audio input.

Parameters

<numeric_value>

Example

SENS:VOLT:AC:SENS 0.1 V
'Selects 100 mV as 100% AM depth.

Characteristics

*RST value: 1 V

SCPI: compliant

3.8 UNIT Subsystem

The Unit subsystem is used to switch the basic measurement unit of setting parameters. In split-screen display, a distinction is made between UNIT1 (SCREEN A) and UNIT2 (SCREEN B).

UNIT<1|2>:DDM

This command selects the unit for ILS DDM reading.

Parameters

UNITless | PCT

Example

`UNIT:DDM PCT`

Characteristics

*RST value: UNITless

SCPI: compliant

UNIT<1|2>:THD

This command selects the unit for distortion measurements.

Parameters

DB | PCT

Example

`UNIT:THD DB`

Characteristics

*RST value: %

SCPI: compliant

3.9 Softkeys Assignment to IEC/IEEE Bus Commands

3.9.1 AVIONICS Hotkey

Softkey	Command
AVIONICS	SENSe<1|2>:]INSTrument:SELect AVIonics
VOR	CALCulate:AVIonics[:STANdard] VOR
ILS	CALCulate:AVIonics[:STANdard] ILS
DISTORTION SPECTRUM	:CALCulate:FEED 'XTIMe:SPECtrum'
DISTORTION ON OFF	CALCulate:AVIonics:SHD[:STATe] ON | OFF
DISTORTION MAX FREQ	CALCulate:AVIonics:THD:FREQuency:UPPer
DISTORTION MAN FREQ	CALCulate:AVIonics:SHD:FREQuency
THD UNIT % DB	UNIT:THD PCT
FUND FREQ 90/150 HZ	CALCulate:AVIonics:THD:FREQuency:FUNDament '90_150'
FUND FREQ 90 HZ	CALCulate:AVIonics:THD:FREQuency:FUNDament '90'
FUND FREQ 150 HZ	CALCulate:AVIonics:THD:FREQuency:FUNDament '150'
FUND FREQ IDENT	CALCulate:AVIonics:THD:FREQuency:FUNDament 'ID'
SETTINGS	---
DDM UNIT % [1]	UNIT:DDM PCT | UNITless
DISTORTION MAX FREQ	CALCulate:AVIonics:THD:FREQuency:UPPer
THD UNIT % DB	UNIT:THD PCT
FUND FREQ 90/150 HZ	CALCulate:AVIonics:THD:FREQuency:FUNDament '90_150'
FUND FREQ 90 HZ	CALCulate:AVIonics:THD:FREQuency:FUNDament '90'
FUND FREQ 150 HZ	CALCulate:AVIonics:THD:FREQuency:FUNDament '150'

FUND FREQ IDENT	CALCulate:AVIonics:THD:FREQuency:FUNDament 'ID'
BASEBAND	---
BASEBAND ON OFF	INPut1:SELect AIQ| AUDio INPut1:SELect RF
BASEBAND SENSITIVTY	SENSe1:VOLTage:AC:SENSitivity
INP LEVEL 4V 400mV	SENSe1:VOLTage:AC:RANGe[:UPPer] , 4, 0.4
INPUT IMP 1MΩ 50Ω	INPut1:IMPedance 1MOHM

3.9.2 FREQ Key

FREQ

CENTER	[SENSe:]FREQuency:CENTer <num_value>
CF-STEPSIZE	
MANUAL	[SENSe:]FREQuency:CENTer:STEP 50 kHz
SINGLE AUTOTUNE	SENS:FREQ:CW:AFC ONCE
SIGNAL TRACK	SENS:FREQ:CW:AFC ON
AF CENTER	SENS:ADEM:AF:CENT 1KHZ
AF START	SENS:ADEM: AF:STAR 0HZ
AF STOP	SENS:ADEM: AF:STOP 2KHZ

3.9.3 SPAN Key

SPAN

FULL SPAN	ADEM:AF:SPAN:FULL
SPAN MANUAL	ADEM:AF:SPAN 2.5 kHz

3.9.4 AMPL Key

Softkey	Command
AMPT	
REF LEVEL	`DISPlay[:WIND:TRAC:Y[:SCALe]:RLEVel <num_value>`
RF LEVEL AUTORANGE	`DISP:WIND:TRAC:Y:RLEV:AUTO ON`
AUTORANGE CONFIG	---
10 DB MIN ON OFF	`INP:ATT:PROT ON`
AUTOPREAMP ON OFF	`INP:GAIN:AUTO ON`
RANGE	
REFERENCE POSITION	`DISP:WIND:TRAC:Y:RPOS 50PCT`
REFERENCE VALUE	`DISP:WIND:TRAC:Y:RVAL 100PCT`
DEVIATION LIN LOG	`DISP:WIND:TRAC:Y:SPAC LOG`
dB PER DIV	`DISP:WIND:TRAC:Y:PDIV 5DB`
RF INPUT AC DC	`INP:COUP AC`
RF ATTEN MANUAL	`INPut:ATTenuation <num_value>`
RF ATTEN AUTO	`INPut:ATTenuation:AUTO ON`
MIXER	
MIXER LVL AUTO	`INPut<1|2>:MIXer:AUTO ON`
MIXER LVL MANUAL	`INPut<1|2>[:POWer]:MIXer <num_value>`
RF INPUT 50Ω 75Ω	`INPut:IMPedance 50 | 75`

3.9.5 BW Key

BW

DEMOD BW AUTO
[SENSe:]BANDwidth|BWIDth:DEMod:AUTO ON

DEMOD BW MANUAL
[SENSe:]BANDwidth|BWIDth:DEMod:AUTO OFF
[SENSe:]BANDwidth|BWIDth:DEMod <num_value>

IF BW AUTO
[SENSe:]BANDwidth|BWIDth[:RESolution]:AUTO ON

IF BW MANUAL
[SENSe:]BANDwidth|BWIDth:AUTO OFF
[SENSe:]BANDwidth|BWIDth[:RESolution] <num_value>

MEAS TIME AUTO
[SENSe:]SWEep:TIME:AUTO ON

MEAS TIME MANUAL
[SENSe:]SWEep:TIME:AUTO OFF
[SENSe:]SWEep:TIME <num_value>

RES BW MANUAL
[SENSe:]ADEM:SPEC:BAND:RES 10 Hz]

3.9.6 SWEEP Key

CONTINUOUS SWEEP
INITiate<1|2>:CONTinuous ON

SINGLE SWEEP
INITiate<1|2>:CONTinuous OFF
INITiate<1|2>[:IMMediate]

MEAS TIME AUTO
[SENSe:]SWEep:TIME:AUTO ON | OFF

MEAS TIME MANUAL
[SENSe:]SWEep:TIME <num_value>

SGL SWEEP DISP OFF
INITiate:DISPlay OFF
INITiate:IMMediate

4 Performance Test

4.1 Test Instructions

The rated specifications of the analyzer are tested after a warm-up time of at least 30 minutes and complete internal calibration.
Starting of internal calibration: [***CAL*** *: CAL TOTAL*]

- If nothing else is specified, all measurements will be done with **external reference frequency**.
- Values given in the following sections are not guaranteed. Only the technical specifications of the data sheet are binding.
- The values given in the datasheet are the guaranteed limits. Due to measurement uncertainties these limits must be extended by the tolerance of the measuring equipment used in this performance test.
- Inputs for settings during measurements are shown as follows:

[<KEY>]	Press a key on the front panel, e.g**. [SPAN**]
[<SOFTKEY>]	Press a softkey, e.g. [MARKER -> PEAK]
[<nn unit>]	Enter a value and terminate by entering the unit, e.g. **[12 kHz]**

Successive entries are separated by [:], e.g. [**BW** : RES BW MANUAL : **3 kHz**]

Test Files for Arbitrary Waveform Generator R&S AMIQ

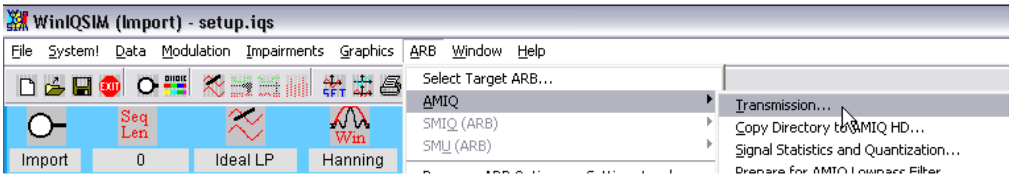
Most of the modulation test signals must be generated using an Arbitrary Waveform Generator in order to attain the requisite accuracy and other characteristics.

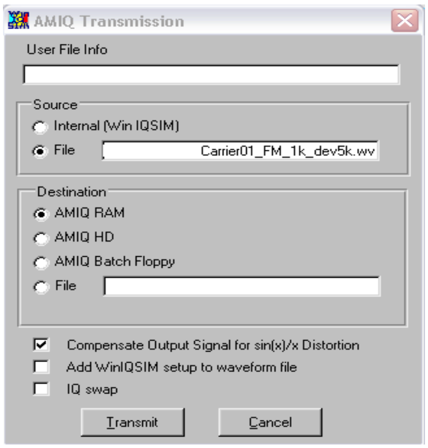
Suitable files for the R&S AMIQ can be downloaded from GLORIS (https://gloris.rohde-schwarz.com/):

Firmware/Software → Software → R&S FSMR → **Modulation Test Files K15**

A convenient method to transfer the files into the AMIQ is to use WinIQSIM, also available from GLORIS:

Firmware/Software → Software → **WinIQSIM**





4.2 Measuring Equipment and Accessories

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S Order No.	Use
1	Arbitrary Waveform Generator	Flat Bandwidth >13MHz Programmable Sampling Rate up to 60 MHz Memory depth ≥ 1.2 M Samples 14 Bit Resolution SFDR > 70 dB @ 0dBm into 50Ω External Reference Freq. Input 2 sinusoidal signals with 90 deg phase difference	AMIQ	1110.2003.04	Audio Input Frequency Counter Uncertainty AM: Modulation Depth Uncertainty FM Deviation Uncertainty
2	WinIQSIM	PC test program for AMIQ			.

Measuring hints

The phase readings on the screen of the VOR/ILS demodulator are limited to a unique range. In VOR mode the default measurement range is 0 to 360 degree, in ILS mode the range is -60 to +60 degree.
Due to this discontionous phase range a reading of 359.98 degree is equal to -0.02 degree.
In the performance test of this demodulator unique phase ranges are used as limits. Example:In the VOR test a measurement at 0 degree VOR phase is performed. The test limit in this case is defined from -0.03 degree to + 0.03 degree.

Due to the discontionous phase range a negative reading of -0.03 degree will not be displayed. The displayed reading of 359.97 degree is equal to -0.03 degree.

The phase readings outside of the continuous range have to be adjusted before the value is checked against the limit

4.3 Performance Test FS-K15

4.3.1 Checking the ILS Demodulation (AM)

The test of the ILS demodulator is performed on several test signals with variation of the following parameters: Modulation depth = 18% to 48 % (covering Localizer and Glideslope ranges), Freq(ID) = 300 Hz to 3990 Hz (to test the full bandwidth of the identifier channel), DDM = 0 to ±0,4 (center to maximum deviation from center), Phase 0 to 59° (to test nonlinearities of the demodulator), Modulation frequency +1% (to test the selectivity).

Test 1 Standard ILS Glideslope Signal, DDM = 0, no distortion

Signal 1 ILS Glideslope, m = 48%

File ILS_AM_ph0_m48_DDM0.WV

	AM		**Frequency**
90 Hz	48 %		90 Hz
150 Hz	48 %		150 Hz
Identifier	10 %		1020 Hz
	DDM	**Phase**	**THD**
90/150 Hz	0	0°	0 %

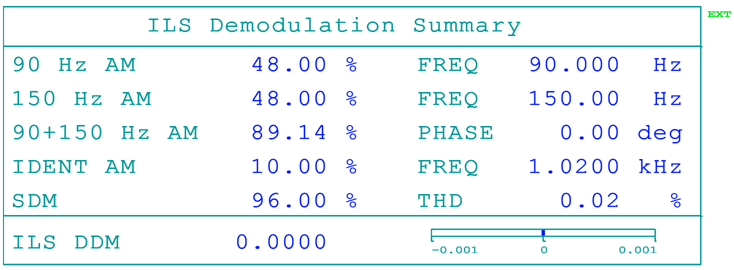
Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.
When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a ILS amplitude modulated carrier. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:
File ILS_AM_ph0_m48_DDM0.WV

Measurement: Read the indications:
90 Hz AM depth and frequency, 150 Hz AM depth and frequency
ID AM depth and frequency, DDM, 90/150 Hz phase and THD



Test 2 ILS Localizer Signal, DDM = 0, distortion meter and ID low frequency test

Signal 2 Localizer m = 18%, fid = 300 Hz

File ILS_AM_ph0_m18_DDM0_fid03.WV

	AM		Frequency
90 Hz	18 %		90 Hz
150 Hz	18 %		150 Hz
Identifier	10 %		300 Hz
	DDM	Phase	THD
90/150 Hz	0	0°	55.56 %

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

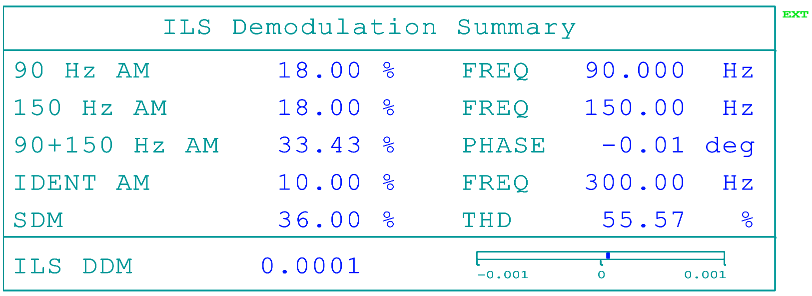
Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a ILS amplitude modulated carrier with a peak level of 0 dBm. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:
File ILS_AM_ph0_m18_DDM0_fid03.WV

Measurement: Read the indications:
90 Hz AM depth and frequency
150 Hz AM depth and frequency
ID AM depth and frequency
DDM, 90/150 Hz phase and THD



Test 3 ILS Localizer Signal, DDM = 0, Phase =45°, ID high frequency test

Signal 3 Localizer, phase 45°, fid = 3990 Hz

File ILS_AM_ph45_m20_DDM0_fid40.WV

	AM		Frequenz
90 Hz	20 %		90 Hz
150 Hz	20 %		150 Hz
Identifier	10 %		3990 Hz
	DDM	Phase	THD
90/150 Hz	0	45°	0 %

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:

[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a ILS amplitude modulated carrier with a peak level of 0 dBm. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File ILS_AM_ph45_m20_DDM0_fid40.WV

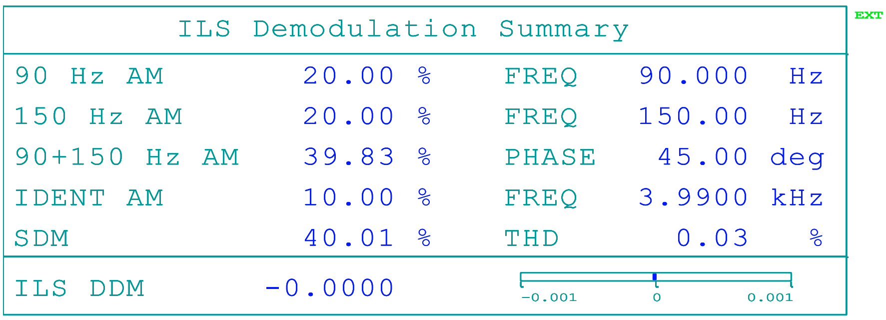
Measurement: Read the indications:

90 Hz AM depth and frequency

150 Hz AM depth and frequency

ID AM depth and frequency

DDM, 90/150 Hz phase and THD



Test 4 Standard ILS Localizer Signal, DDM = 0.2 , (DDM test)

Signal 4 Localizer, DDM = 0.2

File ILS_AM_ph0_m20_DDM02.WV

	AM		Frequency
90 Hz	30 %		90 Hz
150 Hz	10 %		150 Hz
Identifier	10 %		1020 Hz
	DDM	Phase	THD
90/150 Hz	0.2	0°	0 %

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a ILS amplitude modulated carrier with a peak level of 0 dBm. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File ILS_AM_ph0_m20_DDM02.WV

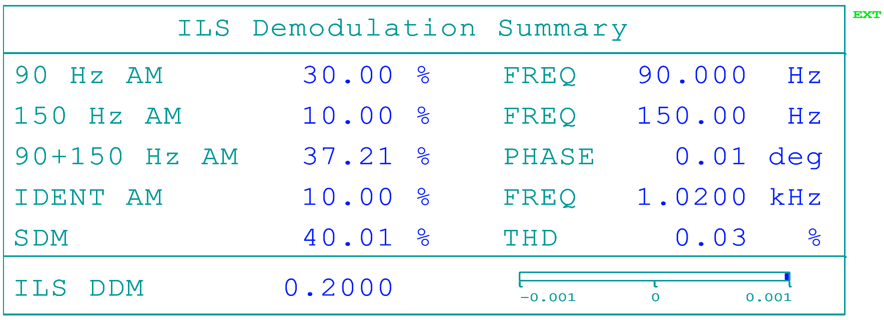
Measurement: Read the indications:

90 Hz AM depth and frequency

150 Hz AM depth and frequency

ID AM depth and frequency

DDM, 90/150 Hz phase and THD



Test 5 ILS Localizer Signal, DDM = -0.2 , Phase = -30° (DDM test at different phase)

Signal 5 Localizer, DDM = -0.2, phase = -30°

File ILS_AM_ph-30_m20_DDM-02.WV

	AM		Frequency
90 Hz	10 %		90 Hz
150 Hz	30 %		150 Hz
Identifier	10 %		1020 Hz
	DDM	Phase	THD
90/150 Hz	-0.2	-30°	0 %

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a ILS amplitude modulated carrier with a peak level of 0 dBm. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File ILS_AM_ph-30_m20_DDM-02.WV

Measurement: Read the indications:

90 Hz AM depth and frequency

150 Hz AM depth and frequency

ID AM depth and frequency

DDM, 90/150 Hz phase and THD

ILS Demodulation Summary						EXT
90 Hz AM	10.00	%	FREQ	90.000	Hz	
150 Hz AM	30.00	%	FREQ	150.00	Hz	
90+150 Hz AM	39.57	%	PHASE	-30.00	deg	
IDENT AM	10.00	%	FREQ	1.0200	kHz	
SDM	40.01	%	THD	0.04	%	
ILS DDM	-0.2000		-0.001	0	0.001	

Test 6 Standard ILS Glideslope Signal, DDM = 0.4 (Glideslope DDM test)

Signal 6 Glideslope, DDM = 0.4

File ILS_AM_ph0_m40_DDM04.WV

	AM		Frequency
90 Hz	60 %		90 Hz
150 Hz	20 %		150 Hz
Identifier	10 %		1020 Hz
	DDM	Phase	THD
90/150 Hz	0.4	0°	0 %

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a ILS amplitude modulated carrier with a peak level of 0 dBm. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File ILS_AM_ph0_m40_DDM04.WV

Measurement: Read the indications:

90 Hz AM depth and frequency

150 Hz AM depth and frequency

ID AM depth and frequency

DDM, 90/150 Hz phase and THD

ILS Demodulation Summary					EXT
90 Hz AM	60.00 %	FREQ	90.000	Hz	
150 Hz AM	20.00 %	FREQ	150.00	Hz	
90+150 Hz AM	74.40 %	PHASE	0.01	deg	
IDENT AM	10.00 %	FREQ	1.0200	kHz	
SDM	80.00 %	THD	0.02	%	
ILS DDM	0.4001	-0.001	0	0.001	

Test 7 ILS Glideslope Signal, DDM = -0.4 , Phase = 59° , Frequency offset 1%

Signal 7 Glideslope, DDM = -0.4, Frequency offset +1%, Phase 59°

Receiver Frequency = 12.12 MHz !

File ILS_AM_ph59_m40_DDM-04_offset01.WV

	AM		Frequency
90 Hz	20 %		90.9 Hz
150 Hz	60 %		151.5 Hz
Identifier	10 %		1030.2 Hz
	DDM	Phase	THD
90/150 Hz	-0.4	59°	0 %

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12.12 MHz**]
[AVIONICS : ILS]
[SWEEP : MEAS TIME MANUAL 2 s]

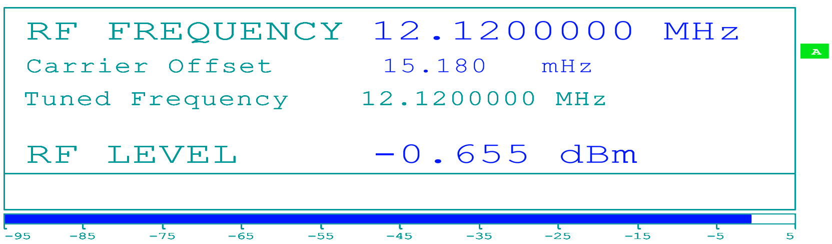
Signal Generator Settings: Generate a ILS amplitude modulated carrier with a peak level of 0 dBm. Set carrier frequency, modulation frequency and depth as listed in the table. 4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

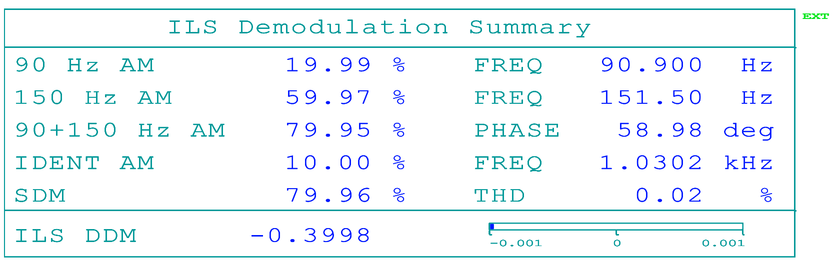
File ILS_AM_ph59_m40_DDM-04_offset01.WV

Measurement: Read the indications:

90 Hz AM depth and frequency, 150 Hz AM depth and frequency

ID AM depth and frequency, DDM, 90/150 Hz phase and THD





4.3.2 Checking the VOR Demodulation (AM, FM)

The test of the VOR demodulator is performed on several test signals with variation of the following parameters:
Modulation depth = 10% to 40 % (30 Hz, 9.96 kHz), Freq(ID) = 300 Hz to 3990 Hz (to test the full bandwidth of the identifier channel), 9.96 kHz carrier with frequency deviation = 200 to 700 Hz, VOR phase 0 to 360°, modulation frequency +1% (to test the selectivity).

Test 1 Standard VOR Signal, VOR phase = 0°, no distortion

Signal 1 Standard VOR
File VOR_AM_ph0_m30_dev480.WV

	AM (depth)	Frequency
30 Hz	30 %	30 Hz
9960 Hz	30 %	9960 Hz
Identifier	10 %	1020 Hz
9960 Hz	FM (deviation)	480 Hz
30/30 Hz	Azimuth	0°

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.
When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : VOR]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a VOR amplitude modulated carrier with a peak level of 0 dBm.
Set carrier frequency, modulation frequency and depth as listed in the table.
4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

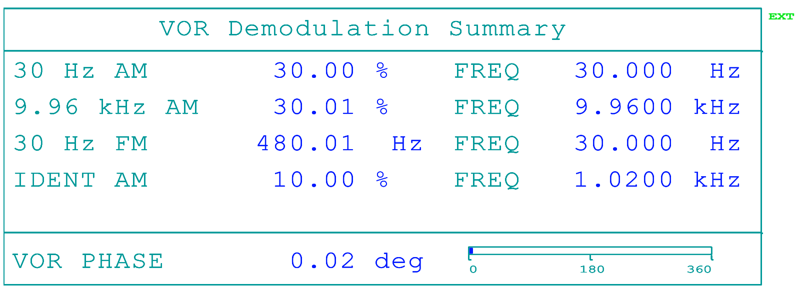
File VOR_AM_ph0_m30_dev480.WV

Measurement: Read the indications:

30 Hz AM depth and frequency, 9.96 kHz AM depth and frequency

30 Hz FM deviation and frequency, ID AM depth and frequency

VOR Phase



Test 2 VOR Signal, low AM depth, Freq(ID) 300 Hz, ID low frequency test

Signal 2 m = 10%, frequency(Id) = 300 Hz

File VOR_AM_ph0_m10_dev480_fid03.WV

	AM (depth)	Frequency
30 Hz	10 %	30 Hz
9960 Hz	10 %	9960 Hz
Identifier	10 %	300 Hz
9960 Hz	FM (deviation)	480 Hz
30/30 Hz	Azimuth	0°

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : VOR]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a VOR amplitude modulated carrier with a peak level of 0 dBm.
Set carrier frequency, modulation frequency and depth as listed in the table.
4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File VOR_AM_ph0_m10_dev480_fid03.WV

Measurement: Read the indications:

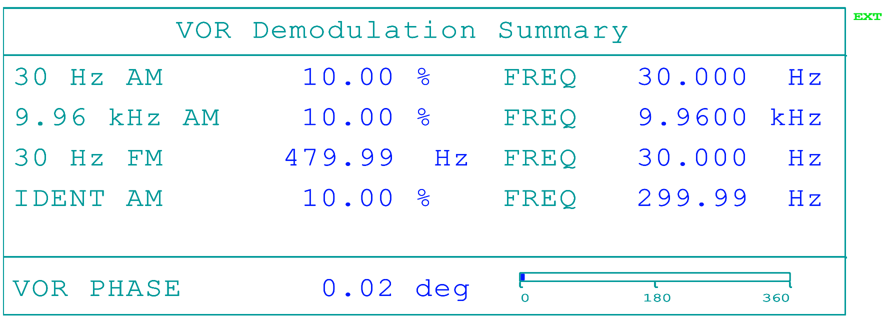
30 Hz AM depth and frequency

9.96 kHz AM depth and frequency

30 Hz FM deviation and frequency

ID AM depth and frequency

VOR Phase, THD (30)



Test 3 VOR, high AM depth, high deviation, ID high freq. test, Phase 350°

Signal 3 m = 40%, fid = 3990 Hz, dev = 700 Hz, Azimuth =350°

File VOR_AM_ph350_m40_dev700_fid40.WV

	AM (depth)	Frequency
30 Hz	40 %	30 Hz
9960 Hz	40 %	9960 Hz
Identifier	10 %	3990 Hz

9960 Hz	FM (deviation)	700 Hz
30/30 Hz	Azimuth	350°

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : VOR]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a VOR amplitude modulated carrier with a peak level of 0 dBm.
Set carrier frequency, modulation frequency and depth as listed in the table.
4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File VOR_AM_ph350_m40_dev700_fid40.WV

Measurement: Read the indications:

30 Hz AM depth and frequency

9.96 kHz AM depth and frequency

30 Hz FM deviation and frequency,

ID AM depth and frequency

VOR Phase

VOR Demodulation Summary			
30 Hz AM	39.99 %	FREQ	30.000 Hz
9.96 kHz AM	39.47 %	FREQ	9.9600 kHz
30 Hz FM	699.61 Hz	FREQ	30.000 Hz
IDENT AM	10.01 %	FREQ	3.9900 kHz
VOR PHASE	350.02 deg	0 180 360	

EXT

Test 4 Standard VOR Signal, VOR phase = 45°, no distortion

Signal 4 Azimuth = 45°

File VOR_AM_ph45_m30_dev480.WV

	AM (depth)	Frequency
30 Hz	30 %	30 Hz
9960 Hz	30 %	9960 Hz
Identifier	10 %	1020 Hz
9960 Hz	FM (deviation)	480 Hz
30/30 Hz	Azimuth	45°

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : VOR]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a VOR amplitude modulated carrier with a peak level of 0 dBm.
Set carrier frequency, modulation frequency and depth as listed in the table.
4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File VOR_AM_ph45_m30_dev480.WV

Measurement: Read the indications:

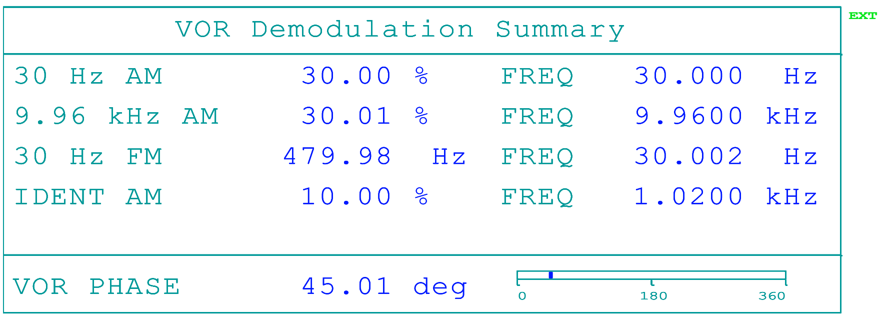
30 Hz AM depth and frequency

9.96 kHz AM depth and frequency

30 Hz FM deviation and frequency

ID AM depth and frequency

VOR Phase



Test 5 VOR Signal, VOR phase = 271°, low deviation (200 Hz)

Signal 5 Azimuth = 271°, Deviation 200 Hz

File VOR_AM_ph271_m30_dev200.WV

	AM (depth)	Frequency
30 Hz	30 %	30 Hz
9960 Hz	30 %	9960 Hz
Identifier	10 %	1020 Hz
9960 Hz	FM (deviation)	200 Hz
30/30 Hz	Azimuth	271°

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : VOR]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a VOR amplitude modulated carrier with a peak level of 0 dBm.
Set carrier frequency, modulation frequency and depth as listed in the table.
4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File VOR_AM_ph271_m30_dev200.WV

Measurement: Read the indications:

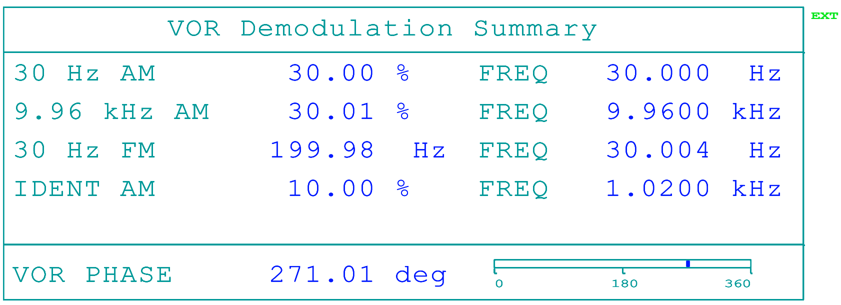
30 Hz AM depth and frequency

9.96 kHz AM depth and frequency

30 Hz FM deviation and frequency

ID AM depth and frequency

VOR Phase



Test 6 VOR Signal, VOR phase = 180.1°, frequency offset 1%

Signal 6 Azimuth = 180.1°, Frequency offset +1%

Receiver Frequency = 12.12 MHz

File VOR_AM_ph180_m30_dev480_offset01.WV

	AM (depth)	Frequency
30 Hz	30 %	30.3 Hz
9960 Hz	30 %	10059.6 Hz
Identifier	10 %	1030.2 Hz
9960 Hz	FM (deviation)	480 Hz
30/30 Hz	Azimuth	180.1°

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the RF Input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[**AMPT** : REF LEVEL : **5 dBm**]
[**FREQ** : RECEIVER FREQUENCY : **12 MHz**]
[AVIONICS : VOR]
[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings:
Generate a VOR amplitude modulated carrier with a peak level of 0 dBm.
Set carrier frequency, modulation frequency and depth as listed in the table.
4x oversampling (4x carrier frequency) is recommended.
When using the R&S AMIQ download the listed files into the AMIQ:

File VOR_AM_ph180_m30_dev480_offset01.WV

Measurement: Read the indications:

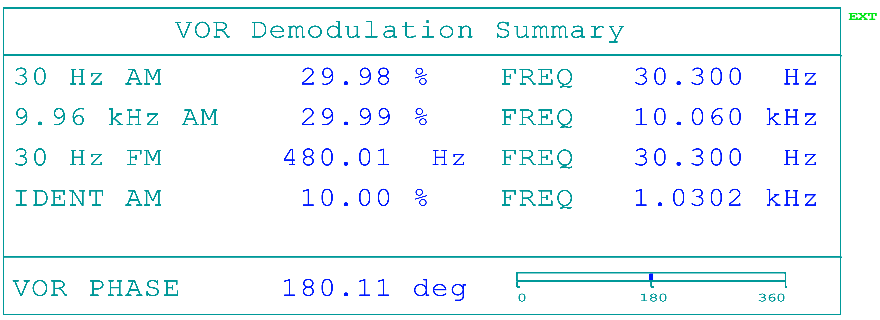
30 Hz AM depth and frequency

9.96 kHz AM depth and frequency

30 Hz FM deviation and frequency

ID AM depth and frequency

VOR Phase



4.3.3 Checking the Audio Input Characteristics (only in case of FSMR and FSQ-B71)

The Baseband input absolute level readings are not calibrated in this section. In the ILS test the absolute level has an influence on the DDM readings. Therefore the baseband sensitivity setting must be corrected in case of any attenuation between the ARB generator and the instruments input connector.
Example: Adjust the baseband sensitivity for ILS test case 1 accordingly that the 90Hz and 150 Hz AM reading is 20.00 % and use this value in all subsequent tests.

Test 1 VOR Frequency and FM Deviation

The test is performed with VOR baseband signals from the AMIQ.
Nominal deviation of 480 Hz and Phase: 0°, 50°, 180°, 300°
Filename: VOR_baseband_ph.wv, where ph is the phase in degree

Test are performed on frequency and deviation readings only.
AM modulation depth is depending on the absolute level accuracy and baseband sensitivity entry.
The test of the absolute level accuracy of the baseband input is part of the instrument calibration.

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the audio or baseband “I” input of the instrument.

When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[AVIONICS : VOR]
FSMR:
- [AVIONICS : BASEBAND ON]
- [AVIONICS : BASEBAND : MAX LEVEL : 4 Volt]
- [AVIONICS : BASEBAND : INP IMP : 50 Ohm]
- [AVIONICS : BASEBAND : SENSITIVTY : 0.833 V]

FSQ with FSQ-B71:
- [AVIONICS : BASEBAND : BASEBAND ANALOG]
- [AVIONICS : BASEBAND : I/Q INPUT : 50 Ohm]
- [AVIONICS : BASEBAND : BALANCED OFF]
- [AVIONICS : BASEBAND : SENSITIVTY : 0.833 V]

[SWEEP : MEAS TIME MANUAL 2 s]

Signal Generator Settings: Generate a VOR carrier with the described parameters.
When using the R&S AMIQ download the listed files into the AMIQ:

File 1	VOR_baseband_0.wv
File 2	VOR_baseband_50.wv
File 3	VOR_baseband_180.wv
File 4	VOR_baseband_300.wv

Measurement: Read the indications from the FS-K15:
30 Hz FM deviation and frequency
Specification:
Deviation: 480 Hz ± 0.5 % (= ± 2.4 Hz)

Test 2 ILS DDM

The test of the ILS demodulator is performed on several test signals from the AMIQ with variation of the following parameters:

Modulation depth = 20% / 40 % (Localizer/Glideslope), DDM = 0, ± 0.2 and ± 0.4, Phase 0/-45°/30°.

Test are performed on DDM readings only.

AM modulation depth is depending on the absolute level accuracy and baseband sensitivity entry. The test of the absolute level accuracy of the baseband input is part of the instrument calibration.

Modulation depth	20%	20%	20%
DDM	0	0.2	-0.2
Phase	0°	0°	0°

Modulation depth	40%	40%	40%	40%	40%	40%
DDM	0	0.4	-0.4	0	0.4	0
Phase	0°	0°	0°	-45°	-45°	30°

Filename example: ILS_baseband_ph0_m40_DDM-04.WV (equals to Phase 0°, m=40%, DDM = -0,4)

Test Equipment: Arbitrary Waveform Generator (Section "Measuring Equipment", item 0)

Test Setup: Connect the Signal Generator to the audio or baseband "I" input of the instrument.
When using the R&S AMIQ the "I" output must be used.

Instrument Settings:
[**PRESET**]
[AVIONICS MODE]
[AVIONICS : ILS]
FSMR:[AVIONICS : BASEBAND ON]
[AVIONICS : BASEBAND : INP LEVEL : 4 Volt]
[AVIONICS : BASEBAND : INP IMP : 50 Ohm]
[AVIONICS : BASEBAND : SENSITIVTY : 0.5 V]
FSQ with FSQ-B71:
[AVIONICS : BASEBAND : BASEBAND ANALOG]
[AVIONICS : BASEBAND : I/Q INPUT : 50 Ohm]
[AVIONICS : BASEBAND : BALANCED OFF]
[AVIONICS : BASEBAND : SENSITIVTY : 0.5 V]

Signal Generator Settings: Generate a ILS carrier with the described parameters.
When using the R&S AMIQ download the listed files into the AMIQ:
Tests for ILS DDM and Phase:

Test 1	ILS_baseband_ph0_m20_DDM0.WV
Test 2	ILS_baseband_ph0_m20_DDM02.WV
Test 3	ILS_baseband_ph0_m20_DDM-02.WV
Test 4	ILS_baseband_ph0_m40_DDM0.WV
Test 5	ILS_baseband_ph0_m40_DDM04.WV
Test 6	ILS_baseband_ph0_m40_DDM-04.WV
Test 7	ILS_baseband_ph-45_m40_DDM0.WV
Test 8	ILS_baseband_ph-45_m40_DDM04.WV
Test 9	ILS_baseband_ph30_m40_DDM0.WV

Measurement: Read the indications from the FS-K15: ILS DDM
Specification:
Glide Slope 32-48 %: 0.0004 DDM ± 1% of rdg. (FSQ-B71: 3.5%)
Localizer 18-22 %: 0.0002 DDM ± 1% of rdg. (FSQ-B71: 3.5%)

4.4 Performance Test Report FS-K15

Table 4-1: Performance Test report

ROHDE & SCHWARZ Performance Test Report Avionics Demodulator FS-K15 Version: 07. Oct 2008

Order number: 1302.0936.02:

Serial number:

Test person:

Date:

Signature:

Characteristic	Ref.	Min. value	Actual value	Max. value	Unit	Tolerance
ILS Demodulation						
Test 1	Page 73					
90 Hz AM Depth		47,808	________	48,192	%	
90 Hz Frequency		89,9982	________	90,0018	Hz	
150 Hz AM Depth		47,808	________	48,192	%	
150 Hz Frequency		149,997	________	150,003	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		1019,98	________	1020,02	Hz	
DDM reading		-0,0004	________	0,0004	[1]	
ILS Phase 90/150 Hz		-0,03	________	0,03	degree	
Harmonic Distortion			________	0,1	%	
Test 2	Page 74					
90 Hz AM Depth		17,928	________	18,072	%	
90 Hz Frequency		89,9982	________	90,0018	Hz	
150 Hz AM Depth		17,928	________	18,072	%	
150 Hz Frequency		149,997	________	150,003	Hz	
ID Modulation Depth		9,96	________	10,04	%	
ID Frequency		299,994	________	300,006	Hz	
DDM reading		-0,0002	________	0,0002	[1]	
ILS Phase 90/150 Hz		-0,03	________	0,03	degree	
Harmonic Distortion		55,2	________	56	%	
Test 3	Page 75					
90 Hz AM Depth		19,92	________	20,08	%	
90 Hz Frequency		89,9982	________	90,0018	Hz	
150 Hz AM Depth		19,92	________	20,08	%	
150 Hz Frequency		149,997	________	150,003	Hz	
ID Modulation Depth		9,96	________	10,04	%	
ID Frequency		3989,921	________	3990,079	Hz	
DDM reading		-0,0002	________	0,0002	[1]	
ILS Phase 90/150 Hz		44,97	________	45,03	degree	

Characteristic	Ref.	Min. value	Actual value	Max. value	Unit	Tolerance
Harmonic Distortion			________	0,1	%	
Test 4	Page 76					
90 Hz AM Depth		29,88	________	30,12	%	
90 Hz Frequency		89,9982	________	90,0018	Hz	
150 Hz AM Depth		9,96	________	10,04	%	
150 Hz Frequency		149,997	________	150,003	Hz	
ID Modulation Depth		9,96	________	10,04	%	
ID Frequency		1019,98	________	1020,02	Hz	
DDM reading		0,1994	________	0,2006	[1]	
ILS Phase 90/150 Hz		-0,03	________	0,03	degree	
Harmonic Distortion			________	0,1	%	
Test 5	Page 77					
90 Hz AM Depth		9,96	________	10,04	%	
90 Hz Frequency		89,9982	________	90,0018	Hz	
150 Hz AM Depth		29,88	________	30,12	%	
150 Hz Frequency		149,997	________	150,003	Hz	
ID Modulation Depth		9,96	________	10,04	%	
ID Frequency		1019,98	________	1020,02	Hz	
DDM reading		-0,2006	________	-0,1994	[1]	
ILS Phase 90/150 Hz		-30,03	________	-29,97	degree	
Harmonic Distortion			________	0,1	%	
Test 6	Page 78					
90 Hz AM Depth		59,76	________	60,24	%	
90 Hz Frequency		89,9982	________	90,0018	Hz	
150 Hz AM Depth		19,92	________	20,08	%	
150 Hz Frequency		149,997	________	150,003	Hz	
ID Modulation Depth		9,96	________	10,04	%	
ID Frequency		1019,98	________	1020,02	Hz	
DDM reading		0,3988	________	0,4012	[1]	
ILS Phase 90/150 Hz		-0,03	________	0,03	degree	
Harmonic Distortion			________	0,1	%	
Test 7	Page 79					
90 Hz AM Depth		19,92	________	20,08	%	
90 Hz Frequency		90,89818	________	90,90182	Hz	
150 Hz AM Depth		59,76	________	60,24	%	
150 Hz Frequency		151,497	________	151,503	Hz	
ID Modulation Depth		9,96	________	10,04	%	
ID Frequency		1030,18	________	1030,22	Hz	
DDM reading		-0,4012	________	-0,3988	[1]	

Characteristic	Ref.	Min. value	Actual value	Max. value	Unit	Tolerance
ILS Phase 90/150 Hz		58,97	________	59,03	degree	
Harmonic Distortion			________	0,1	%	
VOR Demodulation						
Test 1	Page 80					
30 Hz AM Depth		29,85	________	30,15	%	
30 Hz Frequency		29,9994	________	30,0006	Hz	
9960 Hz AM Depth		29,85	________	30,15	%	
9960 Hz Frequency		9959,801	________	9960,199	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		1019,98	________	1020,02	Hz	
30 Hz FM Deviation		477,5	________	482,5	[1]	
VOR Phase 30/30 Hz		-0,03	________	0,03	degree	
Harmonic Distortion			________	0,1	%	
Test 2	Page 81					
30 Hz AM Depth		9,95	________	10,05	%	
30 Hz Frequency		29,9994	________	30,0006	Hz	
9960 Hz AM Depth		9,95	________	10,05	%	
9960 Hz Frequency		9959,801	________	9960,199	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		299,994	________	300,006	Hz	
30 Hz FM Deviation		477,5	________	482,5	[1]	
VOR Phase 30/30 Hz		-0,03	________	0,03	degree	
Harmonic Distortion		90	________	110	%	
Test 3	Page 82					
30 Hz AM Depth		39,8	________	40,2	%	
30 Hz Frequency		29,9994	________	30,0006	Hz	
9960 Hz AM Depth		39,8	________	40,2	%	
9960 Hz Frequency		9959,801	________	9960,199	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		3989,921	________	3990,079	Hz	
30 Hz FM Deviation		696,4	________	703,6	[1]	
VOR Phase 30/30 Hz		349,97	________	350,03	degree	
Harmonic Distortion			________	0,1	%	

Characteristic	Ref.	Min. value	Actual value	Max. value	Unit	Tolerance
Test 4	Page 83					
30 Hz AM Depth		29,85	________	30,15	%	
30 Hz Frequency		29,9994	________	30,0006	Hz	
9960 Hz AM Depth		29,85	________	30,15	%	
9960 Hz Frequency		9959,801	________	9960,199	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		1019,98	________	1020,02	Hz	
30 Hz FM Deviation		477,5	________	482,5	[1]	
VOR Phase 30/30 Hz		44,97	________	45,03	degree	
Harmonic Distortion			________	0,1	%	
Test 5	Page 84					
30 Hz AM Depth		29,85	________	30,15	%	
30 Hz Frequency		29,9994	________	30,0006	Hz	
9960 Hz AM Depth		29,85	________	30,15	%	
9960 Hz Frequency		9959,801	________	9960,199	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		1019,98	________	1020,02	Hz	
30 Hz FM Deviation		198.9	________	201.1	[1]	
VOR Phase 30/30 Hz		270,97	________	271,03	degree	
Harmonic Distortion			________	0,1	%	
Test 6	Page 85					
30 Hz AM Depth		29,85	________	30,15	%	
30 Hz Frequency		30,29940	________	30,3006	Hz	
9960 Hz AM Depth		29,85	________	30,15	%	
9960 Hz Frequency		10059,40	________	10059,80	Hz	
ID Modulation Depth		9,9	________	10,1	%	
ID Frequency		1030,180	________	1030,220	Hz	
30 Hz FM Deviation		477,5	________	482,5	[1]	
VOR Phase 30/30 Hz		180,07	________	180,13	degree	
Harmonic Distortion			________	0,1	%	

Table 4-2 Checking FSMR Audio Input (only with FSMR)

Characteristic	Target value	Min. value	Actual value	Max. value	Unit	Tolerance
Test 1: VOR Phase and FM Deviation	Page 86					
30 Hz AM Frequency		29.9994	________	30.0006	Hz	
9960 Hz Frequency		9959.801	________	9960.199	Hz	
30 Hz FM Deviation		477.5	________	482.5	Hz	
30 Hz FM Frequency		29.9994	________	30.0006	Hz	
Phase 0 degree		-0.03	________	+0.03	degree	
Phase 50 degree		48.97°	________	50.03°	degree	
Phase 180 degree		179.97	________	180.03	degree	
Phase 300 degree		299.97	________	300.03	degree	
ILS Demodulation	Page 87					
Test 1: LOC/ 0.0 / 0°						
DDM reading		-0.0002	________	0.0002		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 2: LOC/ 0.2 / 0°			________			
DDM reading		0.1978	________	0.2022		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 3: LOC/ -0.2 / 0°			________			
DDM reading		-0.2022	________	-0.1978		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 4: GS/ 0.0 / 0°			________			
DDM reading		-0.0004	________	0.0004		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 5: GS/ 0.4 / 0°			________			
DDM reading		0.3956	________	0.4044		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 6: GS/ -0.4 / 0°			________			
DDM reading		-0.4044	________	-0.3956		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 7: GS/ 0.0 / -45°			________			
DDM reading		-0.0004	________	0.0004		
ILS Phase 90/150 Hz		-45.2	________	-44.8	degree	
Test 8: GS/ 0.4 / -45°			________			
DDM reading		0.3956	________	0.4044		
ILS Phase 90/150 Hz		-45.2	________	-44.8	degree	
Test 9: GS/ 0.0 / 30°			________			
DDM reading		-0.0004	________	0.0004		
ILS Phase 90/150 Hz		29.8	________	30.2	degree	

Table 4-3: Checking FSQ-B71 Baseband Input (only with FSQ and FSQ-B71)

Characteristic	Target value	Min. value	Actual value	Max. value	Unit	Tolerance
Test 1: VOR Phase	Page 86					
and FM Deviation						
30 Hz AM Frequency		29.9994	________	30.0006	Hz	
9960 Hz Frequency		9959.801	________	9960.199	Hz	
30 Hz FM Deviation		477.5	________	482.5	Hz	
30 Hz FM Frequency		29.9994	________	30.0006	Hz	
Phase 0 degree		-0.03	________	+0.03	degree	
Phase 50 degree		48.97°	________	50.03°	degree	
Phase 180 degree		179.97	________	180.03	degree	
Phase 300 degree		299.97	________	300.03	degree	
ILS Demodulation	Page 87					
Test 1: LOC/ 0.0 / 0°						
DDM reading		-0.0002	________	0.0002		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 2: LOC/ 0.2 / 0°			________			
DDM reading		0.1928	________	0.2072		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 3: LOC/ -0.2 / 0°			________			
DDM reading		-0.2072	________	-0.1928		
ILS Phase 90/150 Hz		-0.2	________	0.2°	degree	
Test 4: GS/ 0.0 / 0°			________			
DDM reading		-0.0004	________	0.0004		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 5: GS/ 0.4 / 0°			________			
DDM reading		0.3856	________	0.4144		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 6: GS/ -0.4 / 0°			________			
DDM reading		-0.4144	________	-0.3856		
ILS Phase 90/150 Hz		-0.2	________	0.2	degree	
Test 7: GS/ 0.0 / -45°			________			
DDM reading		-0.0004	________	0.0004		
ILS Phase 90/150 Hz		-45.2	________	-44.8	degree	
Test 8: GS/ 0.4 / -45°			________			
DDM reading		0.3856	________	0.4144		
ILS Phase 90/150 Hz		-45.2	________	-44.8	degree	
Test 9: GS/ 0.0 / 30°			________			
DDM reading		-0.0004	________	0.0004		
ILS Phase 90/150 Hz		29.8	________	30.2	degree	

5 Index