Modulation Analyzers FMA/FMB

Modulation Analysis with High Precision

The Rohde & Schwarz Modulation Analyzers FMA and FMB provide fast and high-precision analysis of all parameters of a modulated signal. Thanks to their versatility they can also be used as RF counters, power meters, voltmeters, psophometers and distortion meters.

The two modulation analyzers only differ in the frequency range they cover. The FMB operates from 50 kHz to 5.2 GHz, the FMA from 50 kHz to 1360 MHz but can be retrofitted to 5.2 GHz. These frequencies are becoming increasingly important for new radio services and special outside-broadcasting links.

Radiotelephony and calibration of signal generators are further applications of these analyzers. Their unrivalled measuring accuracy warranties reliable values.

The low inherent spurious modulation and the psophometer function using the optional CCIR and CCITT filters facilitate measurements and the development of oscillators, transmitters, transposers and receivers.

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All important test parameters are indicated simultaneously on clearly arranged LCDs

Characteristics

- Frequency range 50 kHz to 1.36 GHz (5.2 GHz for FMB)
- High measurement speed
- Excellent S/N ratio even at high carrier frequencies
- RF frequency measurement with 10-digit readout
- Extremely accurate AM, FM and φM measurements over a wide modulation frequency range
- AF frequency measurement with 5-digit readout
- Distortion measurement down to 0.005%, continuous in the range 10 Hz to 100 kHz (optional)
- Universal filter capabilities, psophometric weighting filters
- AC/DC measurement of AF voltage
- High-precision power measurement (typ. error <0.5 dB, <0.3 dB guaranteed for FMB)

Measuring accuracy

With a measurement error of 0.5% at modulation frequencies up to 20 kHz and 1% from 20 to 100 kHz, the FMA and FMB offer unprecedented precision in modulation measurements. The accuracy can be enhanced and checked at any time by means of optional AM/FM Calibrator/AF Generator FMA-B4.

Dynamic range

For FM or φM demodulation, an extremely low-noise local oscillator (typ. –130 dBc at 1 GHz, 20 kHz from carrier) is provided, which ensures negligible residual FM and φM up to the highest carrier frequencies. This makes the modulation analyzers ideal for measuring both spurious and wanted modulation.

A weighted FM stereo S/N ratio of typically 78 dB for carrier frequencies up to 170 MHz allows precise S/N ratio measurements on FM broadcast transmitters, channel transposers and sound processing units.

Display

Frequency or level, deviation or modulation depth as well as frequency or distortion are read out separately on three LCDs. All essential device settings, such as mode of operation, type of detector, weighting filter, are displayed too.

A scaled bargraph indicator with a high resolution of one hundred divisions is provided, in particular for adjustments made during modulation or voltage measurements.

If the relative-measurement mode (% or dB) is selected, the bargraph is automatically switched to plus/minus indication when small deviations are measured. This ensures fast and easy adjustment to a defined reference value.

A special min/max hold display simultaneously indicates the current result and the defined minimum and maximum values.

Operation

Modulation Analyzers FMA and FMB are **menu-controlled** to handle the great variety of measurement functions and reduce the number of keys.

The small number of **main function keys** and the alphanumeric display with four softkeys on each side make for clear front-panel layout and fast access to the desired measurement function. Important functions are at the top of the menu hierarchy, the number of submenu levels being limited to a maximum of three.

Parameters, such as reference values for the relative display, are entered via the numeric keypad and terminated with one of the ENTER keys (unit/multiplier keys). The facility for storing up to 20 complete setups largely eliminates operator's errors in complex applications.

All FMA and FMB functions can be **remote-controlled.** The IEC-bus interface complying with IEEE 488.2 enables plain-text programming so facilitating program writing. To set an FM deemphasis of 50 µs for example, the following entry is made:

DEMODULATION:FM:DEEMPHASIS 50 US

The few main function keys afford great ease of operation:

RF	All RF settings such as tuning frequency input level RF frequency counter
DEMOD	Selecting the demodulation mode
AUDIO	Setting the AF counter and DIST/SINAD meter
SPEC FUNC	Special functions such as voltmeter mode, IEC-bus address, bargraph indicator control, etc.
FILTER	Selecting the audio filters
DETECTOR	Selecting the detector for modulation display
CALIBRATE	Calibration functions
INFO	Information on all options connected and on the special settings not displayed
MENU BACK	Going from a lower to a higher menu

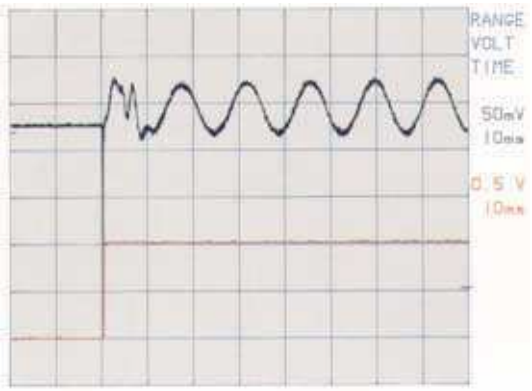
Measurement functions

The FMA and FMB provide comprehensive measurement functions for conventional modulation analysis:

- Fast, fully automatic adjustment to input frequencies from 50 kHz to 1360 MHz (5.2 GHz)
- RF frequency measurement with 10-digit readout and resolution up to 0.1 Hz
- Measurement of AM modulation depth, FM and φM deviation with maximum error of 0.5%, wide dynamic range and 3-dB bandwidth of >300 kHz
- FM and φM deviation measurement range 700 kHz (700 rad)
- AM, FM and φM demodulation from a carrier frequency of 50 kHz onwards
- AF frequency measurement with 5-digit readout and resolution down to 1 mHz
- THD and SINAD measurements from 10 Hz to 100 kHz with a dynamic range of >80 dB (optional)
- Weighted measurements with high-pass filters 10/20/300 Hz, lowpass filters 3/23/100 kHz as well as optional CCIR, CCITT and other special weighting filters
- Precise detectors: separate +PK and –PK detectors with extremely short response time, true rms detector, quasi-peak detector to CCIR 468-4 with filter option
- DC and AC voltage measurements

Softkeys enable fast access to measurement functions

The FMA measures powers to an accuracy of typically 0.5 dB over the total frequency range. Thanks to its highprecision attenuator and special calibration facility the FMB guarantees a value of ð0.3 dB. External attenuators are taken into account in the readout. An overload protection for input powers up to 5 W is provided in all units as standard.



Transient measurement on radio sets

Upper curve: FM output signal

Lower curve: trigger signal at AM output (DC-coupled)

Application

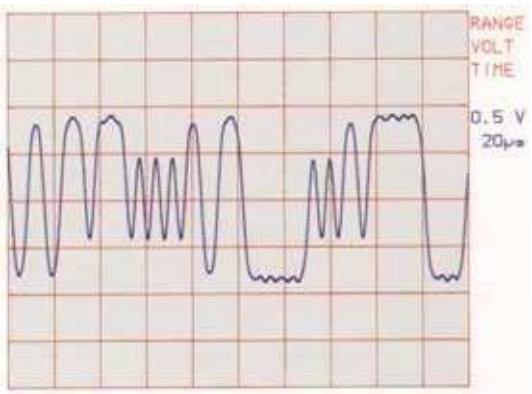
A phase-compensated noise-suppression filter is provided at the FM-MPX output, mainly for use with the internal or any external stereo decoder.

Separate +PK and –PK detectors featuring fast response time and high accuracy are ideal for simultaneously detecting positive and negative peak deviation of FM stereo program signals. With the use of the PK hold function these values can be measured continuously over extremely short to very long periods.

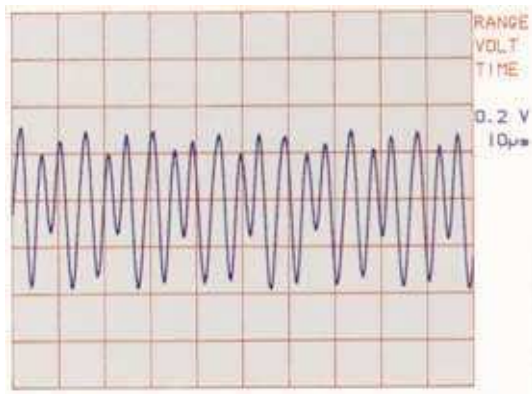
DC-coupled AM and FM demodulator outputs, high DC stability, short settling time of the FM demodulator (<100 µs for a frequency error of <500 Hz) and a storage oscilloscope connected to the AM and FM outputs make it possible to measure on/off transients of radio equipment to FTZ 17R2028. The AM output signal whose DC voltage component is proportional to the RF input level is used as a trigger signal.

The FM demodulator has a 3-dB bandwidth of 330 kHz and measures deviations up to 700 kHz. It can be used to analyze modulators such as the GMSK*) modulators in digital mobile-radio networks.

*) Gaussian minimum shift keying



GMSK signal (such as used in digital mobile-radio system) frequency-demodulated by FMA (B x T = 0.3, f_{bit} = 270,833 baud (pseudo-random bit sequence); the high demodulation bandwidth of 330 kHz ensures an undistorted signal at the FM or AM output; the frequency deviation can be measured accurately



GMSK signal as shown above, but modulated with all 1's; the 2.9-kHz deviation generated by the non-ideal GMSK modulator can be measured with the required bandwidth

Peak deviation monitoring
When used together with a process controller, eg PSA from Rohde & Schwarz, the FMA and FMB are particularly suitable for monitoring the peak deviation of VHF broadcast transmitters. In the PK hold mode, all modulation peaks, even the narrowest, are measured to a high accuracy by the +PK and –PK detectors which operate in parallel and have a very short response time. The monitoring intervals can be from ð100 ms to any duration. For each interval, all parameters measured by the detectors such as +PK, -PK, rms and quasi-peak are read out.

Modulation Analyzers FMA and FMB afford a high measurement speed thanks to the following features:

- Fast automatic frequency adjustment by direct frequency measurement up to 1.36 GHz, even if the AM depth is high.
- Two independent frequency counters for simultaneous RF and AF counting.
- All measurement times can be adapted to the specific measurement problem, eg lowest test frequency or required counter resolution.

Measurement functions that are not required can be switched off, for example to allow extremely fast modulation measurements with preset RF level and frequency. A maximum of 10 modulation values can thus be measured per second.

Fitted with a low-noise synthesizer of 0.1-Hz resolution, broadband IF connectors and free slots, the modulation analyzers are **designed to meet future applications.** The FMA frequency range can be extended to 5.2 GHz (option FMA-B12).

Options

DIST/SINAD Meter FMA-B2
The DIST/SINAD meter can be continuously tuned from 10 Hz to 100 kHz either automatically or manually. It is able to measure distortion (THD + N) down to typically <0.005% and thus meets the requirements of pure audio measurements using a voltmeter. The result can also be read out as a SINAD value in dB.

Filter FMA-B1
This option contains the following universal weighting filters:

- Psophometric filter to CCIR 468-4 with quasi-peak detector
- Filter P53 to CCITT; 30-kHz and 120-kHz Bessel lowpass filters; highpass filters can be switched in for correct peak measurements on squarewave modulation signals
- 5-Hz lowpass filter for hum suppression in DC voltmeter mode
- Special φM filter which allows correct demodulation with modulation frequencies of 10 Hz and above
- 4.2-kHz lowpass filter with steep skirts, particularly for spurious modulation measurements on AM broadcast transmitters (German ARD Standard Specifications No. 5/4.1)

10-MHz Reference Oscillator FMA-B10
Highly stable 10-MHz reference oscillator with aging of <1 x 10-9/day

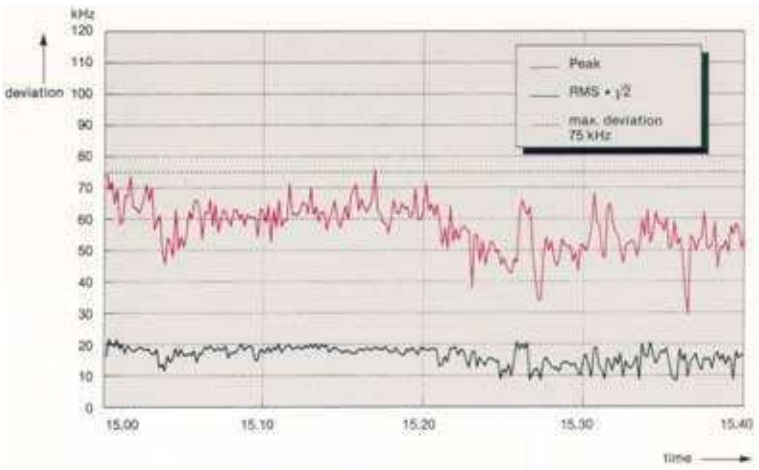
AM/FM Calibrator/AF Generator FMA-B4
This option is an extremely precise AM/FM calibration source with an error of <0.1% and at the same time a universal baseband generator fitted with two switch-selected outputs for AF, single- tone, two-tone and stereo multiplex signals (data sheet PD 756.9951).

5.2-GHz Frequency-range Extension FMA-B12 (for FMA only)
This unit extends the FMA frequency range to 5.2 GHz, eg for new radio services or special outside-broadcasting links.

Stereo Decoder FMA-B3
The FMA-B3 decodes the internal or any external FM stereo signal (see data sheet PD 756.9551).

AF Analyzer FMA-B8
Enables FMA and FMB for in-depth AF analysis such as
– selective modulation depth and AF level measurements from 10 to 150 kHz
– selective harmonic distortion and true THD measurements
– universal intermodulation measurements

When used with an external PC, FMA and FMB are able to monitor peak deviation measured at intervals of <100 ms



Specifications

(The specifications apply to both FMA and FMB unless specified otherwise)

Frequeny range 50 kHz to 1360 MHz (FMA)
50 kHz to 5.2 GHz (FMB or FMA with option FMA-B12)

Frequency tuning: automatic[1] or manual
Display: 10-digit readout
Resolution: 0.1/1/10/100 Hz, selectable
Frequency error: ±1 digit + error of reference frequency

Reference oscillator	standard	option FMA-B10
Aging	$1x10^{-6}$/year	$1x10^{-7}$/year
after 30 days of operation	–	$1x10^{-9}$/day
Temperature effect	$2.5x10^{-6}$ (0 to 55 °C)	$2x10^{-9}$/°C
Warmup time	15 min	15 min

External reference input/output: manual or remote-controlled switchover

RF input Z_{in} = 50 Ω, N connector

SWR			
FMA	<1.4 (with 10 dB attenuation)		
FMB or FMA with FMA-B12	f_{in}: 50 kHz to 1.36 GHz	1.36 to 2.72 GHz	>2.72 GHz
attenuation ≥10 dB in power-meter mode (attenuation ≥20 dB)	≤1.4	≤2	≤2
	≤1.2	≤1.5	≤2

Level ranges		
f_{in}:	50 kHz to 1.36 GHz	1.36 to 5.2 GHz
	–37.5 to +30 dBm	–31.5 to +30 dBm

Overload protection: up to 5 W (15 V RMS)
Maximum peak voltage: 25 V (including DC)

RF power measurement

FMA		
Frequency range	50 kHz to 1.36 GHz	
Power measurement range	0.18 µW to 1 W (–37.5 to +30 dBm)	
Measurement error	≤±1.5 dB	±0.05 µW (–37.5 to –10 dBm)
	≤1 dB, typ. 0.5 dB	(–10 to +30 dBm)

FMB or FMA with FMB-B12			
Power measurement range	0.18 µW to 1 W (–37.5 to +30 dBm)		
Error limits[2] with input level:	–37.5 to –10 dBm	–10 to +5 dBm	+5 to +30 dBm
f_{in} = 50 kHz to 1.36 GHz:	±1 dB	±0.3 dB	±0.5 dB (±0.05 µW)
f_{in} = 1.36 GHz to 5.2 GHz	±1.5 dB	±0.5 dB	±1 dB (±0.05 µW)

Amplitude modulation measurement

Modulation frequency range: 10 Hz to 200 kHz
Resolution: 0.1% of rdg; max. 0.001 % AM
Measurement error[3] with peak detection (% of rdg, plus peak residual AM)

f_{in}:	50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
f_{mod}			meas. error
m ≤80%	30 Hz to 3 kHz	30 Hz to 10 kHz	30 Hz to 20 kHz	≤0.8%/ typ. 0.5%
m ≤95%	–	30 Hz to 20 kHz	30 Hz to 100 kHz	≤1%
	10 Hz to 8 kHz	10 Hz to 20 kHz	10 Hz to 100 kHz	≤2%
	–	10 Hz to 50 kHz	10 Hz to 200 kHz	≤5%

Residual AM[4]	f <1.36 GHz	f ≥1.36 GHz
to CCITT	≤0.01%	≤0.02%
20 Hz to 23 kHz, RMS	≤0.03%	≤0.06%
to CCIR	≤0.05%	≤0.1%

Incidental AM in FM (f_{mod} = 1 kHz, meas. bandwidth 20 Hz to 3 kHz)

f_{in} = 50 kHz to 10 MHz, deviation = 5 kHz	≤0.2%
f_{in} ≥10 MHz, deviation = 50 kHz	≤0.1%

AF distortion[5] for f_{mod} = 10 Hz to 20 kHz

m = 40%	≤0.2%
40% ≤m ≤80%	≤0.4%

Frequency modulation measurement

Modulation frequency range: 10 Hz to 200 kHz
Max. measurable deviation for

f_{in}:	50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	f_{in}/10	150 kHz	700 kHz

Meas. error[3] with peak detection (plus peak residual FM)

f_{in}: 50 to 300 kHz		300 kHz to 10 MHz		≥10 MHz	
f_{mod}	error	f_{mod}	error	f_{mod}	error
30 Hz to 5 kHz	≤0.5%	30 Hz to 10 kHz	≤0.5%	30 Hz to 20 kHz	≤0.5%
10 Hz to 8 kHz	≤2%	30 Hz to 20 kHz	≤1%	30 Hz to 100 kHz	≤1%
		10 Hz to 50 kHz	≤2%	10 Hz to 200 kHz	≤2%

Resolution better than 0.1% of rdg (min. 0.1 Hz)

Residual FM[4] for f_{in} (in MHz)	≤340	≤680	≤1360 MHz
CCITT, RMS	≤0.5 Hz	≤0.7 Hz	≤1 Hz
20 Hz to 23 kHz, RMS	≤2 Hz	≤3 Hz	≤5 Hz
CCIR, quasipeak + 50 µs deemph.	≤3 Hz	≤4 Hz	≤6 Hz
with f_{in} (in GHz)	≤2.72	≤5.2	
CCITT, RMS	≤2 Hz	≤4 Hz	
20 Hz to 23 kHz, RMS	≤10 Hz	≤20 Hz	
CCIR, quasipeak +50 µs deemph.	≤12 Hz	≤24 Hz	

Stereo S/N ratio[4] weighted to CCIR, 40 kHz deviation, at FM output (with noise filter)

f_{in}: 10 to ≤170 MHz	≥76 dB, typ. 78 dB
170 to ≤340 MHz	≥73 dB
340 to 680 MHz	≥68 dB

Stereo crosstalk (f_{in}≥10 MHz, without noise filter)

f_{mod} = 1 kHz	≥56 dB down
30 Hz ≤ f_{mod} ≤15 kHz	≥50 dB down

AF distortion for

deviation of	75 kHz	500 kHz
f_{in}≥10 MHz		
f_{mod} = 30 Hz to 20 kHz[5]	≤0.05%	≤0.2%
= 20 kHz to 100 kHz	≤0.15%	≤0.5%
f_{in} >500 kHz		
f_{mod} = 30 Hz to 20 kHz	≤0.1%	–

Incidental FM (m = 50%, f_{mod} = 1 kHz, B = 20 Hz to 3 kHz, plus peak residual FM): ≤10 Hz
Deemphasis: 50/75/750 µs selectable, effective at AF output and, if selected, for result display

Phase modulation measurement

Modulation frequency range: 200 Hz to 200 kHz
Max. measurable deviation (up to max. 1 kHz AF, –6 dB/octave for f >1 kHz)

f_{in}:	50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	1/10 f_{in}/kHz x 1 rad	150 rad	700 rad

Error[3] of peak detection (plus peak residual φM)

f_{mod}	300 Hz to 5 kHz	300 Hz to 10 kHz	300 Hz to 100 kHz
with special φM filter (FMA-B1):			
	10 Hz to 5 kHz	10 Hz to 10 kHz	10 Hz to 10 kHz
	≤2%	≤2%	≤2%

Resolution <0.1% (minimum 0.0001 rad)

Residual φM[4] for f_{in}	≤680 MHz	≤1.36 GHz
CCITT weighting	≤0.002 rad	≤0.004 rad
300 Hz to 23 kHz	≤0.005 rad	≤0.01 rad
at f_{in}	≤2.72 GHz	≤5.2 GHz
CCITT weighting	≤0.008 rad	≤0.016 rad
300 Hz to 23 kHz	≤0.02 rad	≤0.04 rad

AF distortion (at AF output) (f_{mod} 200 Hz to 20 kHz, Δφ = 4 rad, f_{in} ≥500 kHz): ≤0.1%

AF voltmeter

DC voltage measurement:
Range: ±10 µV to 20 V
Offset voltage[6]
unbalanced input: ≤1 mV
balanced input: ≤3 mV
} can be corrected to ≤30 µV using offset function
Resolution: <0.1%

Error	
3-kHz lowpass filter	±0.5% ± 100 µV ± offset voltage
5-kHz lowpass filter (with filter option)	±0.5% ± 10 µV ± offset voltage
AC voltage measurement:	
Frequency range	10 Hz to 300 kHz
Measurement range	30 µV to 20 V
Resolution	0.1% of rdg
Error (RMS detector)	
30 Hz to 20 kHz	≤1% ± 30 µV (100-kHz lowpass filter)
10 Hz to 100 kHz	ð≤2% ± 100 µV (without lowpass filter)
10 Hz to 200 kHz	ð≤3% ± 100 µV (without lowpass filter)
Weighting facilities	all AF measuring facilities, such as detector, filter, frequency counter and distortion meter, can also be used in voltage measurements
Inputs	
unbalanced	input impedance 100 kΩ ll 50 pF, BNC connector
balanced	input impedance 600 Ω, 3-contact connectors to DIN 41 628

AF detector

Peak dectector	positive or negative peak of AF or arithmetic mean of both
RMS detector	true RMS-responding rectifier, readout as RMS value or converted to peak for sinewave
Quasi-peak detector	to CCIR Rec. 468-4

Weighting filters

Highpass filters	10 Hz (2nd order) 20 Hz (3rd order) 300 Hz (2nd order)
Lowpass filters	3 kHz (4th order) 23 kHz (4th order; meets CCIR 468-4, unweighted, if combined with 20-Hz highpass) 100 kHz (4th order)
Filter option	CCIR 468-4 (weighted) CCITT P53 5-Hz lowpass (for DC measurement) 30-kHz Bessel lowpass, 4th order 120-kHz Bessel lowpass, 4th order 4.2-kHz Cauer lowpass special φM filter (phase demodulation for modulation frequencies ≥10 Hz) external filters possible

AF frequency display

	5 digits
Frequency range	10 Hz to 300 kHz
Resolution	1 mHz to 10 Hz
Error	±0.005% ±3 mHz ±1 digit

Distortion meter (option FMA-B2)

Readout either in % or SINAD in dB, automatic adjustment for S/N Š≥20 dB	
Measurement range	10 Hz to 100 kHz
Display range	
THD	0.005 to 50%
SINAD	6 to 86 dB
Maximum error	
10 Hz to 100 kHz (harmonics up to 300 kHz)	±2 dB ± 0.15% THD
20 Hz to 20 kHz (with 100-kHz lowpass)	±1 dB ± 0.03% THD

Measuring time

Automatic tuning; RF, modulation and modulation-frequency measurement with 10 Hz RF resolution (HP filter and PK detector switched on)	typ. 1 s
Fast modulation measurement (RF, modulation range and level programmed)	≤120 ms
DIST measurement f_{mod} Š≥30 Hz	typ. 2.5 s
Š≥300 Hz	typ. 1 s

Outputs

IF output	max. 200 mV into 50 Ω
AM output	max. 1 V into 600 Ω (can be DC-coupled)
FM/φM output	
for FM	6 dBm (1.545 V) into 600 Ω, 40 kHz deviaiton (DC-coupled)
for φM	1.545 V into 600 Ω, 40 rad
Distortion output (with optional DIST/SINAD meter)	max. 1 V into 600 Ω
AF output	1 to 4 V into 600 Ω (peak voltage)
10-MHz reference frequency	switch-selected output/input
output	+12 dBm, 50 Ω, sinewave
input	–10 to +12 dBm
Interface for firmware update	7-contact Cannon connector

Remote control

Interface	IEC 625-1/625-2 (IEEE 488.1/488.2), connector: 24-contact Amphenol; controls all device functions including Serial Poll and Parallel Poll
Interface functions	SH1, AH1, L4, T5, SR1, RL1, DC1, DT1, PP1, CO

General Data

Environmental conditions	to IEC 359, class I
Rated temperature range	0 to +55 °C
Storage temperature range	–40 to +70 °C
RFI suppression	to VDE 0871, limit B and German PTT regulations 527/1979
Power supply	100/120/220/240 V ±10%, 47 to 440 Hz (170 VA)
Dimensions, weight	435 mm x 192 mm x 460 mm, 25 kg

Ordering information

Order designation		
Modulation Analyzer FMA	852.8500.52	
Modulation Analyzer FMB	856.5005.52	
Accessories supplied	special cable for firmware update, manual, power cable, spare fuses	
Options		
Filter	FMA-B1	855.2002.52
DIST/SINAD Meter	FMA-B2	855.0000.52
FM Stereo Decoder (see data sheet PD 756.9551)	FMA-B3	856.0003.52
AM/FM Calibrator/AF Generator (data sheet PD 756.9951)	FMA-B4	855.6008.52
AF Analyzer/DSP Unit (data sheet PD 757.0635)	FMA-B8	855.9007.55
RF/IF Selection (data sheet PD 757.0912; only for FMA without FMA-B12)	FMA-B9	856.6501.52
Reference Oscillator	FMA-B10	856.3502.52
5.2-GHz Frequency Range Extension for FMA	FMA-B12	855.8500.52
Recommended extras		
Service Kit	FMA-Z1	856.4009.52
19" Adapter	ZZA-94	396.4905.00
Transport Case	ZZK-944	1013.9366.00
High-power Attenuator 20 dB, 50 W	RDL50	1035.1700.52

[1]) In specified input-level range; for amplitude-modulated signals with m ≤80%: specified minimum input level +10 dB.

[2]) Frequency-response correction switched on, ambient temperature 20 to 25 °C, additional error per 10 °C deviation: 0.1 dB for levels ≥–10 dBm, 0.2 dB for levels <–10 dBm.

[3]) In temperature range 20 to 30 °C, additional error of ±0.5% over total temperature range; error of RMS detection may be up to twice as high as that of peak detection.

[4]) For input level ≥20 dB above specified minimum input level.

[5]) 100-kHz lowpass filter switched on.

[6]) With input attenuator switched on: value x 10.

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Data sheet

Version 02.00

December 2003

Modulation Analyzer R&S®FMAB

The specialist for sound broadcast signals from 50 kHz to 1360 MHz

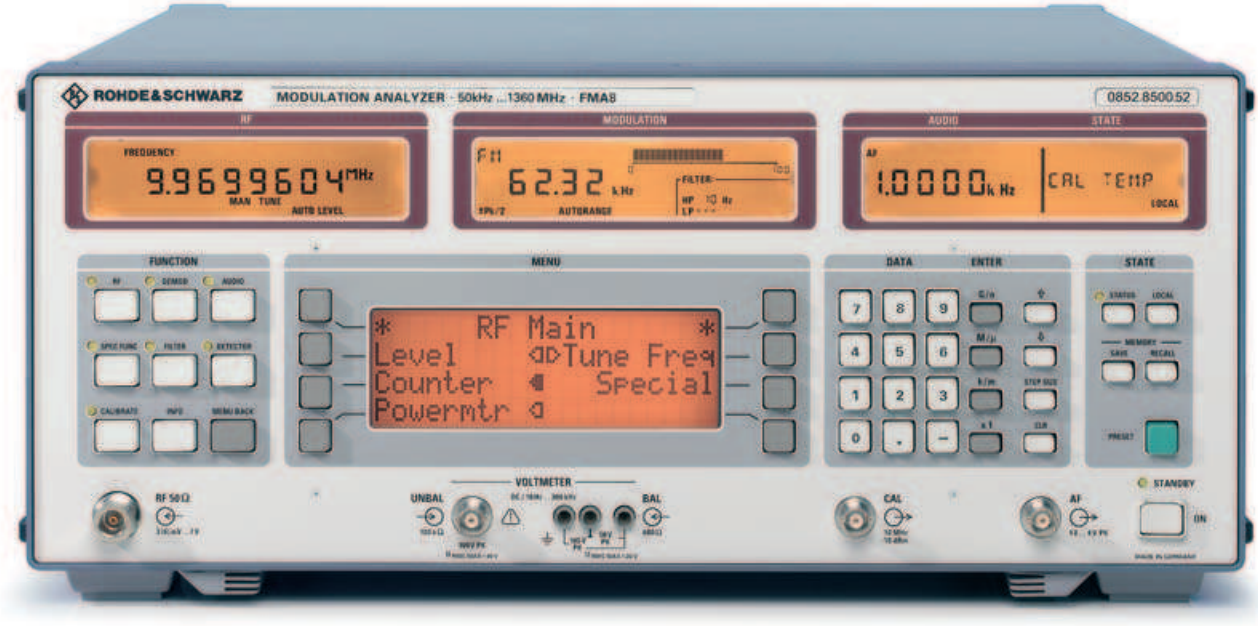
- Built-in precision stereo decoder both for internal FM stereo decoding and for decoding of an external stereo multiplex signal
- External stereo decoder input
- Demodulation of RDS and traffic program signals
- ITU-R detector and standard weighted/unweighted ITU-R filters
- Distortion meter from 10 Hz to 100 kHz
- RF frequency measurement with 10-digit readout, maximum resolution 0.1 Hz
- High-precision AM, FM and φM measurement over a wide modulation frequency range
- Complete AF analysis in the L, R, M and S channels including distortion measurement and S/N ratio measurement to ITU-R standard
- Selective measurement of pilot tone deviation and deviation of 57 kHz traffic program carrier
- Built-in RDS demodulator with clock and data output for external decoding
- Measurement of modulation depth of 57 kHz traffic program carrier
- High-accuracy power measurement (typ. error <0.5 dB)

ROHDE&SCHWARZ

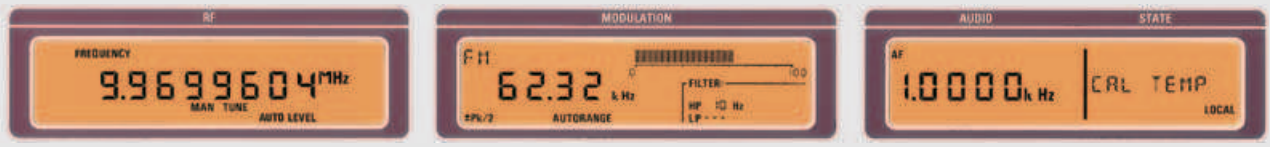
The Modulation Analyzer R&S®FMAB has been especially designed for the analysis of FM stereo broadcast signals. It combines the universal features of the R&S®FMA basic model and the additional measurement capabilities of the built-in stereo decoder.

The measurement tasks of the R&S®FMAB mainly cover the field of sound broadcasting and include comprehensive analysis of VHF transmitters, channel transposers and VHF/baseband converters. Since the stereo decoder with all its analysis functions can be separately used via the rear-panel input, measurements on FM receivers and stereo coders are also possible.

Three large illuminated LCD displays simultaneously read out the measured carrier frequency, modulation and modulation frequency, plus additional information about device status and settings. The clear front-panel layout, with softkeys and a few main function keys, makes for user-friendly operation. Previously complex measurements on FM stereo signals thus become very simple.



Front view of R&S® FMAB



All essential test parameters can be read at a glance on clearly arranged LCD displays

Characteristics

Owing to the clear layout of the R&S®FMAB, all essential test parameters can be read at a glance on the LCD displays. Superimposed additional information, such as the test channel, deemphasis switched on, affords high measurement reliability.

Precision stereo decoder
The precision stereo decoder has been especially designed for wide dynamic range and flat amplitude and phase response that are required in FM stereo measurements. The weighted stereo S/N ratio of ≥80 dB and the channel crosstalk attenuation of ≥60 dB in the range 30 Hz to 15 kHz are top-class.

The special characteristics of the built-in FM demodulator regarding frequency and phase response as well as low distortion are ideally matched to the stereo decoder. The values achieved meet the relevant specifications of broadcasting corporations and are even better in many cases.

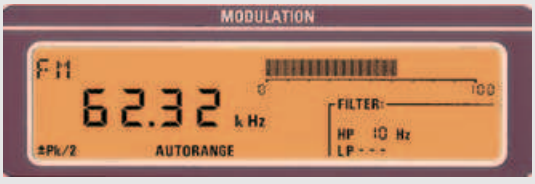
Dynamic range
An extremely low-noise local oscillator (typ. –130 dBc at 1 GHz, 20 kHz carrier offset) ensures a sufficient S/N ratio for FM stereo decoding even far above the VHF band, e.g. for measurements on channel transposers in the UHF range. A weighted FM stereo S/N ratio of typically 78 dB for carrier frequencies up to 170 MHz allows precise S/N ratio measurements on FM broadcast transmitters, channel transposers and VHF/baseband converters.

Result display
Frequency or level, deviation or modulation depth as well as frequency or distortion are read out independently of one another on three LCD displays. All essential device settings, such as operating mode, test channel, type of detector, weighting filter, are superimposed on the relevant display.

A scaled bargraph indicator with a high resolution (one hundred divisions) is provided especially for the alignment of DUTs followed by modulation and voltage measurements.

When relative measurement (% or dB) is selected, the bargraph indicator automatically switches to plus/minus indication in the measurement of small deviations. This ensures fast and easy adjustment to a defined reference value.

A special min/max hold mode allows simultaneous analog display of the current result and the defined minimum and maximum values.



The analog bargraph indicator is ideally suited for adjustments, e.g. to a defined reference value

Operation

Due to its versatile measurement functions, the R&S®FMAB is menu-controlled so that there is no need for a great number of individual keys.

The minimal number of main function keys as well as an alphanumeric menu display with four softkeys arranged at both sides make for clear front-panel layout and fast access to the desired measurement functions. Important functions are at a high menu level, the number of submenu levels being limited to a maximum of three so that finding one's way in the menu is easy.

Parameters, like for instance a reference value for relative display, can be entered via the numeric keypad and are terminated with one of the ENTER keys (unit/multiplier keys). The fact that up to 20 complete setups can be stored considerably enhances the measurement reliability in complex applications.

Remote control

The Modulation Analyzer R&S®FMAB features full remote-control capability. The FM stereo measurement facilities are system-compatible. The IEC/IEEE bus interface fully complies with the IEEE 488.2 standard and enables plain-text programming, which greatly facilitates program writing. For setting an FM deemphasis of 50 µs, for instance, with FM stereo decoding switched on, the following entry is made:

STEREODECODER:DEEMPHASIS 50 US

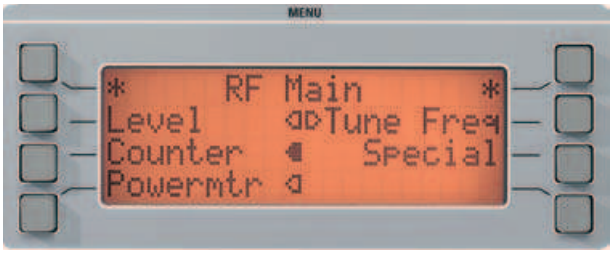
Measurement functions

The R&S®FMAB features standard measurement functions in modulation analysis and a wide variety of additional capabilities owing to the built-in stereo decoder:

- Fast, fully automatic ranging to input frequencies from 50 kHz to 1360 MHz at levels from 3 mV to 7 V
- RF frequency measurement with 10-digit readout and resolution down to 0.1 Hz
- AM modulation depth, FM and φM deviation with error of less than 0.5%, wide dynamic range and 3 dB bandwidth of >300 kHz; FM and φM deviation measurement range 700 kHz (rad); AM, FM and φM demodulation from 50 kHz carrier frequency upwards
- Audio frequency measurements with 5-digit readout and resolution down to 1 mHz
- Distortion and SINAD measurement continuously from 10 Hz to 100 kHz with a dynamic range of >80 dB
- Psophometric weighting filters
  - Highpass filters 10/20/300 Hz
  - Lowpass filters 3/23/100 kHz
  - ITU-R filters (468-4) weighted and unweighted
  - ITU-T and other special weighting filters

The few main function keys make the R&S® FMAB user-friendly:

RF	All RF settings such as tuning frequency, input level and RF frequency counter
DEMOD	Selecting the demodulation modes and access to the FM stereo decoder functions
AUDIO	Setting the audio frequency counter or the DIST/SINAD meter
SPEC FUNC	Special functions such as voltmeter mode, IEC/IEEE bus address, bargraph indicator control, etc
FILTER	Selecting the audio filters
DETECTOR	Selecting the detector for the modulation display
CALIBRATE	Calibrating functions
INFO	Readout of all internal settings on the menu display
MENU BACK	Going back a level in the menu tree



Softkeys enable fast access to desired measurement functions

- Precision detectors: separate +PK and –PK detector with extremely short response time, MAX PEAK function; true RMS detector; quasi-peak detector to ITU-R 468-4
- AC and DC voltage measurements
- Power measurement (error typ. ≤0.5 dB, overload protection circuit for up to 5 W input power)

Options

The R&S®FMAB can be expanded by the optional highly stable 10 MHz Reference Oscillator R&S®FMA-B10 with aging of $<1 \times 10^{-9}$/day. The frequency measurement error at 100 MHz of maximally 200 Hz is thus reduced down to 10 Hz within a calibration interval of one year.

The AM/FM Calibrator R&S®FMA-B4 including an AF generator from 10 Hz to 100 kHz with two external, separately switchable outputs is also available as an option. The error of the calibration source is less than 0.1%.

The 5.2 GHz Frequency Extension R&S®FMA-B12 is provided for special applications at higher frequencies, e.g. outside-broadcast links in the GHz range.

Applications

A phase-compensated noise suppression filter with a bandwidth of 95 kHz (–3 dB) can be switched into circuit between FM demodulator and stereo decoder especially for internal stereo decoding. High-frequency spurious components can thus be efficiently kept away from the stereo decoder, with negligible effect on the phase linearity and channel crosstalk from L to R and R to L. In conjunction with the option R&S®FMA-B4 (calibrator and audio generator), the R&S®FMAB can be expanded to form a complete test set especially for FM broadcast transmitters. All quality-relevant parameters of VHF sound broadcast transmitters can thus be measured without the need for any additional measuring instruments.

Separate +PK and –PK detectors featuring very short response time and high precision are ideally suited for simultaneous detection of positive and negative peak deviation of FM stereo program signals. In conjunction with the PK HOLD function, peak deviations can be monitored for periods ranging from very short to a duration of any length. If the MAX PEAK function is selected on the R&S®FMAB, the maximum deviation will be indicated on the display.

Peak deviation monitoring
In conjunction with a process controller, e.g. the R&S®PSA, the R&S®FMAB is ideal for monitoring the peak deviation of VHF broadcast transmitters. In the PK HOLD mode, +PK and –PK detectors operating in parallel and featuring a very short response time ensure precise measurement of all, even the narrowest of modulation peaks. The monitoring intervals can be from ≤100 ms up to any duration. The values measured by all detectors such as +PK, –PK, RMS and quasi-peak can be read out per unit time.

Rear view of the R&S®FMAB

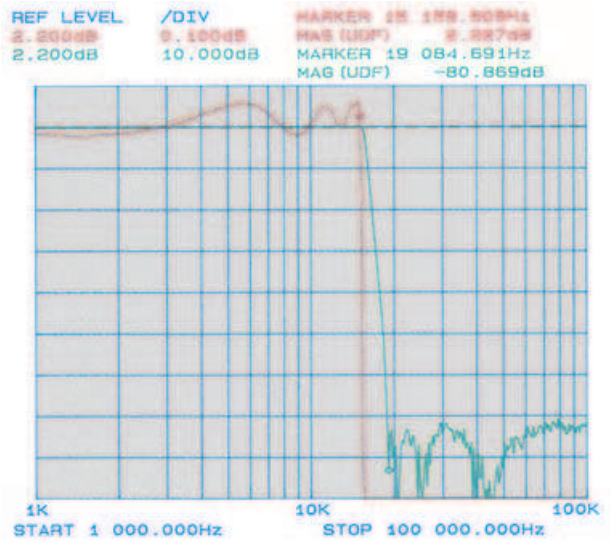
The R&S®FMAB is designed tor high measurement speed:

- Fast, automatic frequency adjustment by direct frequency measurement up to 1.36 GHz
- Correct frequency measurement even at large AM depth due to state-of-the-art technologies
- Two independent frequency counters for simultaneous RF and AF measurement
- All measurement times can be adapted to the specific measurement problem, e.g. lowest measurement frequency or required counter resolution

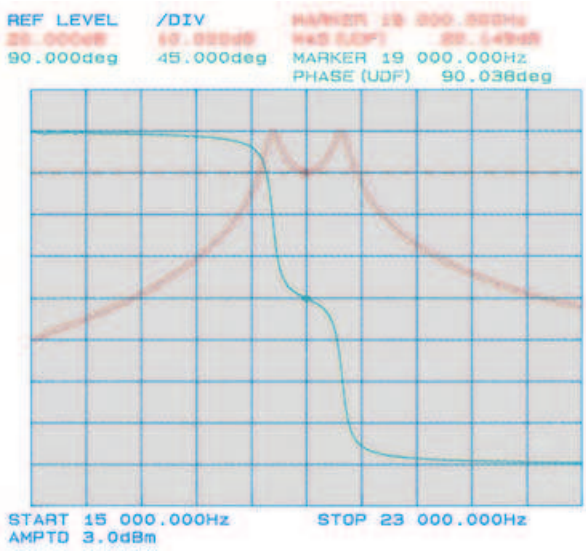
Measurement functions that are not required can be switched off, e.g. for extremely fast modulation measurement with preset RF level and preset RF frequency. In this way, 10 modulation values can be measured per second.

Future-oriented design

The frequency range can be extended up to 5.2 GHz, thus allowing measurements on special broadcasting and program distribution systems. The built-in firmware can easily be updated via a serial interface using a PC compatible with the industry standard.



Frequency response in L channel;
Selected components ensure minimum frequency response and high spurious suppression in the L, R, M, S channels



Frequency response of pilot filter;
A high-selectivity pilot tone filter allows unimpaired measurement of the pilot tone deviation; the phase error of the pilot tone filter can be automatically eliminated with the aid of a method specially developed by Rohde&Schwarz; new standards are thus set in the measurement of stereo channel crosstalk

Specifications

Frequency	
Frequency range	50 kHz to 1360 MHz
Frequency tuning	automatic[1] or manual
Display	10-digit readout
Resolution	0.1/1/10/100 Hz selectable
Frequency error and drift	±1 digit + error of reference frequency
Reference oscillator	**standard** **option R&S®FMA-B10**
Aging	2×10^{-6}/year 1×10^{-7}/year
After 30 days of operation	– 1×10^{-9}/day
Temperature effect	2.5×10^{-6} 2×10^{-9}/°C (0 °C to 55 °C)
Warmup time	15 min 15 min
External reference input/output	manual or remote-controlled switch-over
Output level	12 dBm ±2 dB
Input level range	–10 dBm to +15 dBm
RF input	Z_{in} = 50 Ω, N connector, VSWR <1.4 with 10 dB attenuation
Overload protection	up to 5 W (15 V RMS)
Maximum peak voltage	25 V (including DC)
RF power measurement	
Frequency range	50 kHz to 1360 MHz
Power measurement range	0.18 µW to 1 W (–37.5 dBm to +30 dBm)
Measurement error	
0.18 µW ≤ P < 0.1 mW	≤±1.5 dB ±0.05 µW
P ≥0.1 mW	≤1 dB (typ. 0.5 dB)
Amplitude modulation measurement	
Modulation frequency range	10 Hz to 200 kHz
Resolution	0.1% of reading; max. 0.001% AM

Measurement error[2] with peak detection (% of reading, plus peak residual AM)

f_{in}	50 to 300 kHz	>300 kHz to 10 MHz	≥10 MHz	**measurement error**
		fmod		
m ≤80%	30 Hz to 3 kHz	30 Hz to 10 kHz	30 Hz to 20 kHz	≤0.8%
m ≤95%	—	30 Hz to 20 kHz	30 Hz to 100 kHz	≤1%
	10 Hz to 8 kHz	10 Hz to 20 kHz	10 Hz to 100 kHz	≤ 2%
	—	10 Hz to 50 kHz	10 Hz to 200 kHz	≤5%

Residual AM[3]	
To ITU-T	≤0.01%
20 Hz to 23 kHz, RMS	≤0.03%
To ITU-R	≤0.05%
Incidental AM in FM mode (f_{mod} = 1 kHz, meas. bandwidth 20 Hz to 3 kHz)	
f_{in} = 50 kHz to 10 MHz, deviation = 5 kHz	≤0.2%
f_{in} ≥10 MHz, deviation = 50 kHz	≤0.1%
AF distortion for f_{mod} = 10 Hz to 20 kHz (for f_{in} <300 kHz: f_{mod} = 10 Hz to 5 kHz)	
m = 40%	≤0.2%
40% ≤ m ≤ 80%	≤0.4%

Frequency modulation measurement			
Modulation frequency range	10 Hz to 200 kHz		
Max. measurable deviation for			
f_{in}: 50 kHz to 300 kHz	f_{in}/10		
f_{in}: 300 kHz to 10 MHz	150 kHz		
f_{in}: ≥10 MHz	700 kHz		
Meas. error[2] with peak detection (plus peak residual FM)			
f_{in}: 50 kHz to 300 kHz	f_{mod}	error	
	30 Hz to 5 kHz	≤0.5%	
	10 Hz to 8 kHz	≤2%	
f_{in}: 300 kHz to 10 MHz	f_{mod}	error	
	30 Hz to 10 kHz	≤0.5%	
	30 Hz to 20 kHz	≤1%	
	10 Hz to 50 kHz	≤2%	
f_{in}: ≤10 MHz	f_{mod}	error	
	30 Hz to 20 kHz	≤0.5%	
	30 Hz to 100 kHz	≤1%	
	10 Hz to 200 kHz	≤2%	
Resolution	better than 0.1% of reading (min. 0.1 Hz)		

Residual FM[3] for f_{in}	≤340 MHz	≤680 MHz	≤1360 MHz
To ITU-T, RMS	≤0.5 Hz	≤0.7 Hz	≤1 Hz
20 Hz to 23 kHz, RMS	≤2 Hz	≤3 Hz	≤5 Hz
ITU-R, quasi-peak +50 µs deemphasis	≤3 Hz	≤4 Hz	≤6Hz

Stereo S/N ratio[3] weighted to ITU-R, 40 kHz deviation, at FM output (with noise filter)		
f_{in}: 10 MHz to ≤170 MHz	≥76 dB	
f_{in}: 170 MHz to ≤340 MHz	≥73 dB	
f_{in}: 340 MHz to 680 MHz	≥68 dB	
Stereo crosstalk (f_{in} ≥10 MHz, without noise filter)		
f_{mod} = 1 kHz	≥56 dB down	
30 Hz ≤ f_{mod} ≤15 kHz	≥50 dB down	
AF distortion for deviation of f_{in} ≥10 MHz	75 kHz	500 kHz
f_{mod} = 30 Hz to 20 kHz[4]	≤0.05%	≤0.2%
f_{mod} = 20 kHz to 100 kHz	≤0.15%	≤0.5%
f_{in}> 500 kHz		
f_{mod} = 30 Hz to 20 kHz	≤0.1%	—
Incidental FM (m = 50%, f_{mod} = 1 kHz, B = 20 Hz to 3 kHz, plus peak residual FM)	≤10 Hz	
Deemphasis	50/75/750 µs selectable, effective at AF output and, if selected, for readout of results	

Phase modulation measurement	
Modulation frequency range	200 Hz to 200 kHz
With special φM filter	10 Hz to 20 kHz
Max. measurable deviation (up to max. 1 kHz AF, –6 dB/octave for f >1 kHz)	
f_{in}: 50 kHz to 300 kHz	1/10 x f_{in}/kHz x 1 rad
f_{in}: 300 kHz to 10 MHz	150 rad
f_{in}: ≥10 MHz	700 rad

Error[2] of peak detection (plus peak residual φM) f_{mod}: 300 Hz to 5 kHz f_{mod}: 300 Hz to 10 kHz f_{mod}: 300 Hz to 100 kHz With special φM filter: f_{mod}: 10 Hz to 5 kHz f_{mod}: 10 Hz to 10 kHz	 ≤2% ≤2% ≤2% ≤2% ≤2%
Resolution	<0.1% (minimum 0.0001 rad)
Residual φM[3] for f_{in} ITU-T weighting 300 Hz to 23 kHz	≤680 MHz 680 MHz ≤0.002 rad ≤0.004 rad ≤0.005 rad ≤0.01 rad
AF distortion (at AF output) (f_{mod} 200 Hz to 20 kHz, $\Delta\varphi$ = 4 rad, f_{in} ≥500 kHz)	≤0.1%
AF voltmeter	
DC voltage measurement Range	 ±10 µV to 20 V
Offset voltage[5] Unbalanced input Balanced input	 ≤1 mV } can be corrected to ≤30 µV ≤3 mV } using offset calibration
Resolution	<0.1%
Error	±0.5% ±10 µV ±offset voltage
AC voltage measurement Frequency range Measurement range Resolution	 10 Hz to 300 kHz 30 µV to 20 V 0.1% of reading
Error (RMS detector) 30 Hz to 20 kHz 10 Hz to 100 kHz 10 Hz to 200 kHz	 ≤1% ±30 µV (100 kHz lowpass filter) ≤2% ±100 µV (without lowpass filter) ≤3% ±100 µV (without lowpass filter)
Weighting facilities	all AF measuring facilities, such as detector, filter, frequency counter and distortion meter, can also be used in voltage measurements
Inputs Unbalanced Balanced	 input impedance 100 kΩ II <50 pF, BNC connector input impedance 600 Ω, 3-contact connectors to DIN 41628
AF detector	
Peak detector	positive or negative peak of AF or their arithmetic mean
RMS detector	true RMS-responding rectifier, read-out as RMS value or converted to peak for sinewave
Quasi-peak detector	detector to ITU-R Rec. 468-4
Weighting filters	
Highpass filters	10 Hz (2nd order) 20 Hz (3rd order) 300 Hz (2nd order)
Lowpass filters	3 kHz (4th order) 23 kHz (4th order) 100 kHz (4th order) 5 Hz lowpass (for DC measurement) 30 kHz Bessel lowpass (4th order) 120 kHz Bessel lowpass (4th order) 4.2 kHz Cauer lowpass
Standard filters	ITU-R 468-4 weighted ITU-R 468-4 unweighted ITU-T P53; plus external filters
AF frequency display	5 digits
Frequency range	10 Hz to 300 kHz
Resolution	1 mHz to 10 Hz
Error	±0.005% ±3 mHz ±1 digit
Distortion measurement	
Readout either in % or SINAD in dB, automatic adjustment for S/N ≥20 dB	
Measurement range	10 Hz to 100 kHz
Display range THD SINAD	 0.005% to 50% 6 dB to 86 dB
Maximum error 10 Hz to 100 kHz (harmonics up to 300 kHz) 20 Hz to 20 kHz (with 100 kHz lowpass filter)	 ±2 dB ±0.15% THD ±1 dB ±0.03% THD

Stereo decoder

Crosstalk 30 Hz to 15 kHz, RMS or ITU-R detector L to R, R to L M to S, S to M	 ≥60 dB down ≥50 dB down
Frequency response L, R, M, S 30 Hz to 15 kHz	 max. ±0.1 dB
Level difference between L and R	≤0.1 dB
Measurement errors L, R, M, S 19 kHz pilot tone Level, deviation 57 kHz carrier (level) AM of 57 kHz carrier (f_{mod} = 10 Hz to 125 Hz)	 ≤2% ≤5% ≤2% of reading +0.1% AM
Nonlinear distortion (with input level 6 dBm and 12.5 dBm, L, R, M, S outputs) THD (30 Hz to 15 kHz) Intermodulation distortion to DIN 45403	 ≤0.1% d_2 ≤0.05%, d_3 ≤0.1%
S/N ratio, referred to +6 dBm at 500 Hz, deemphasis 50 µs ITU-R unweighted ITU-R weighted	 ≥80 dB ≥80 dB
Auxiliary carrier suppression, referred to +6 dBm Pilot tone (19 kHz) RDS/ARI (57 kHz)	 ≥90 dB ≥80 dB
Deemphasis	50 µs or 75 µs, switch-selectable
External decoder input	balanced, 3-contact connector to DIN 41628 on rear panel
Common-mode rejection f ≤1 kHz 1 kHz < f ≤ 15 kHz 15 kHz < f ≤ 100 kHz	 ≥60 dB ≥50 dB ≥36 dB
Input impedance	≥40 kΩ

Input level range	–12 dBm to +12.5 dBm (600 Ω) (nominal +6 dBm/40 kHz)
Resolution of level setting	≤0.2 dB
Stereo decoder outputs	
L, R, M	balanced, 3-contact connectors on rear panel, to DIN 41628, +6 dBm, Z_{out} ≤30 Ω, Z_I ≥300 Ω
S (L–R/2)	unbalanced, BNC connector, Z_I ≥600 Ω
RDS demodulator outputs	9-contact Cannon connector on rear panel
Signals available	data, clock, quality signal, TP information, 57 kHz carrier (TTL)
Measuring time	
Automatic tuning; RF, modulation and modulation frequency measurement with 10 Hz RF resolution (HP filter and PK detector switched on)	typ. 1 s
Fast modulation measurement (RF, modulation range and level already programmed)	≤120 ms
DIST measurement f_{mod} ≥30 Hz f_{mod} ≥300 Hz	 typ. 2.5 s typ. 1 s
Outputs	
IF output	max. 200 mV into 50 Ω
AM output	max. 1 V into 600 Ω (can be DC-coupled)
FM/φM output For FM For φM	 6 dBm (1.545 V) into 600 Ω, 40 kHz deviation (DC-coupled) 1.545 V into 600 Ω, 40 rad

Distortion output	max. 1 V into 600 Ω
AF output	1 V to 4 V peak into 600 Ω with autoranging
Remote control	
Interface	IEC 625-1/625-2 (IEEE 488.1/488.2), connector: 24-contact Amphenol; controlling all device functions including Serial Poll and Parallel Poll
Interface functions	SHI, AH1, L4, T5, SR1, RL1, DC1, DT1, PP1, CO
General data	
Temperature Operating temperature range Permissible temperature range Storage temperature range	 0 °C to +55 °C 0 °C to +55 °C –40 °C to +70 °C
Humidity	+40 °C, non-condensing, 80% relative humidity, meets EN 60068-2-3
RFI suppression	meets EN 55011 class B and EN 61326 (EMC Directive 89/336/EEC)
Safety	meets EN 61010-1 : 1991
Power supply	100/120/220/240 V ±10%, 47 Hz to 440 Hz (170 VA)
Dimensions, weight	435 mm x 192 mm x 460 mm, 25 kg

1) For amplitude-modulated signals: P_{in} ≥–27 dBm, m ≤80%.
2) In temperature range 20 °C to 30 °C, additional error of ±0,5% over entire temperature range; error of RMS detection may be up to twice as high as of peak detection.
3) For input level ≥20 dB above specified minimum input level.
4) 100 kHz lowpass filter switched in.
5) Input attenuator switched on: value x 10.

Ordering information

Modulation Analyzer	R&S®FMAB	856.4750.52
Accessories supplied		
Special cable for firmware updating, manual, power cable, spare fuses		
Options		
Reference Oscillator	R&S®FMA-B10	856.3502.52
AM/FM Calibrator	R&S®FMA-B4	855.6008.52
5.2 GHz Frequency Extension	R&S®FMA-B12	855.8500.52
Recommended extras		
High-Power Attenuator 20 dB, 50 W	R&S®RDL	1035.1716.00
Service Kit	R&S®FMA-Z1	856.4009.52
19" Adapter	R&S®ZZA-94	396.4905.00

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

ROHDE&SCHWARZ

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Selective Modulation Analyzer FMAS

Stereo receiver and modulation analyzer in one unit

The Selective Modulation Analyzer FMAS from Rohde & Schwarz is the first instrument to combine the characteristics of a universal modulation analyzer with those of an FM stereo/TV dual-sound receiver in the frequency range 5 to 1000 MHz*).

Features

- Excellent static and dynamic selectivity
- Level range 10 µV to 7 V
- Outstanding transfer characteristic
- High overload capability to interfering signals
- Selective RF level measurement

Uses

- Remote measurements on VHF broadcasting and TV dual-sound transmitters such as
  - peak deviation monitoring
  - field-strength and frequency measurements
  - VHF coverage measurements to ARD/DBP Specification 5 R 4/1.3
- Modulation analysis of TV sound signals
- Modulation analysis
  - in cable networks and headends
  - at VHF transmitter combining networks
  - of TV sound subcarriers in the satellite baseband
- FM stereo relay reception

*) This combination can also be obtained by retrofitting FMAB (data sheet PD 756.9551) with options RF/IF Selection FMA-B9 and AF Analyzer/DSP Unit FMA-B8 (data sheet PD 757.0635).

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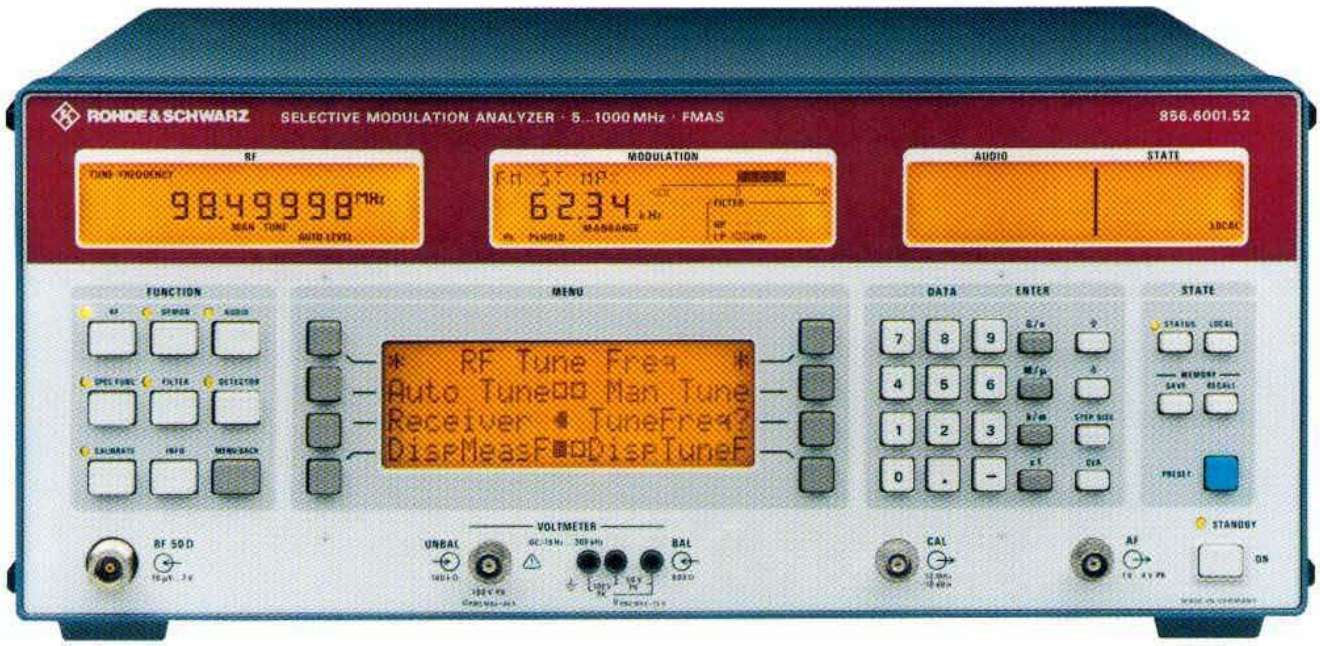


Characteristics

FMAS is the first instrument to offer the capabilities of a modulation analyzer together with those of an FM stereo/TV dual-sound receiver. As the receiver can be switched on and off as required, the whole range of applications afforded by a modulation analyzer in the frequency range 50 kHz to 1360 MHz is readily available*). At a high sensitivity of 10 µV, a tunable 4-pole preselection filter (from 87.5 to 108 MHz and >183 MHz) and a high-level input mixer guarantee high overload capability to interfering signals in the receive mode.

Phase-linear IF filters with an amplitude equalizer at the AF together with a low-noise LO yield excellent static and dynamic selectivity and, at the same time, guarantee a high S/N ratio as well as low linear and non-linear distortions.

As there is always a compromise to be made between high selectivity and low distortion and between a high S/N ratio and immunity to overloading, the user may adapt the FMAS to his particular measurement problem:

With the narrow IF filters **FM narrow** and **TV sound**, maximum selectivity can be obtained but distortions are slightly increased. The FM narrow filter makes the FMAS comply with ARD Specification 5/3.5 for stereo relay receivers and is ideally suitable for all kinds of remote measurements such as VHF peak deviation monitoring even under unfavourable receiving conditions.

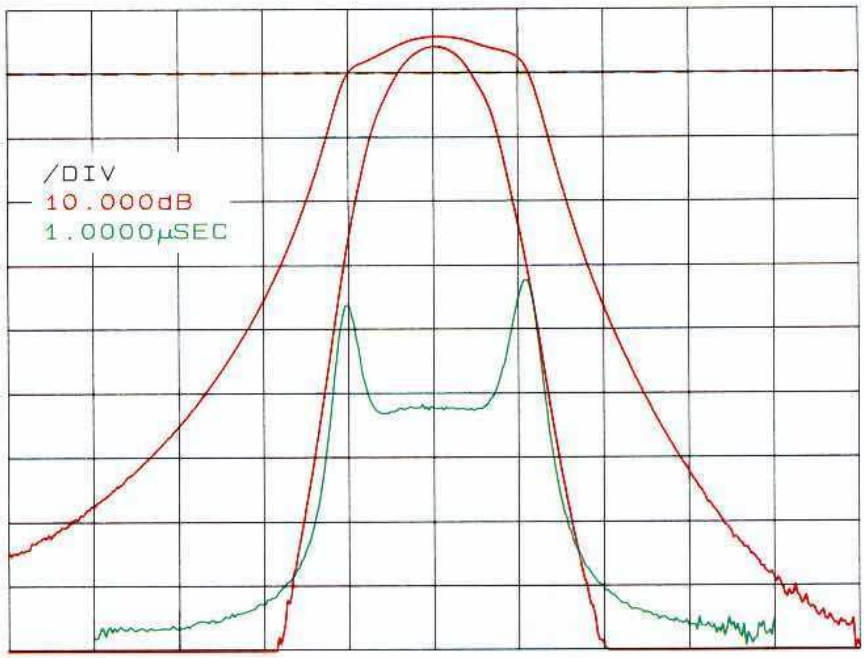
With the IF filter **FM wide,** the FMAS complies with ARD Specification 5/3.4 for FM test demodulators. In addition to the required low distortion, high selectivity (see diagram) is obtained with this filter too. The wide IF filter may be used for example at transmitter combining networks whenever at least two adjacent channels are not occupied.

In the **low-noise** mode, the preamplifier is permanently on and the mixer level is increased so that the maximum S/N ratio is obtained. In the **low-distortion** mode, the mixer level is kept low and the preamplifier is switched off. This mode should be used for measurements on antennas where strong, closely spaced interfering signals within the bandwidth of the preselection filter cause intermodulation in the receive channel. The maximum obtainable S/N ratio is reduced only by about 3 dB but the RF/IF intermodulation suppression improves by 10 dB.

*) See FMAB data sheet PD 756.9551

Factory-stored level calibration data versus frequency guarantee high-precision selective level measurements. With the aid of the AM/FM Calibrator/AF Generator option FMA-B4, level calibration can be updated any time at a fixed RF (10 MHz). Elaborate temperature compensation techniques ensure compliance with specifications over a wide temperature range in the receive mode through

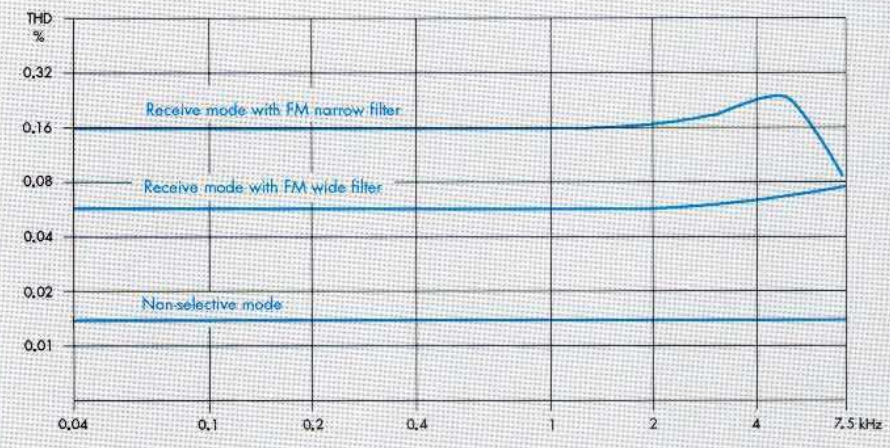
- temperature-responsive tuning of the RF preselector filters by the processor,
- temperature-compensated IF filters,
- computational correction of the selective RF level indication.



Characteristics of various IF filters in the FMAS (frequency axis 200 kHz/div)

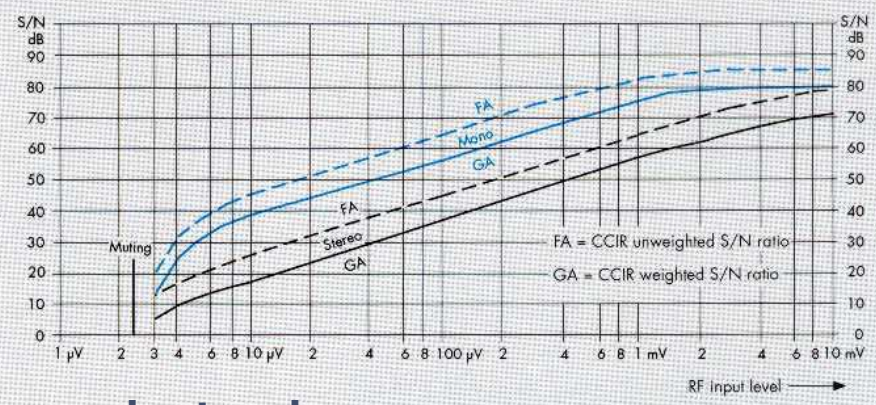
red: Maximum selectivity is obtained with the **FM narrow** filter. With a wider bandwidth the **FM wide** filter still offers good selectivity.

green: The particularly low distortion of the FM wide filter is obtained thanks to a very flat group-delay response in the range ±100 kHz around the centre frequency.



Stereo THD at 75 kHz dev. Thanks to high phase linearity, distortion remains low even with the narrow IF filter.

Considerably lower distortion is obtained with the FM wide filter which is particularly suitable for modulation analysis in cable networks and transmitter combining networks.



S/N ratio of input voltage (referred to 40 kHz dev). The high sensitivity and selectivity make the FMAS particularly suitable for measurements directly at the antenna.

Uses

Measurements which up to now were time-consuming and laborious become simple with the FMAS:

The IF filter FM narrow meets all requirements of relay receivers. Remote measurements on VHF transmitters are easier and much more accurate. It is no longer necessary to use a separate receiver with IF filters that are not optimal for FM mono or stereo signals. In addition, the receiver's S/N ratio is often inadequate because of poor phase noise.

Other fields of application for the FM narrow filter are accurate peak deviation monitoring, remote measurements of field strength and frequency with high precision as well as coverage measurements. In many cases it is not the field strength but multi-path reception that puts limits on the coverage area of a VHF transmitter. The degree of multi-path reception can be determined by parallel evaluation of AM and FM components of a received FM mono or stereo signal.

In the FMAS this is possible with the built-in AF analyzer and the quotient measurement function. Measured results are indicated in "% modulation depth/kHz deviation". Thus FMAS complies with the specifications of ARD and DBP Telekom. In addition, the built-in stereo decoder allows aural monitoring via headphones.

The special IF filter TV sound makes the FMAS suitable for modulation analysis of dual-sound carriers in TV transmitters and in cable networks, uninfluenced by vision modulation or adjacent channels. Further applications are remote deviation monitoring as well as level and frequency monitoring of TV sound carriers. The TV-sound filter permits also TV sound subcarriers in the satellite baseband to be analyzed.

The IF filter FM wide is particularly suitable for **modulation analysis** of the relatively wideband FM stereo signals for all applications where adjacent channels are not occupied. AF frequency response, modulation distortion and stereo crosstalk of this filter are considerably lower than those of the FM narrow filter. All transmitters of a particular site can be measured at the transmitter combining network so that the analyzer need not be carried from one transmitter to another. Such measurements save time, simplify automatic monitoring and make sure that the signal quality is not impaired by transmitter combining filters.

Specifications

The specifications apply to the FMAS in the receive mode. For the non-selective mode refer to FMAB data sheet PD 756.9551. (Instead of the distortion meter FMAS includes AF Analyzer/DSP Unit FMA-B8, data sheet 757.0635).

Frequency

Frequency range	5 to 1000 MHz	
1st IF	158.5 MHz at f_{in} = 87.5 to 108 MHz and 183 to 273 MHz, otherwise 208.5 MHz	
Image frequencies	f_{in} + 317 MHz at 158.5 MHz IF f_{in} + 417 MHz at 208.5 MHz IF f_{in} + 17 MHz, f_{in} – 3 MHz	
IF bandwidths (–3 dB)	FM wide 350 kHz	FM narrow/TV sound 150 kHz
Shape factor (–3/–60 dB)	3.4	3.7

RF level

RF input level range	–87 to +30 dBm (10 µV to 7 V)
Overload protection	up to 5 W (15 V_{rms}), max. peak voltage 25 V
VSWR	≤2.7 (without attenuation) ≤1.4 (with ≥10 dB attenuation)
Selective level measurement (peak measurement)	
Measurement error [1])	
5 to 500 MHz	≤±2 dB ±3 µV
500 to 1000 MHz	≤±3 dB ±3 µV
LO feed through at f_{in} + IF	
87.5 to 108 MHz	≤20 µV
otherwise	≤6 µV

FM stereo

Selectivity
Ratio of wanted to unwanted signal for a weighted S/N ratio of ≥54 dB referred to a wanted signal of Δf 40 kHz, f_{mod} 500 Hz. Stereo measurements with a 50 µs deemphasis in the stereo decoder.
Specifications apply to input levels ≥200 µV (–61 dBm) for mono and ≥2 mV (–41 dBm) for stereo.

	Stereo		Mono	
Common-channel suppression				
Frequency difference				
0 to 10 kHz				
Unwanted signal, unmodulated	≤49 dB		≤49 dB	
Unwanted signal, modulated				
f_{mod} 500 Hz				
dev. ±40 kHz	≤63 dB		≤44 dB	
Nearby selectivity				
Unwanted signal, modulated				
f_{mod} 500 Hz, Δf 75 kHz	FM wide	FM narrow	FM wide	FM narrow
Frequency difference				
±100 kHz	≤64 dB	≤61 dB	≤7 dB	≤4 dB
±200 kHz	≤25 dB	≤11 dB	≤7 dB	≤0 dB
±300 kHz	≤5 dB	≤–15 dB	≤4 dB	≤–16 dB
±600 kHz	–	–	≤–26 dB	≤–46 dB
Far-off selectivity				
Unwanted signal, modulated				
f_{mod} 500 Hz, Δf 75 kHz, frequency difference ≥1.2 MHz (except for image frequency and 1st IF)				
87.5 to 108 MHz	–	–	≤–54 dB	≤–54 dB
otherwise	–	–	≤–40 dB	≤–40 dB

Image-frequency rejection
Unwanted signal, modulated
f_{mod} 500 Hz, FM: Δf 75 kHz,
AM: m=90% at image frequency ±6 kHz

	Stereo	Mono
87.5 to 108 MHz	≤–10 dB	≤–30 dB
otherwise	≤+10 dB	≤–10 dB

IF rejection
Unwanted signal, modulated
f_{mod} 500 Hz, FM: Δf 75 kHz,
AM: 90% at IF ±6 kHz

87.5 to 108 MHz	≤–20 dB	≤–40 dB
5 to <87.5/ >108 to 350 MHz	≤+15 dB	≤–5 dB
otherwise	≤–10 dB	≤–30 dB

Linear distortions
Amplitude frequency response
measured at MPX signal output,
Δf 40 kHz,
ref. frequency 500 Hz

	FM wide	FM narrow
40 Hz to 43 kHz	≤±0.1 dB	≤±0.1 dB
43 to 53 kHz	≤±0.1 dB	≤±0.3 dB
53 to 61 kHz	≤±0.2 dB	≤±1 dB
61 to 70 kHz	≤±0.5 dB	≤±3 dB
70 to 75 kHz	≤±1.5 dB	≤±5 dB

Stereo crosstalk between L and R channel
measured via stereodecoder,
without deemphasis

40 Hz to 5 kHz	≥–50 dB	≥–37 dB
5 to 15 kHz	≥–44 dB	≥–31 dB

Nonlinear distortions
THD measured at MPX signal
output (mono)

	Δf 75 kHz		Δf 100 kHz	
	FM wide	FM narrow	FM wide	FM narrow
40 Hz to 5 kHz	–	≤0.5%	–	≤1%
40 Hz to 15 kHz	≤0.25%	–	≤0.5%	–

Measured via stereodecoder	Stereo		Mono	
	FM wide	FM narrow	FM wide	FM narrow
40 Hz to 5 kHz				
Δf 75 kHz	≤0.3%	≤0.8%	≤0.25%	≤0.5%
Δf 100 kHz	≤0.6%	≤1.6%	≤0.5%	≤1%

Difference-frequency distortion
to IEC 268-3
measured at MPX signal
output (mono),
difference frequency 1 kHz,
Δf 75 kHz

	FM wide	FM narrow
5 to 15 kHz		
d_2	≤0.1%	≤0.25%
d_3	≤0.15%	≤0.37%
15 to 53 kHz		
d_2	≤0.2%	≤0.5%
d_3	≤0.3%	≤0.75%
Difference frequency 1 kHz, Δf 100 kHz		
5 to 15 kHz		
d_2	≤0.2%	≤0.5%
d_3	≤0.3%	≤0.75%
15 to 53 kHz		
d_2	≤0.4%	≤1%
d_3	≤0.6%	≤1.5%

S/N ratio
to CCIR 468-4, deemphasis 50 µs,
ref. to Δf 40 kHz
Unweighted S/N ratio,
low-noise mode[2])

	Stereo			Mono		
f_{in}/MHz:	5 to 130	130 to 470	470 to 1000	5 to 130	130 to 470	470 to 1000
Input level						
≥200 µV	–	–	–	≥63 dB	≥63 dB	≥63 dB
≥2 mV	≥75 dB	≥68 dB	≥65 dB	≥80 dB	≥80 dB	≥78 dB
≥20 mV	≥75 dB	≥68 dB	≥65 dB	≥80 dB	≥80 dB	≥78 dB

Weighted S/N ratio,
low-noise mode[2])

	Stereo			Mono		
f_{in}/MHz:	5 to 130	130 to 470	470 to 1000	5 to 130	130 to 470	470 to 1000
Input level						
≥200 µV	–	–	–	≥58 dB	≥58 dB	≥58 dB
≥2 mV	≥58 dB	≥58 dB	≥56 dB	≥76 dB	≥76 dB	≥74 dB
≥20 mV	≥70 dB	≥63 dB	≥60 dB	≥76 dB	≥76 dB	≥74 dB

TV dual sound

Input signal	TV dual-sound signal, standard B/G, at IF or in bands I, II and IV, V, with and without modulated vision carrier
Deviation measurement error 30 Hz to 15 kHz, Δf ≤70 kHz	≤±1% + residual FM
Difference error with successive deviation measurement, sound channel 1/sound channel 2, 30 Hz to 15 kHz	≤±0.3% + residual FM

Non-linear distortions THD	Δf 50 kHz	Δf 70 kHz
f_{mod} 30 Hz to 5 kHz	≤0.3%	≤0.5%
f_{mod} 5 to 15 kHz	≤0.5%	≤1%

Difference-frequency distortion (30 Hz to 15 kHz)		
d_2	≤0.2%	≤0.3%
d_3	≤0.3%	≤0.5%

S/N ratio
Quasi-peak measurement to CCIR 468-4, weighted and unweighted. Deemphasis 50 µs referred to Δf 30 kHz.

Input level (selective)	Unweighted	Weighted
≥200 µV	≥53 dB	≥53 dB
≥2 mV	≥73 dB	≥73 dB

Channel crosstalk, ref. to Δf 30 kHz, selective measurement, deemphasis 50 µs, other sound subcarrier modulated with frequencies from 30 Hz to 15 kHz, Δf 55 kHz, level (selective) ≥5 mV	≥80 dB

Ordering information

Order designation	Selective Modulation Analyzer FMAS	856.6001.52
Accessories supplied	special cable for firmware update, manual, power cable, spare fuses	
Options		
AM/FM Calibrator/AF Generator	FMA-B4	855.6008.52
Reference Oscillator ($\Delta f/f\ 10^{-7}$/year)	FMA-B10	856.3502.52
Other options	see FMA/FMB data sheet PD 756.9300	
Recommended extras		
Log-periodic Antenna	HL023 A1	577.8017.02
High-power Attenuator (20 dB, 50 W)	RDL50	1035.1700.52
To be fitted into FMA or FMAB		
AF Analyzer/DSP Unit	FMA-B8	855.9007.55
RF/IF Selection	FMA-B9	856.6501.52

[1]) In the range 15 to 35°C, over the full temperature range the error doubles.

[2]) In the low-distortion mode, the S/N value may be lower by up to typ. 3 dB

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Modulation Analyzer FMAV

Modulation analysis for VOR/ILS air navigation

Modulation Analyzer FMAV, a member of the FMA family, features the versatile measurement functions of the FMA basic model and fulfills the requirements for measurements on ground stations of VOR/ILS air navigation systems.

With its extremely low measurement error achieved by means of digital signal processing, FMAV meets the stringent requirements placed on measuring instruments for ILS systems of category III.

The comprehensive measurement functions make FMAV ideal for all modulation measurements including phase measurements on ILS/VOR systems as well as for use as a calibrator for VOR/ILS signal generators.

FMAV has been designed especially for air-traffic control authorities, airport operators as well as for manufacturers of air navigation test systems and airborne systems.

Due to its unrivalled measurement accuracy, comprehensive measurement functions and great ease of operation, FMAV ensures an extremely high reliability standard of air navigation systems.

ROHDE&SCHWARZ

All essential test parameters can be read at a glance on clearly arranged LCD displays

Special FMAV measurements

- Selective modulation depth measurement on VOR/ILS systems with an error of less than 0.8% (for ILS: ≤0.5%)
- DDM measurement with an error of ≤0.0002 DDM for localizer and ≤0.0005 DDM for glide path
- Deviation measurement of VOR subcarrier
- Modulation frequency measurement of VOR/ILS signals
- ILS/VOR phase measurement with extremely high accuracy and resolution down to 0.001°

General FMAV measurements

- RF frequency measurement with 10-digit readout and error ≤10 Hz at 100 MHz within calibration interval thanks to highly stable reference oscillator (aging $<10^{-9}$/day)
- AM, FM and φM measurements over a wide modulation frequency range
- AF measurement with 5-digit readout
- Selective distortion and intermodulation measurement
- Universal filter capabilities, psophometric weighting filters (optional)
- AF voltage measurement
- RF power measurement with error of typ. <0.5 dB

Characteristics

In addition to the broadband analog demodulators, AF filters and detectors of the FMA basic model, FMAV has a signal processor.

This signal processor module allows the relatively narrowband modulation contents of air navigation signals to be sampled at the IF already and then digitally demodulated, filtered and evaluated.

The IF is digitized by a 16-bit A/D converter; the digital sampling values are further processed by the signal processor.

In contrast to analog demodulators, filters and detectors, the digital AF filters of the signal processor module are practically error-free and have no drift whatsoever due to aging or temperature.

The digitally demodulated and filtered signals are additionally converted into analog signals by a D/A converter and are available as two channels at two BNC connectors on the rear panel, eg for visual checking on an oscilloscope.

Operation

Due to its versatile measurement functions, the FMAV is menu-controlled so that there is no need for a great number of individual keys.

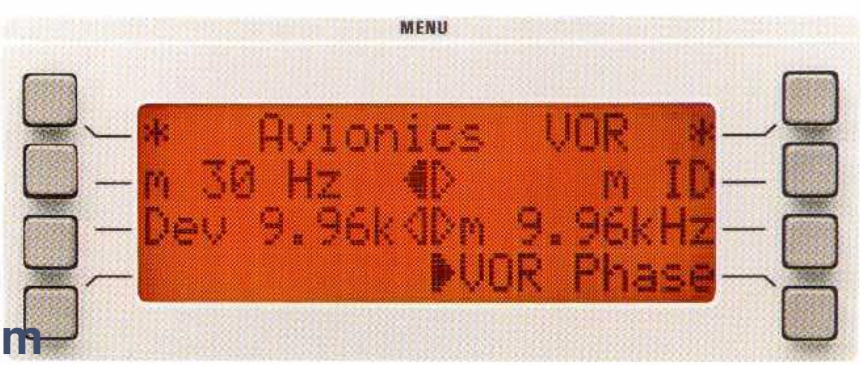
A minimum number of main function keys as well as an alphanumeric menu display with four softkeys down each side make for clear front-panel layout and fast access to the desired measurement functions. Important functions are at the top of the menu hierarchy, the number of submenu levels being limited to a maximum of three so that finding one's way in the menu is easy.

Three large, illuminated LCD displays simultaneously read out the measured values for:

- carrier frequency or power
- modulation depth, deviation or DDM
- modulation frequency, distortion or phase

Device status and settings are also displayed.

Softkeys enable fast access to desired measurement functions



Parameters, like for instance a reference value for relative display, can be entered via the numeric keypad and are terminated with one of the ENTER keys (unit/multiplier key). The fact that up to 20 complete setups can be stored considerably enhances the measurement reliability in complex applications.

Modulation Analyzer FMAV features full remote-control capability. The IEC-bus interface complies with the IEEE 488.2 standard and enables plain-text programming, which greatly facilitates program writing. The inquiry for the ILS DDM value, for instance, reads: DEMODULATION: AVIONICS:ILS:DDM?

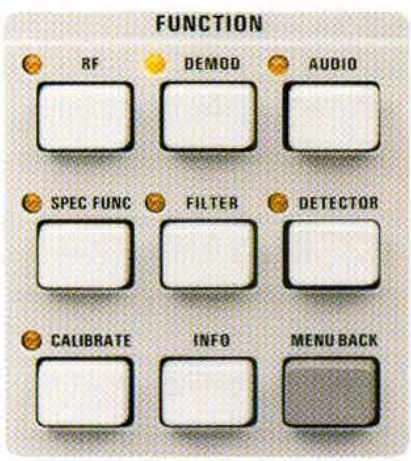
Measurement functions

ILS signals

- Selective measurement of 90-Hz, 150-Hz and sum modulation depth without influence from additional signals (identifiers) with an error of less than 0.5% of reading
- Measurement of modulation depth of identifier signal in the range from 300 Hz to 4 kHz without influence from ILS signals
- High-precision DDM measurement with an error of less than 0.0002 DDM for localizer and 0.0005 DDM for glide path
- Selective measurement of modulation frequency
- 90-Hz/150-Hz phase measurement
- Unaffected selective measurement of all ILS distortion products

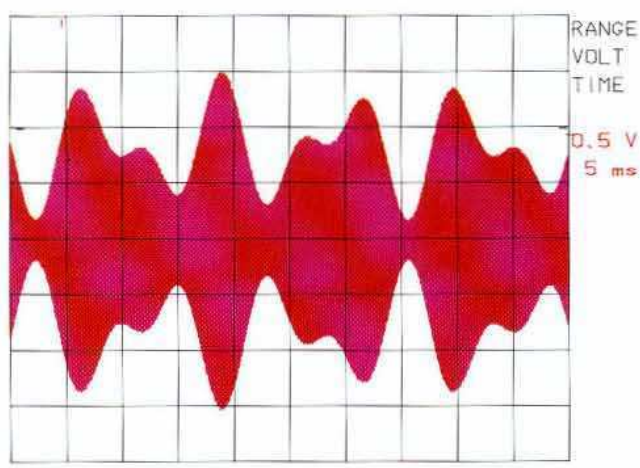
VOR signals

- Selective measurement of 30-Hz and 9.96-kHz modulation depth
- Modulation-depth measurement of identifier signal in the range from 300 Hz to 4 kHz without impairment from VOR signal
- Deviation measurement on 9.96-kHz subcarrier
- Modulation-frequency measurement at 30 Hz, 9.96 kHz and of FM-demodulated 30-Hz signal
- High-precision phase measurement on 30-Hz signals (error <0.02°)

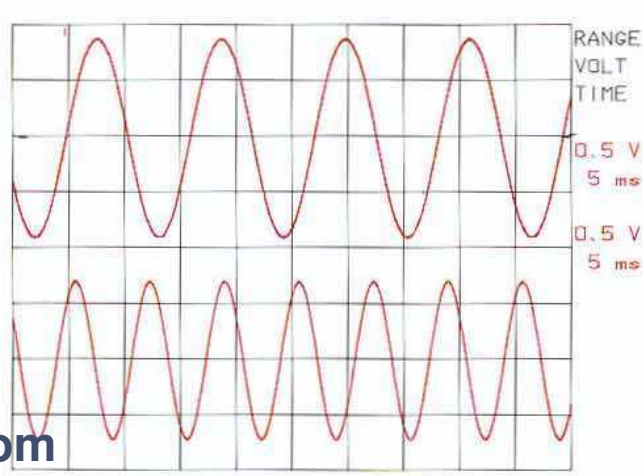


The few main function keys make the FMAV user-friendly:

RF	All RF settings such as tuning frequency, input level, RF frequency counter
DEMOD	Selecting the demodulation modes
AUDIO	Setting the audio frequency counter or the DIST/SINAD meter
SPEC FUNC	Special functions like voltmeter mode, IEC/IEEE-bus address, bargraph indicator, control etc.
FILTER	Selecting the audio filters
DETECTOR	Selecting the detector for the modulation display
CALIBRATE	Calibration functions
INFO	Readout of all internal settings on the menu display
MENU BACK	Going back a level in the menu tree



ILS signal
DDM=0.1 Δφ=45°:
90 Hz: m=45 %, φ=0°;
150 Hz: m=35 %, φ=45°



Demodulated ILS signal
top:
90 Hz (φ=0°), filtered;
bottom:
150 Hz (φ=45°), filtered

TACAN signals*)

- Selective measurement of 15-Hz, 135-Hz and sum modulation depth with an error of less than 0.5% of reading
- Phase measurement 15 Hz/135 Hz
- Selective measurements of modulation frequency
- Distortion measurement (optional) using the standard analog AM demodulator at all modulation frequencies from 10 Hz to 100 kHz

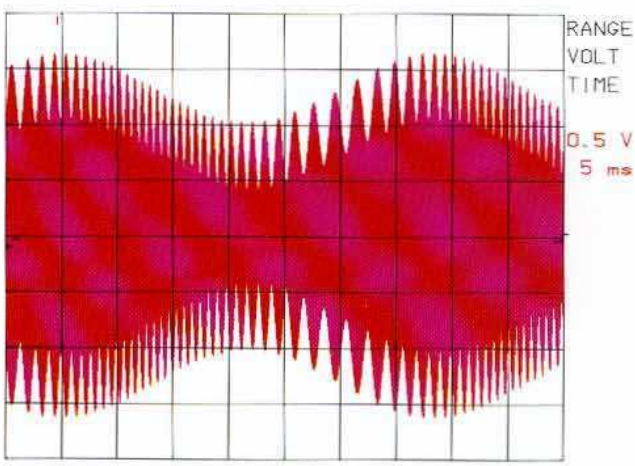
In-depth AF analysis

based on selective harmonic distortion and intermodulation measurement is standard with the FMAV

- Selective harmonic distortion measurement of d_2, d_3, ... d_i
- True THD measurement of intermodulation products to IEC 268-3
- Universal measurement of intermodulation products to IEC 268-3
- Scaled display of AF spectrum by direct connection of an oscilloscope
- Selective distortion measurement on n x 30 Hz components (ILS signal)
- Baseband ILS and VOR measurements at voltmeter input

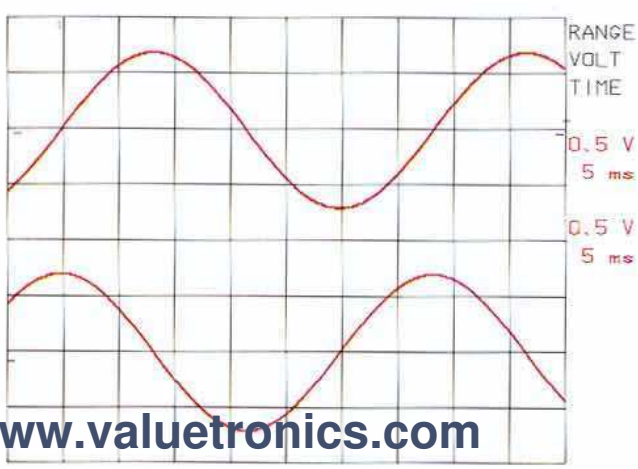
*) Measurements are possible only on nonpulsed signals, not on realworld TACAN signals.

Certified Quality System
ISO 9001
DQS REG. NO 1954-02



VOR signal
30 Hz: m=30 %,
φ=90°
9.96 kHz*): m=30 %
FM:
deviation 480 Hz
f_{mod}=30 Hz
phase=0°
(reference)

*) Frequency not to scale



Demodulated VOR signal
top:
FM-demodulated reference signal (φ=0°)
bottom:
AM-demodulated signal, 30-Hz filtering (φ=90°)

Options

The options available for the FMA basic model can also be used for the FMAV as far as they are appropriate for the FMAV applications.

Filter FMA-B1

This filter option contains universal analog AF filters, of which CCITT filter P53 is of special interest, since it allows weighted noise measurements in radiotelephone systems.

AM/FM Calibrator/AF Generator FMA-B4

The high-precision internal modulation source (error <0.1%) is used for calibrating the built-in analog demodulators and the AF measurement section. It also enables a simple performance check of the digital VOR/ILS measurement section.

Since this option is able to produce high-precision VOR/ILS baseband signals (2 rear AF outputs), signal generators can be modulated and hence be used in VOR/ILS systems.

RF/IF Selection FMA-B9 (model .57)

The retrofittable option RF/IF selection from 5 to 400 MHz extends the FMAV to a calibrated VOR/ILS receiver of high sensitivity for off-air measurements.

Specifications

Frequency range	50 kHz to 1360 MHz
Frequency tuning	automatic[1]) or manual
Display	10-digit readout
Resolution	0.1/1/10/100 Hz selectable
Frequency error	±1 digit + error of reference frequency
Reference oscillator	
Aging	1×10^{-7}/year
After 30 days of operation	1×10^{-9}/day
Temperature effect	2×10^{-9}/°C
Warmup time	15 min
External reference input/output	manual or remote-controlled switchover
RF input	Z_{in} = 50 Ω, N connector, VSWR <1.4 with 10-dB attenuation
Overload protection	up to 5 W (15 V RMS)
Maximum peak voltage	25 V (including DC)
RF power measurement	
Frequency range	50 kHz to 1360 MHz
Power measurement range	0.18 µW to 1 W (–37.5 to + 30 dBm)
Measurement error	
0.18 µW ≤P <0.1 mW	≤1.5 dB ±0.05 µW
P ≥0.1 mW	≤1 dB (typ. 0.5 dB)
Amplitude modulation measurement	
Modulation frequency range	10 Hz to 200 kHz
Resolution	0.1% of rdg; max 0.001% AM

Measurement error[2]) with peak detection (% of rdg, plus peak residual AM)

f_{in}	50 to 300 kHz	300 kHz to 10 MHz	≥ 10 MHz	error
	f_{mod}			
m ≤80%	30 Hz to 3 kHz	30 Hz to 10 kHz	30 Hz to 20 kHz	≤0.8%
m ≤95%	–	30 Hz to 20 kHz	30 Hz to 100 kHz	≤1%
	10 Hz to 8 kHz	10 Hz to 20 kHz	10 Hz to 100 kHz	≤2%
	–	10 Hz to 50 kHz	10 Hz to 200 kHz	≤5%

Residual AM[3])	
to CCITT	≤0.01%
20 Hz to 23 kHz, RMS	≤0.03%
to CCIR	≤0.05%
Incidental AM in FM mode (f_{mod} = 1 kHz, meas. bandwidth 20 Hz to 3 kHz)	
f_{in} = 50 kHz to 10 MHz, deviation = 5 kHz	≤0.2%
f_{in} ≥10 MHz, deviation = 50 kHz	≤0.1%
AF distortion[4]) for f_{mod} = 10 Hz to 20 kHz	
m = 40%	≤0.2%
40% <m ≤80%	≤0.4%
Frequency modulation measurement	
Modulation frequency range	10 Hz to 200 kHz

Maximum measureable deviation for

f_{in}	50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	f_{in}/10	150 kHz	700 kHz

Measurement error[2]) with peak detection (plus peak residual FM)

f_{in}	50 to 300 kHz		300 kHz to 10 MHz		≥10 MHz	
	f_{mod}	error	f_{mod}	error	f_{mod}	error
	30 Hz to 5 kHz	≤0.5%	30 Hz to 10 kHz	≤0.5%	30 Hz to 20 kHz	≤0.5%
	10 Hz to 8 kHz	≤2%	30 Hz to 20 kHz	≤1%	30 Hz to 100 kHz	≤1%
			10 Hz to 50 kHz	≤2%	10 Hz to 200 kHz	≤2%

Resolution better than 0.1% of rdg (min. 0.1 Hz)

Residual FM[3]) for f_{in}	≤340 MHz	≤680 MHz	≤1360 MHz
to CCITT, RMS	≤0.5 Hz	≤0.7 Hz	≤1 Hz
20 Hz to 23 kHz, RMS	≤2 Hz	≤3 Hz	≤5 Hz
CCIR weighting, 300 Hz to 50 kHz	≤3 Hz	≤4 Hz	≤6 Hz

AF distortion for deviation	75 kHz	500 kHz
f_{in} ≥10 MHz		
f_{mod} = 30 Hz to 20 kHz[5])	≤0.05%	≤0.2%
f_{mod} = 20 to 100 kHz	≤0.15%	≤0.5%
f_{in} >500 kHz		
f_{mod} = 30 Hz to 20 kHz	≤0.1%	
Incidental FM (m = 50%, f_{mod} = 1 kHz, BW = 20 Hz to 3 kHz, plus peak residual FM)	≤10 Hz	
Deemphasis	50/75/750 µs selectable, effective at AF output and, if selected, for readout of results	
Phase modulation measurement		
Modulation frequency range	200 Hz to 200 kHz	

Maximum measurable deviation (up to max. 1 kHz AF, –6 dB/octave for f >1 kHz)

f_{in}	50 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	1/10 x f_{in}/kHz x 1 rad	150 rad	700 rad

Error[2]) of peak detection (plus peak residual φM)

f_{mod}	300 Hz to 5 kHz	300 Hz to 10 kHz	300 Hz to 100 kHz
	≤2%	≤2%	≤2%

Resolution	<0.1% (minimum 0.0001 rad)	
Residual φM[3]) for f_{in}	≤680 MHz	>680 MHz
CCITT weighting	≤0.002 rad	≤0.004 rad
300 Hz to 23 kHz	≤0.005 rad	≤0.01 rad
AF distortion (at AF output), f_{mod} = 200 Hz to 20 kHz, Δφ = 4 rad, f_{in} ≥500 kHz	≤0.1%	
AF voltmeter		
DC voltage measurement		
Range	±10 µV to 20 V	
Offset voltage[6])		
unbalanced input	≤1 mV) can be corrected to ≤30 µV	
balanced input	≤3 mV) using offset function	
Resolution	<0.1%	
Error		
3-kHz lowpass filter	±0.5% ± 100 µV ± offset voltage	
5-Hz lowpass filter (with filter option)	±0.5% ± 10 µV ± offset voltage	
AC voltage measurement		
Frequency range	10 Hz to 300 kHz	
Measurement range	30 µV to 20 V	
Resolution	0.1% of rdg	
Error (RMS detector)		
30 Hz to 20 kHz	≤1% ± 30 µV (100-kHz lowpass filter)	
10 Hz to 100 kHz	≤2% ± 100 µV (without lowpass filter)	
10 Hz to 200 kHz	≤3% ± 100 µV (without lowpass filter)	
Weighting facilities	all AF measuring facilities, such as detector, filter, frequency counter and distortion meter, can also be used in voltage measurements	
Inputs		
unbalanced	input impedance 100 kΩ ‖ 50 pF, BNC connector	
balanced	input impedance 600 Ω, three-contact connectors to DIN 41628	
AF detector		
Peak detector	positive or negative peak of AF or the arithmetic mean of the two	
RMS detector	true RMS-responding rectifiers, readout as RMS value or converted to peak for sinewave	
Quasipeak detector	detector to CCIR Rec. 468-4	
Weighting filters		
Highpass filters	10 Hz (2nd order) 20 Hz (3rd order) 300 Hz (2nd order)	
Lowpass filters	3 kHz (4th order) 23 kHz (4th order, combined with 20-Hz highpass filter to CCIR 468-4, unweighted) 100 kHz (4th order)	

Filter option	CCIR 468-4 (weighted) CCITT P53 5-Hz lowpass (for DC measurement) 30-kHz Bessel lowpass, 4th order 120-kHz Bessel lowpass, 4th order 4.2-kHz Cauer lowpass special φM filter (phase modulation for modulation frequency ≤10 Hz) external filters possible

AF frequency display

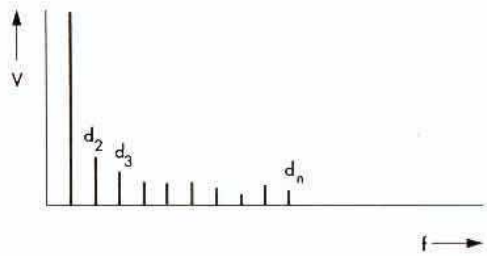
Frequency range	5 digits 10 Hz to 300 kHz
Resolution	1 mHz to 10 Hz
Error	±0.005% ± 3 mHz ± 1 digit

Selective distortion measurement

Readout	in % or dB
Display range	0.001 to 20%, −100 to −14 dB
Measurement of individual distortion d_i (i = 2, 3, ... 10)	
Measurement error	
10 Hz ≤ f_1 ≤14 kHz, f_{di} ≤ 42 kHz	≤5% of rdg ± 0.02% absolute

THD measurement

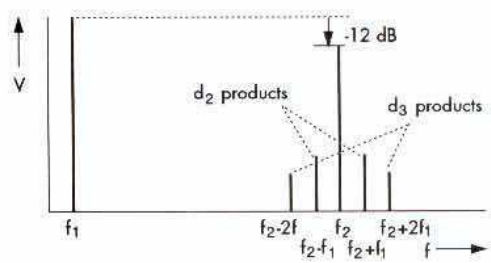
Measurement of harmonic i = n (n = 2 to 10 selectable)	
Measurement error	
10 Hz ≤ f_1 ≤14 kHz, f_{dn} ≤42 kHz	≤5% of rdg ± 0.03% absolute



Intermodulation measurement

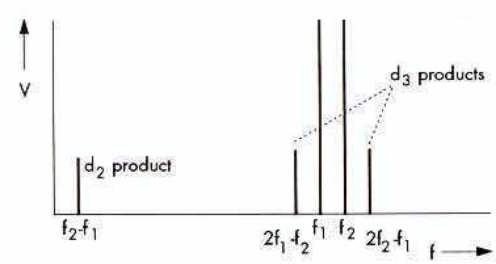
Intermodulation distortion d_2, d_3 to DIN 45403 and IEC 268-3

Readout	in % or dB
Display range	0.001 to 20%, −100 to −14 dB
Measurement error	
$f_2 + 2 \times f_1$ ≤42 kHz, f_1 ≥10 Hz	≤5% of rdg ± 0.1% absolute



Difference-frequency distortion d_2, d_3 to DIN 45403 and IEC 268-3

Readout	in % or dB
Display range	0.001 to 20%, −100 to −14 dB
Measurement error (f_2–f_1 ≥30 Hz)	
2 x f_2–f_1 ≤42 kHz	≤5% of rdg ± 0.05% absolute



Measurement of distortion and intermodulation products on ILS signals

(AM with 90 Hz, 150 Hz (DDM=0) and identifier signal 1020 Hz)

Selectable single or total harmonic distortion (THD) measurement on 90 Hz, 150 Hz and 1020 Hz components	
Accuracy	≤5% of rdg ±0.1% absolute
Selective distortion measurement of n x 30 Hz components from 30 to 1200 Hz relative to 90 Hz component (=100%)	
Accuracy	≤5% of rdg ±0.1% absolute
Total harmonic distortion (THD) measurement of speech channel from 300 Hz to 3 kHz (90, 150 Hz components on, 1020 Hz comp. off)	
Accuracy	≤5% of rdg ±0.1% absolute

Measuring time

Automatic tuning; RF, modulation and modulation frequency measurement with 10 Hz RF resolution (highpass filter and PK detector switched on)	typ. 1 s
Fast modulation measurement (RF, modulation range and level programmed)	≤120 ms
DIST measurement f_{mod} ≥ 30 Hz	typ. 2.5 s
f_{mod} ≥ 300 Hz	typ. 1 s

Outputs

IF output	max. 200 mV into 50 Ω
AM output	max. 1 V into 600 Ω (can be DC-coupled)
FM/φM output	
for FM	6 dBm (1.545 V) into 600 Ω, 40 kHz deviation (DC-coupled)
for φM	1.545 V into 600 Ω, 40 rad
Distortion output (with optional DIST/SINAD meter)	max. 1 V into 600 Ω
AF output	1 to 4 V into 600 Ω (peak voltage)
10-MHz reference frequency	input/output selectable
Output	+12 dBm, 50 Ω
Input	−10 to +12 dBm
Deflection for external oscilloscope	
DSP1	Y deflection, 0 to 4 V, BNC female
DSP2	X deflection, 0 to 4 V, BNC female
Scale markers	
Vertical	13 markers, 10 dB/div
Horizontal	10 markers

Remote control

Interface	IEC 625-1/625-2 (IEEE 488.1/488.2) connector: 24-contact Amphenol; controlling all device functions including Serial Poll and Parallel Poll
Interface functions	SH1, AH1, L4, T5, SR1, RL1, DC1, DT1, PP1, C0

VOR/ILS-specific data

These data are guaranteed within the frequency ranges specified (f_{in}). They are typical values for all frequencies ≥10 MHz

VOR

f_{in}: 10 MHz; 108 to 120 MHz	
Amplitude modulation measurement	
m: 10 to 90%	
f_{mod}	measurement error[7]) (% of rdg)
30 Hz ± 1%	≤0.8%
9.96 kHz ± 1%	≤0.8%
300 Hz to 4 kHz	≤1.2% (typ. ≤0.8%)
Frequency modulation measurement at 9.96-kHz carrier	
Max. measurable deviation	700 Hz
f_{mod}	measurement error[7]) (% of rdg)
30 Hz ±1%	≤0.5% ± 0.1 Hz
Phase difference measurement at 30 Hz	
Measurement range	0 to 360°
Measurement error	≤±0.03° (typ. ≤±0.02°)
Resolution	≤0.01°

ILS
f_{in}: 10 MHz; 108 to 120 MHz; 328 to 336 MHz
Amplitude modulation measurement
m: 10 to 90%

f_{mod}	measurement error[7]) (% of rdg)
90 Hz ± 2%	≤0.5%
150 Hz ± 2%	≤0.5%
300 Hz to 4 kHz (identifier)	≤1.5% (typ. ≤0.8%)

DDM measurement
Measurement range: 0 to ± 0.2 DDM
f_{mod}: 90 Hz ±1% and 150 Hz ± 1%

m	measurement error[7])
18 to 22%	≤±0.0002 DDM ± 0.1% of rdg
32 to 48%	≤±0.0005 DDM ± 0.1% of rdg

Resolution: ≤0.0001 DDM

Measurement of phase angle between 90-Hz and 150-Hz signals	
Measurement range	±60°
Measurement error	≤±0.2°
Resolution	≤0.01°

TACAN*)
f_{in}: 10 MHz; 950 to 1250 MHz

Amplitude modulation measurement
m: 10 to 90%

f_{mod}	measurement error[7]) (% of rdg)
15 Hz ± 2%	≤0.5%
135 Hz ± 2%	≤0.5%

Measurement of phase angle between 15-Hz and 135-Hz signals	
Measurement range	±180° (135 Hz)
Measurement error	≤±0.5°
Resolution	≤0.01°

*) Measurements are possible only on nonpulsed signals (not on realworld TACAN signals)

AF outputs DSP1, DSP2	max. 4 V into 600 Ω
DC offset	≤±3 mV
Additional error	
Scaling for AM	4 V/100% ± 1% ± 2 mV
Scaling for FM	4 V/1 kHz ±1% ± 2 mV
Gain difference for ILS (90 to 150 Hz)	0.2%
Phase difference for	
VOR (30 Hz)	0.05°
TACAN (15 to 135 Hz)	0.2°
ILS (90 to 150 Hz)	0.3°

VOR/ILS baseband at voltmeter UNBAL input
AM sensitivity 100 mV to 10 V peak, 100% AM

VOR:
Amplitude modulation measurement

f_{mod}	measurement error [7]) (% of rdg)
30 Hz ± 1%, 9.96 kHz ± 1%	≤0.8%
300 Hz to 4 kHz (identifier)	≤1.2%

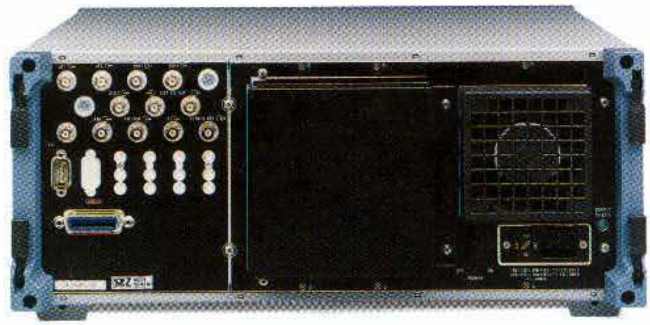
Frequency modulation measurement at 9.96 kHz carrier
Maximum measurable deviation 700 Hz

f_{mod}	measurement error [7])
30 Hz ± 1%	≤0.5% ± 0.1 Hz

Phase difference measurement at 30 Hz	
Measurement range	0 to 360°
Measurement error	≤±0.02°
Resolution	≤0.01°

ILS:
Amplitude modulation measurement

f_{mod}	measurement error [7]) (% of rdg)
90 Hz ± 2%, 150 Hz ± 2%	≤0.5%
300 Hz to 4 kHz (identifier)	≤1.5%



Rear view of FMAV

DDM measurement
Measurement range 0 to ± 0.2 DDM
f_{mod} 90 Hz ± 1%, 150 Hz ± 1%

m	measurement error [7])
18 to 22%	≤±0.0002 DDM ± 0.1% of rdg
32 to 48%	≤±0.0005 DDM ± 0.1% of rdg

General data

Environmental conditions	to IEC 359, class I
Rated temperature range	0 to +55 °C
Storage temperature range	–40 to +70 °C
RFI suppression	complies with VDE 0871, limit B and German PTT regulations 527/1979
Power supply	100/120/220/240 V ± 10%, 47 to 440 Hz (170 VA)
Dimensions, weight	435 mm x 192 mm x 460 mm, 19 kg

[1]) For amplitude-modulated signals: P_{in} ≥–27 dBm, m ≤80%.
[2]) In temperature range 20 to 30 °C, additional error of ±0.5% over entire temperature range; error of RMS detection may be up to twice as high as of peak detection.
[3]) For input level ≥20 dB above specified minimum input level.
[4]) For f_{in}<300 kHz: f_{mod}=10 Hz to 8 kHz.
[5]) 100-kHz lowpass filter switched in.
[6]) Input attenuator switched on: value x 10.
[7]) In temperature range 20 to 30 °C, additional error ±0.3% over entire temperature range.

Ordering information

Order designation	VOR/ILS Modulation Analyzer FMAV	856.4509.52
Accessories supplied	special cable for firmware update, manual, power cable, spare fuses	
Options		
Filter	FMA-B1	855.2002.52
AM/FM Calibrator/AF Generator	FMA-B4	855.6008.52
RF/IF Selection	FMA-B9	856.6501.57
Recommended extras		
High-power Attenuator, 20 dB, 50 W	RDL 50	1035.1700.52
19" Adapter	ZZA-94	396.4905.00
Set of Front Handles	ZZG-94	396.5160.00
Transit Case	ZZK-944	1013.9366.00
Service Kit	FMA-Z1	856.4009.52

Certified Quality System
ISO 9001
DQS REG. NO 1954-02

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