ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

MODULATION ANALYZER

FMA

50 kHz to 1360 MHz — **852.8500.52**

FMAB

50 kHz to 1360 MHz — **856.4750.52**

FMAS

50 kHz to 1360 MHz — **852.6061.52**

FMAV

50 kHz to 1360 MHz — **856.4509.52**

FMB

50 kHz to 5.2 GHz — **856.5005.52**

Printed in the Federal
Republic of Germany

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to ISO 9001.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément à la norme ISO 9001.

ROHDE & SCHWARZ

095.1000 Bl.0 ./96

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Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:
   IP degree of protection 2X, Pollution severity 2, overvoltage category 2, altitude max. 2000 m.
   The unit may be operated only from supply networks fused with max. 16 A.
2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards.
   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).
3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.
4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.
5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.
   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.
6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.
7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.
   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.
8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.
   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.
9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.
   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.
   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.
   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.
   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. Any additional safety instructions given in this manual are also to be observed.

ROHDE&SCHWARZ
EC Certificate of Conformity

CE

Certificate No.: 960295

This is to certify that:

Equipment type	Order No.	Designation
FMA	0852.8500.52	Modulation Analyzer
FMAB	0856.4750.52	
FMAS	0856.6001.52	
FMAV	0856.4509.52	
FMB	0856.5005.52	

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1996

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 02.12.96

Central Quality Management FS-QZ / Becker

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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 guarantees 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.

ROHDE&SCHWARZ

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.

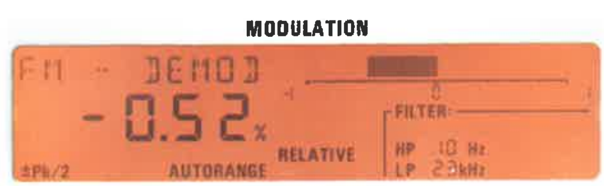
Display

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.

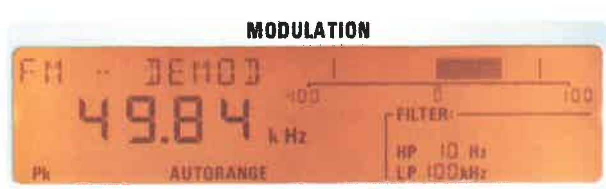
A scaled bargraph indicator with a high resolution of one hundred divisions is provided, in particular for adjustments made during modulation or voltage measurements.

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.



The analog bargraph indicator is ideal for adjustments, eg to a defined reference value



In min/max hold mode, the current result can be displayed in analog form between minimum and maximum values

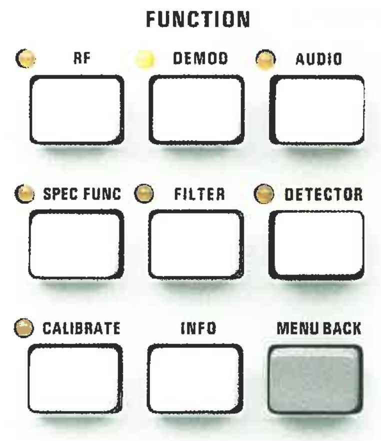
Operation

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:

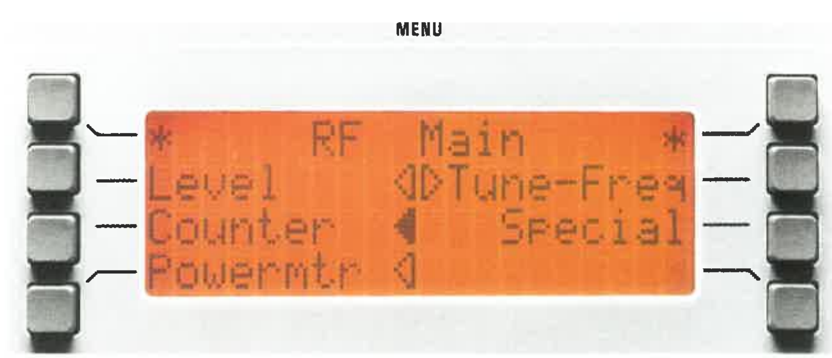
RF	All RF settings such as tuning frequency input level RF frequency counter
DEMOD	Selecting the demodulation mode
AUDIO	Setting the AF counter and DIST/SINAD meter
SPEC FUNC	Special functions such as voltmeter mode, IEC-bus address, bargraph indicator control, etc.
FILTER	Selecting the audio filters
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

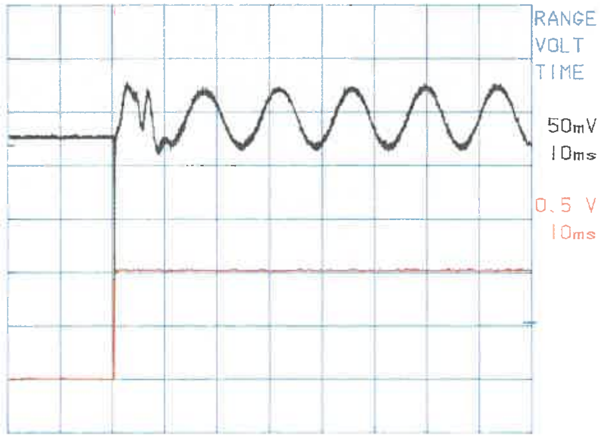
The FMA and FMB provide comprehensive measurement functions for conventional modulation analysis:

- 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 highpass 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 high-precision attenuator and special calibration facility the FMB guarantees a value of ≤0.3 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.



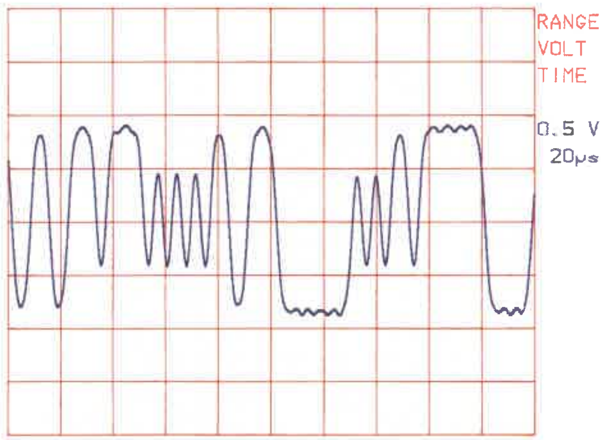
Transient measurement on radio sets

Upper curve: FM output signal

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

Application

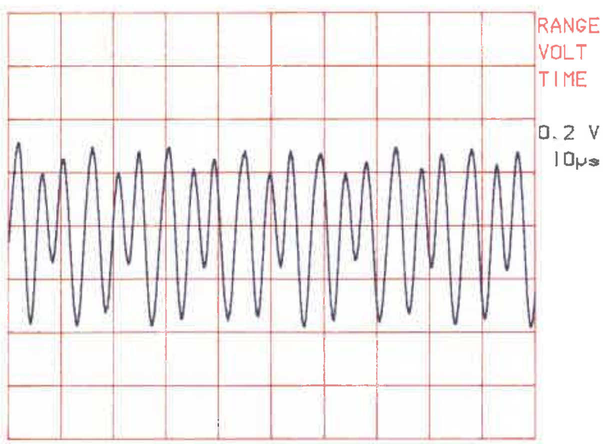
A phase-compensated noise-suppression filter is provided at the FM-MPX output, mainly for use with the internal or any external stereo decoder.



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

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.



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

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

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 100 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.

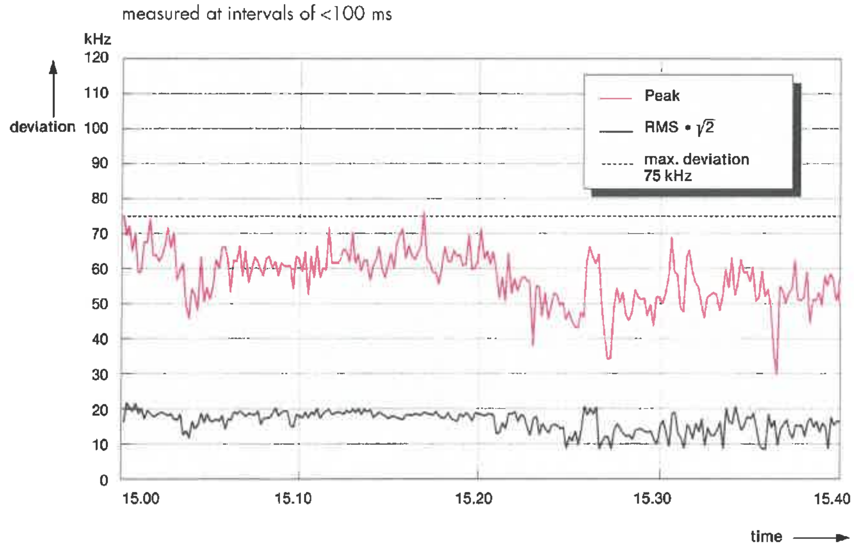
Stereo Decoder FMA-B3

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	1×10^{-6}/year	1×10^{-7}/year
after 30 days of operation	–	1×10^{-9}/day
Temperature effect	2.5×10^{-6} (0 to 55 °C)	2×10^{-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	≤1.4	≤2	≤2
in power-meter mode (attenuation ≥20 dB)	≤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 (±0.05 µW)	±0.3 dB	±0.5 dB
f_{in} = 1.36 GHz to 5.2 GHz	±1.5 dB (±0.05 µW)	±0.5 dB	±1 dB

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 } can be corrected to
balanced input	≤3 mV } ≤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	≤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 II 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 ≥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} ≥30 Hz	typ. 2.5 s
≥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
Set of front handles	ZZG-94	396.5160.00
Transport Case	ZZK-944	1013.9366.00
High-power Attenuator 20 dB, 50 W	RDL50	1035.1700.52
Connector Unit	FMA-Z2	1048.8495.52

[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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ROHDE & SCHWARZ

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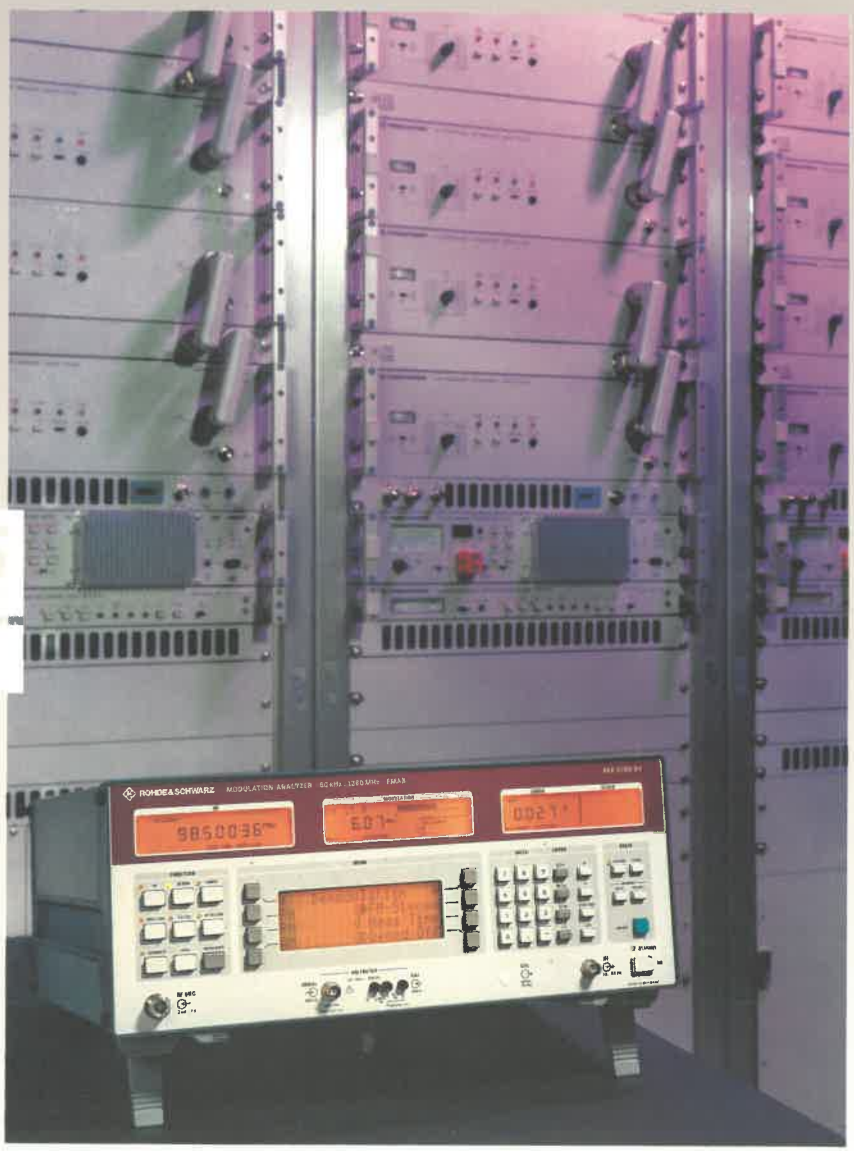
ROHDE&SCHWARZ

Modulation Analyzer
FMAB

50 kHz to 1360 MHz

The specialist
for sound broadcast
signals



IEC 625 Bus IEEE 488

- First analyzer with built-in precision stereodecoder
- External stereodecoder input
- Demodulation of RDS and traffic program signals
- CCIR detector and standard weighted/unweighted CCIR filters
- Distortion meter from 10 Hz to 100 kHz

Modulation Analyzer FMAB

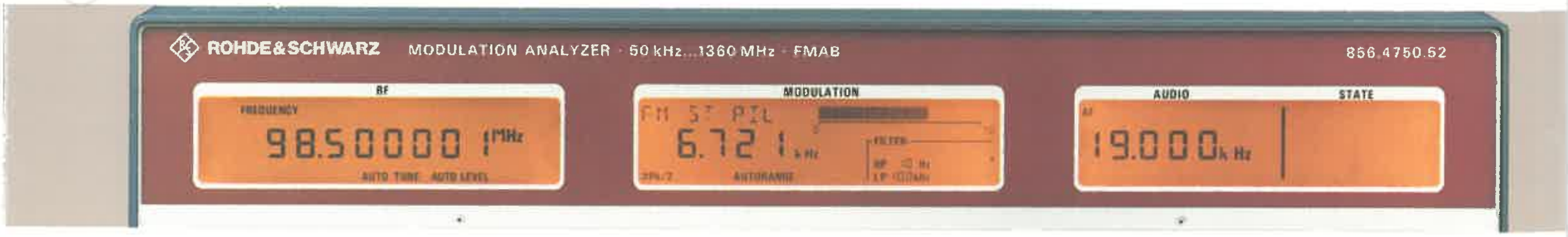
50 kHz to 1360 MHz

- RF frequency measurement with 10-digit readout
- High-precision AM, FM and φM measurement over a wide modulation frequency range
- Built-in precision stereodecoder both for internal FM stereo decoding and for decoding of an external stereo multiplex signal
- Complete AF analysis in the L, R, M, S channels including distortion measurement and S/N ratio measurement to CCIR standard
- Selective measurement of pilot 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)

Modulation Analyzer FMAB has been especially designed for the **analysis of FM stereo broadcast signals.** It combines the universal features of the FMA basic model and the additional measurement capabilities of the built-in stereodecoder.

The measurement tasks of the FMAB mainly cover the field of sound broadcasting and include comprehensive analysis of VHF transmitters, channel transposers and VHF/baseband converters. Since the stereodecoder with all its analysis functions can be separately used via the rear-panel input, measurements on FM receivers and stereocoders 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.



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

Characteristics

Thanks to the clear layout of the 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, etc. affords high measurement reliability.

The **precision stereodecoder** has been especially designed for wide dynamic range and flat amplitude and phase response that are required in FM stereo measurements. The values guaranteed for 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 stereodecoder. The values guaranteed meet the relevant specifications of broadcasting corporations and are even better in many cases.

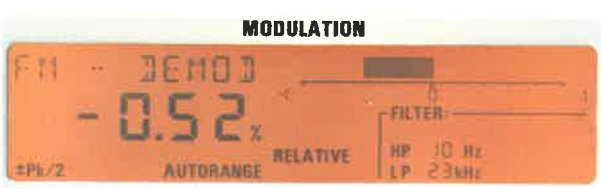
Dynamic range An extremely low-noise local oscillator (typ. —130 dBc at 1 GHz, 20-kHz carrier offset) ensures a sufficient S/N ratio for FM stereodecoding even far above the VHF band, eg for measurements on channel transposers in the UHF range. A weighted FM stereo S/N ratio of typically 78 dB for carrier 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, etc are superimposed on the relevant display.

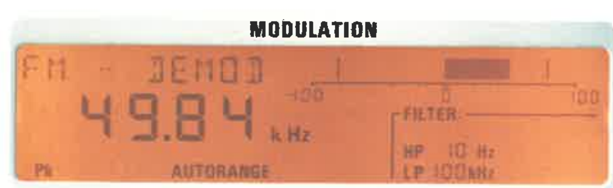
A scaled bargraph indicator with a high resolution (one hundred divisions) is provided especially for the alignment of DUTS followed by modulation and voltage measurements.

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, eg to a defined reference value



In min/max hold mode the current result can be displayed in analog form between minimum and maximum value

Operation

Due to its versatile measurement functions, the 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.

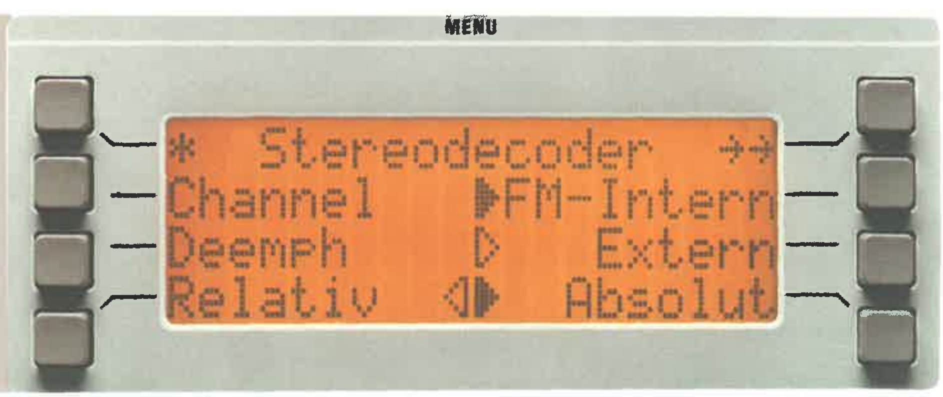
Parameters, like for instance a reference value for relative display, can be entered via the numeric keypad and are terminated with one of the ENTER keys (unit/multiplier keys). The fact that up to 20 complete setups can be stored considerably enhances the measurement reliability in complex applications.

Remote control The Modulation Analyzer FMAB features full remote-control capability. The FM stereo measurement facilities are system-compatible. The IEC-bus interface fully complies with the new 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 stereodecoding switched on, the following entry is made:

STEREODECODER:DEEMPHASIS 50 US

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

RF	All RF settings such as tuning frequency input level RF frequency counter
DEMOD	Selecting the demodulation modes and access to the FM stereodecoder functions
AUDIO	Setting the audio frequency counter or the DIST/SINAD meter
SPEC FUNC	Special functions like voltmeter mode, IEC-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

Measurement functions

The FMAB features standard measurement functions in modulation analysis and a wide variety of additional capabilities thanks to the built-in stereodecoder:

- 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 (700 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
  CCIR filters (468-4) weighted and unweighted
  CCITT and other special weighting filters
- Precision detectors: separate +PK and —PK detector with extremely short response time, MAX PEAK function
  True RMS detector
  Quasi-peak detector to CCIR 468-4
- AC and DC voltage measurement
- Power measurement (error typ. ≤0.5 dB, overload protection circuit for up to 5 W input power)

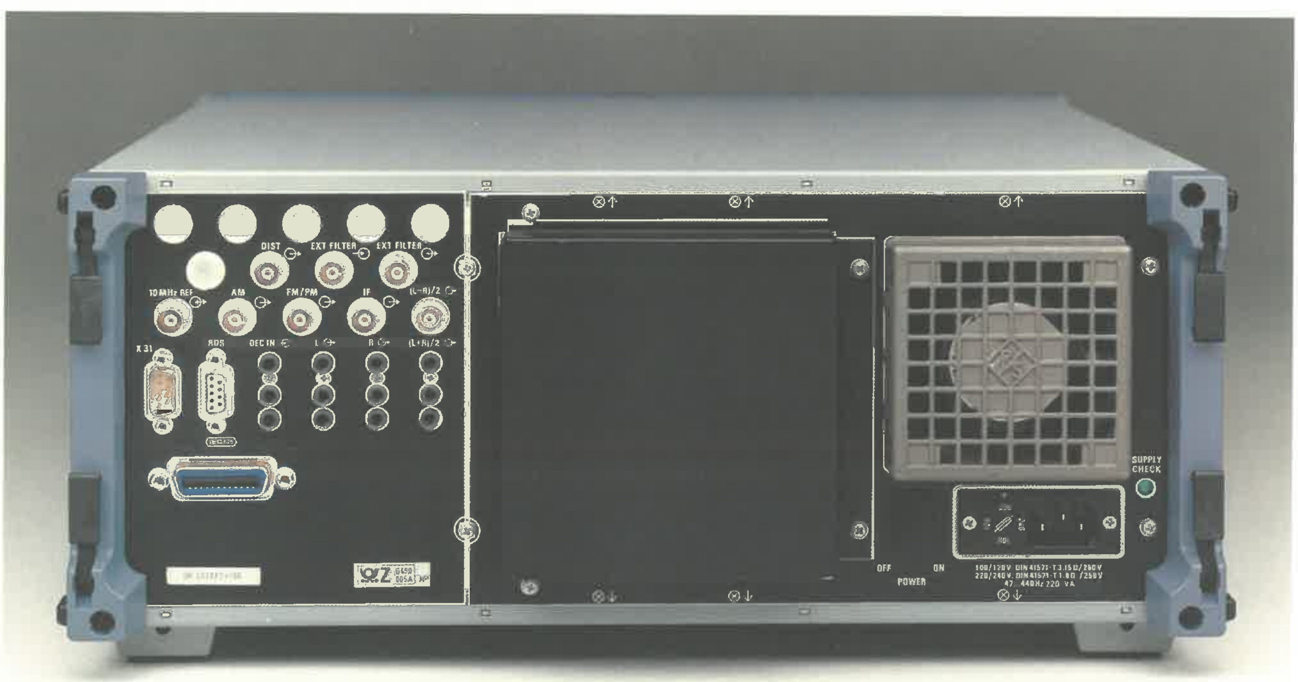
Options

The FMAB can be expanded by the optional highly stable **10-MHz Reference Oscillator (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 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%.

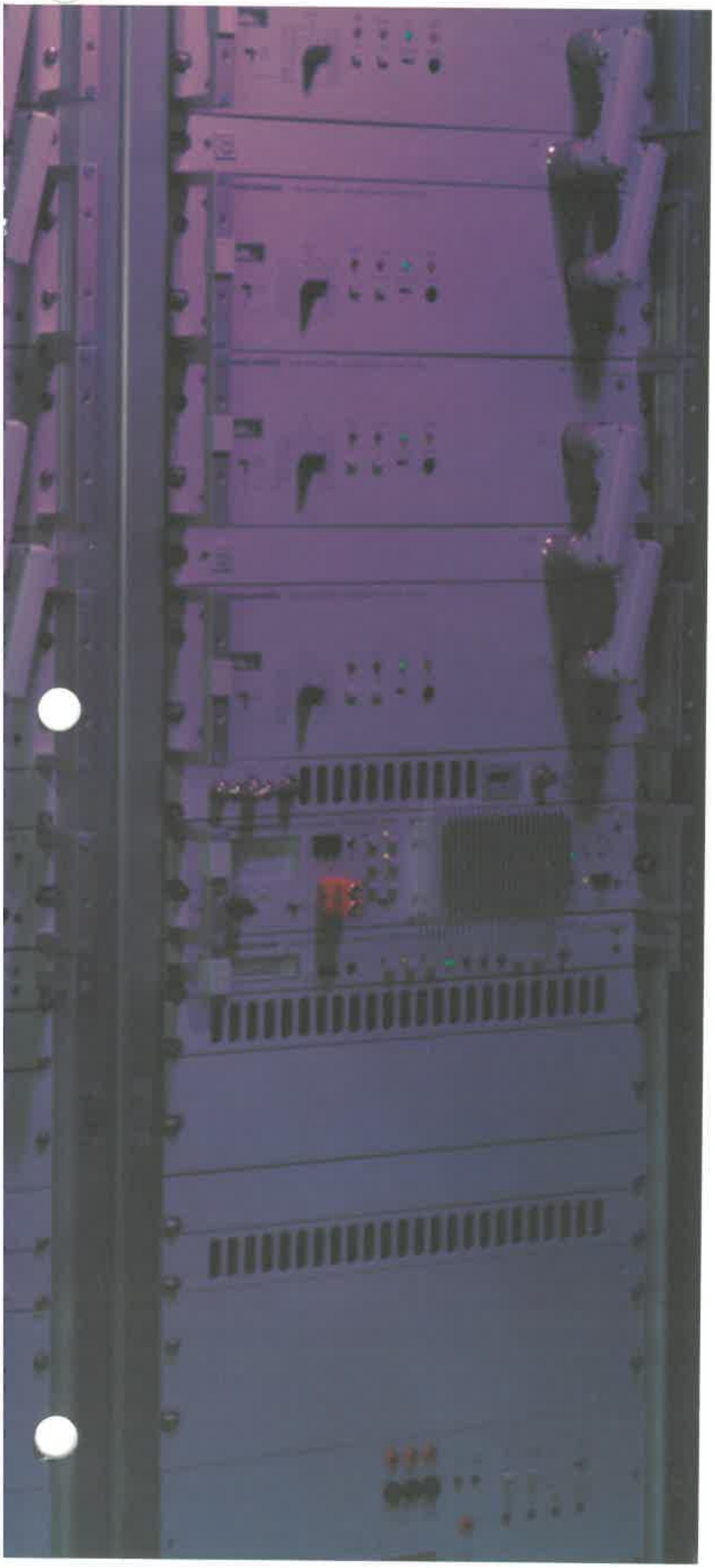
A **5.2-GHz Frequency Extension (Option FMA-B12)** is provided for special applications at higher frequencies, eg outside-broadcast links in the GHz range.

Rear view of FMAB




ROHDE&SCHWARZ
MODULATION ANALYZER · 50 kHz...1360 MHz · FMAB
856.4750.52
RF
MODULATION
AUDIO
STATE
MENU
FUNCTION
DATA
ENTER
VOLTMETER
STANDBY
RF 50 Ω
CAL
AF

IEC 625 Bus
IEEE 488



Modulation Analyzer FMAB

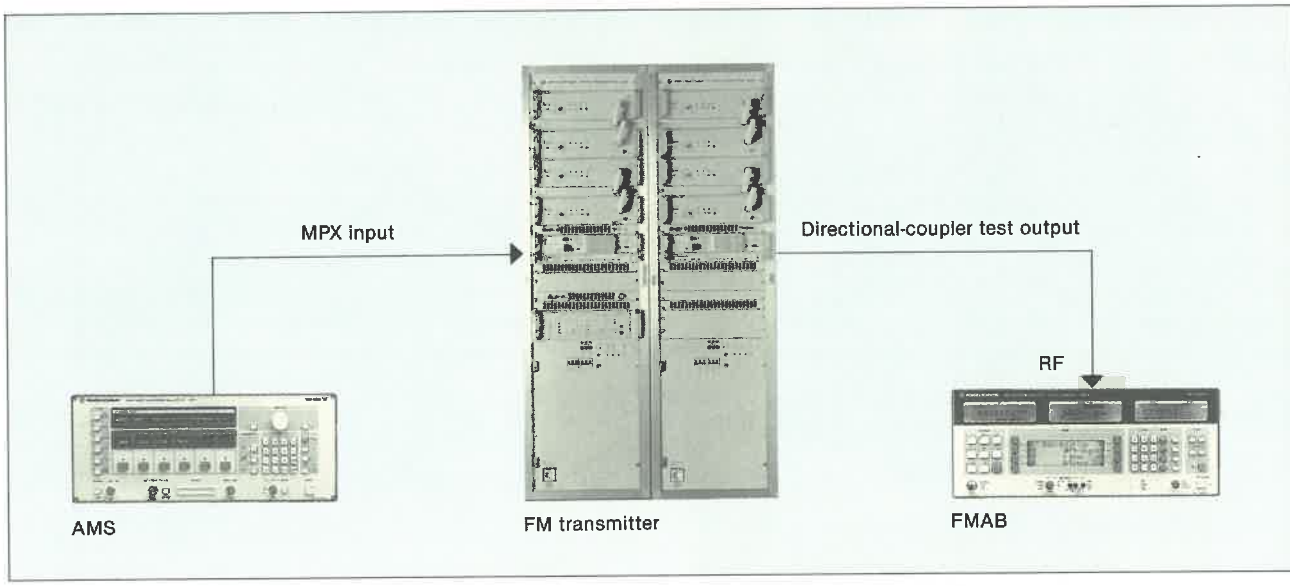
50 kHz to 1360 MHz

- RF frequency measurement with 10-digit readout. maximum resolution 0.1 Hz
- High-precision AM. FM. φM measurement over a wide modulation frequency range (error ≤0.5% for FM)
- Low-frequency measurement with 5-digit readout. resolution 1 mHz
- Distortion measurement down to <0.005%. continuous in the range from 10 Hz to 100 kHz
- Wide range of filters. psophometric weighting filters
- AF voltage measurement AC/DC
- High-accuracy power measurement (typ. error <0.5 dB)
- Built-in precision stereodecoder both for internal FM stereodecoding and for decoding of external stereo multiplex signals
- Complete AF analysis in L. R. M. S channels including distortion measurement and S/N ratio measurements to CCIR standards
- Selective measurement of pilot tone deviation and deviation of 57-kHz traffic program carrier
- Built-in RDS demodulator for external decoding
- Modulation-depth measurement on 57-kHz traffic program carrier

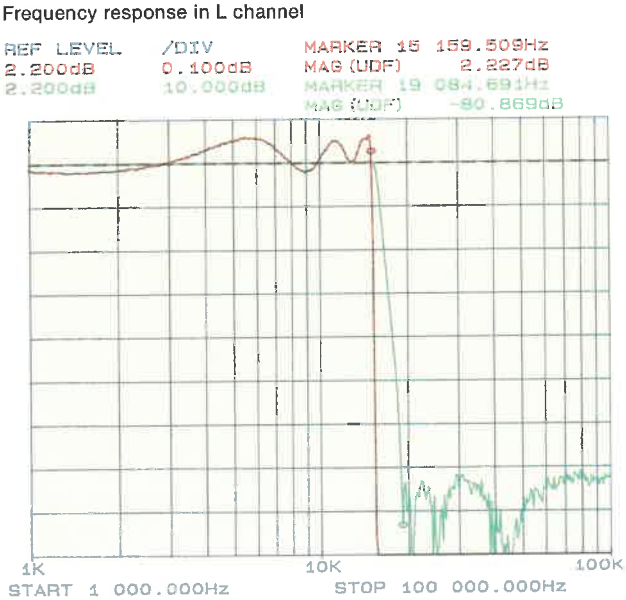
Applications

A phase-compensated noise suppression filter with a bandwidth of 95 kHz (—3 dB) can be switched into circuit between FM demodulator and stereodecoder especially for internal stereodecoding. High-frequency spurious components can thus be efficiently kept away from the stereodecoder, with negligible effect on the phase linearity and channel crosstalk from L to R and R to L. In conjunction with the **Arbitrary Waveform Generator AMS** from R&S, which produces a synthetic stereo multiplex signal with a crosstalk attenuation of more than 60 dB, the 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.

FMAB in conjunction with Arbitrary Waveform Generator AMS for transmitter measurements

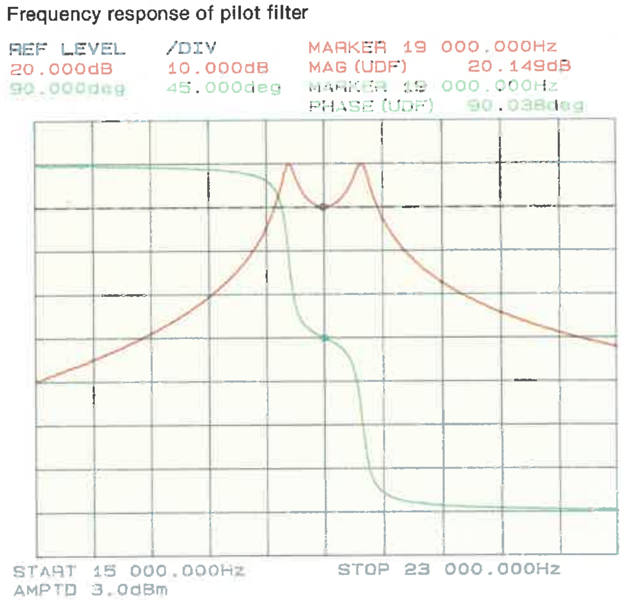


Frequency response in L channel



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 R&S. New standards are thus set in the measurement of stereo channel crosstalk.

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 FMAB, the maximum deviation will be indicated on the display.

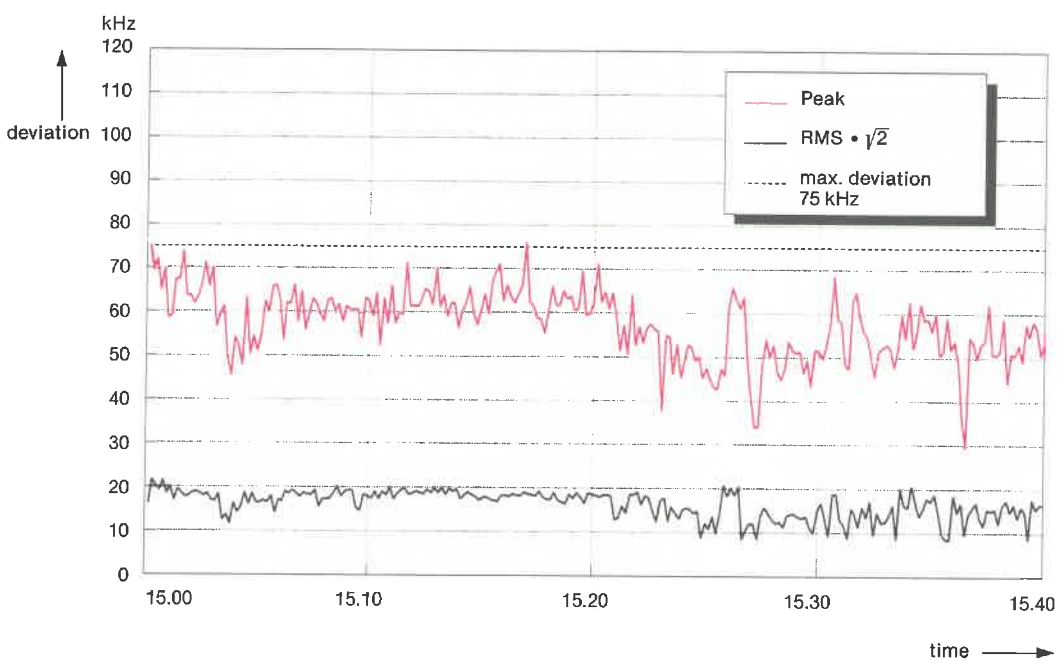
Peak deviation monitoring In conjunction with a process controller, eg the PSA from R & S, the FMAB is ideal for monitoring the peak deviation of VHF broadcast transmitters. In the PK hold mode, +PK and —PK detectors operating in parallel and featuring a very short response time ensure precise measurement 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.

The FMAB is designed for **high measurement speed:**

- Fast, automatic frequency adjustment by direct frequency measurement up to 1.36 GHz
- Correct frequency measurement even at large AM depth thanks 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, eg lowest measurement frequency or required counter resolution

Measurement functions that are not required can be switched off, eg 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.



With the aid of an external PC, the FMAB is also suitable for monitoring of peak deviation measured at intervals of <100 ms

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 and drift	±1 digit + error of reference frequency	
Reference oscillator	**standard**	**option 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} (0 to 55°C)	2×10^{-9}/°C
Warmup time	15 min	15 min
External reference input/output	manual or remote-controlled switchover	
Output level	12 dBm ±2 dB	
Input level range	–10 ... +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 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	meas. 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 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 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	f_{in}/10	150 kHz	700 kHz

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

f_{mod}	error
f_{in}: 50 to 300 kHz	
30 Hz to 5 kHz	≤0.5%
10 Hz to 8 kHz	≤2%
f_{in}: 300 kHz to 10 MHz	
30 Hz to 10 kHz	≤0.5%
30 Hz to 20 kHz	≤1%
10 Hz to 50 kHz	≤2%
f_{in}: ≤10 MHz	
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 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, quasi-peak +50 µs deemphasis	≤3 Hz	≤4 Hz	≤6 Hz

Stereo S/N ratio[3]) weighted to CCIR, 40 kHz deviation, at FM output (with noise filter)

f_{in}: 10 to ≤170 MHz	≥76 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[4])	≤0.05%	≤0.2%
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, 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 to 300 kHz	300 kHz to 10 MHz	≥10 MHz
	1/10 × f_{in}/kHz × 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
with special φM filter: f_{mod}	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[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[5])	
unbalanced input	≤1 mV } can be corrected to ≤30 µV using offset calibration
balanced input	≤3 mV }
Resolution	<0.1%
Error	±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 their arithmetic mean
RMS detector	true RMS-responding rectifier, readout as RMS value or converted to peak for sinewave
Quasi-peak 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) 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	CCIR 468-4 weighted CCIR 468-4 unweighted CCITT 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	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 filter)	±1 dB ±0.03% THD

Stereodecoder

Crosstalk 30 Hz to 15 kHz, RMS or CCIR detector	
L to R, R to L	≥60 dB down
M to S, S to M	≥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	≤2%
57-kHz carrier (level)	≤5%
AM of 57-kHz carrier (f_{mod} = 10 to 125 Hz)	≤2% of rdg +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)	≤0.1%
Intermodulation distortion to DIN 45403	d_2 ≤0.05%, d_3 ≤0.1%
S/N ratio, referred to +6 dBm at 500 Hz, deemphasis 50 µs	
CCIR unweighted	≥80 dB
CCIR weighted	≥80 dB
Auxiliary carrier suppression, referred to +6 dBm	
Pilot tone (19 kHz)	≥90 dB
RDS/ARI (57 kHz)	≥80 dB
Deemphasis	50 or 75 µs, switch-selectable

External decoder input	balanced, 3-contact connector to DIN 41628 on rear panel
Common-mode rejection	
f ≤1 kHz	≥60 dB
1 kHz <f ≤15 kHz	≥50 dB
15 kHz <f ≤100 kHz	≥36 dB
Input impedance	≥40 kΩ
Input level range	–12 to +12.5 dBm (600 Ω) (nominal +6 dBm/40 kHz)
Resolution of level setting	≤0.2 dB

Stereodecoder outputs

L, R, M	balanced, 3-contact connectors on rear panel, to DIN 41628, +6 dBm, Z_{out} ≤30 Ω, Z_l ≥300 Ω
S (L—R/2)	unbalanced, BNC connector, Z_l ≥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	typ. 2.5 s
≥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	max. 1 V into 600 Ω
AF output	1 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	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	complies with VDE 0871, limit B and 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 FMAB 856.4750.52
Accessories supplied	special cable for firmware updating, manual, power cable, spare fuses

Options

Reference Oscillator	FMA-B10	856.3502.52
AM/FM Calibrator	FMA-B4	855.6008.52
5.2-GHz Frequency Extension	FMA-B12	855.8500.52

Recommended extras

High-power Attenuator 20 dB, 50 W	RDL	1035.1716.00
Service Kit	FMA-Z1	856.4009.52
19" Adapter	ZZA-94	396.4905.00
Set of Front Handles	ZZG-94	396.5160.00
Transport Case	ZZK-944	1013.9366.00

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) 100-kHz lowpass filter switched in.

5) Input attenuator switched on: value x 10.

ROHDE&SCHWARZ

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Telex 523703 (rsd) · Teletex 897487 = RSD
Telefax (089) 4129-2164

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PD 756.9551.21 691 (U we)

AF Analyzer/DSP Unit FMA-B8

Option for use with modulation analyzers of the FMA family for in-depth AF analysis without requiring further instruments

- Selective modulation-depth and AF-level measurements
- Selective harmonic distortion measurement of d_2, d_3, d_n
- True THD measurement, largely unaffected by spurious and noise signals
- Universal measurement of intermodulation products to relevant standards; eg measurement of difference-frequency distortion to German ARD specifications
- Phase noise measurement capability, indication in dBc/Hz
- Scaled display of AF spectrum through direct connection of an oscilloscope
- With options AM-FM Calibrator/AF Generator FMA-B4 and FMA-B8, the analyzers of FMA family are upgraded to complete transmitter test system

ROHDE & SCHWARZ

Highly integrated measuring instruments are more cost-effective than a series of single instruments

The optional AF Analyzer/DSP Unit FMA-B8 considerably enhances the AF analysis capabilities of FMA modulation analyzers, thus completely fulfilling user requirements. For the first time, an RF modulation analyzer is capable of AF analysis that goes far beyond the customary measurement of weighted spurious modulation, noise voltage and THD + N (total harmonic distortion + noise).

In-depth analysis without need for further instruments

The option enables

- selective modulation-depth and AF level measurement
- selective harmonic distortion measurement of d_2, d_3, d_n
- true THD measurement
- universal measurement of intermodulation products to relevant standards
- simple phase noise measurement capability by FFT-analysis of the FM demodulator output

The very low inherent noise of both the FMA local oscillator and the FM demodulator enables phase noise measurement down to <–130 dBc/Hz at f_c=500 MHz and 20-kHz offset.

All these features above make a previously needed, separate AF (FFT) analyzer superfluous even for complex modulation analysis; moreover, measurements are greatly simplified.

Broadcast applications

Together with the optional AM-FM Calibrator/AF Generator FMA-B4 (data sheet PD 756.9951), the FMA-B8 turns the modulation analyzers of the FMA family into complete and universal modulation test systems for transmitters and transposers:

- AF Generator FMA-B4 provides precise stimuli signals (single-tone, two-tone, stereo multiplex signals)
- AF Analyzer FMA-B8 features universal analysis capabilities

For any frequency in the AF range 10 Hz to 100 kHz, a selective measurement of harmonic distortion products can be made as well as a correct THD measurement (largely unaffected by spurious signals such as noise or hum).

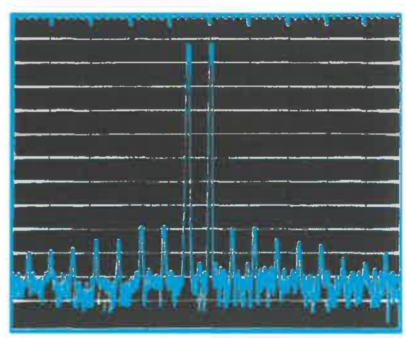
Furthermore, the 2nd and 3rd order intermodulation products can be measured to DIN 45403 and IEC 268-3 either as intermodulation distortion or as difference-frequency distortion. Measurement of the difference-frequency distortion is for instance prescribed by the German ARD specifications 5/3.1 for broadcast transmitters.

Digital signal processing ensures highest measurement accuracy

The operating principle of the optional AF Analyzer/DSP Unit is based on digital signal processing. A precision 16-bit A/D converter samples the AF signal. A high-speed signal processor determines the spectrum of the AF signal by means of fast Fourier transform. Harmonic distortion, intermodulation distortion and difference-frequency distortion are read out in dB or percent on the audio display of the modulation analyzer.

Scaled display of AF spectrum on any ordinary oscilloscope

The AF spectrum can be displayed with scaling on an oscilloscope in X-Y mode, which can be directly connected to the rear FMA outputs DSP1 and DSP2. This provides the user with additional information about the indicated digital value at a glance.



AF spectrum on oscilloscope connected to FMA outputs DSP1 and DSP2

Specifications

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)

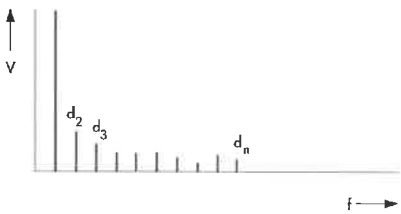
Measurement error

$10\ Hz \le f_1 \le 14\ kHz$, $f_{di} \le 42\ kHz$	$f_1 \le 50\ kHz$, $f_{di} \le 150\ kHz$
≤5% of rdg ±0.02% absolute	≤5% of rdg ±0.05% absolute

THD measurement
Measurement of harmonic i = n (n = 2 to 10 selectable)

Measurement error

$10\ Hz \le f_1 \le 14\ kHz$, $f_{dn} \le 42\ kHz$	$f_1 \le 50\ kHz$, $f_{dn} \le 150\ kHz$
≤5% of rdg ±0.03% absolute	≤5% of rdg ±0.1 % absolute



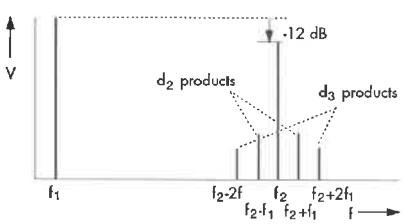
Intermodulation measurement

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

$f_2 + 2 \times f_1 \le 42\ kHz$, $f_1 \ge 10\ Hz$	$42\ kHz < f_2 + 2 \times f_1 \le 150\ kHz$, $f_1 \ge 30\ Hz$
≤5% of rdg ±0.1% absolute	≤5% of rdg ±0.2% absolute

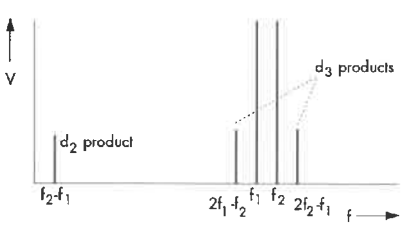


Difference-frequency distortion d_2, d_3 to DIN 45403 and IEC 268-3

Readout	in % or dB
Display range	0.001 to 20%, −100 to −14 dB

Measurement error ($f_2 - f_1 \ge 30\ Hz$)

$2 \times f_2 - f_1 \le 42\ kHz$	$42\ kHz < 2 \times f_2 - f_1 \le 150\ kHz$
≤5% of rdg ±0.02% absolute	≤5% of rdg ±0.05% absolute



Selective modulation and voltage measurement
in voltmeter, AM, FM and φM mode, using special bandpass filter

Special bandpass filter

Center frequency f_c	Bandwidth (3 dB)
10 to <50 Hz	2.27 Hz
50 to <500 Hz	6.8 Hz
0.5 to <5 kHz	22.7 Hz
5 to <25 kHz	204 Hz
>25 kHz	816 Hz

Shape factor 3 dB/80 dB[1]	<4
Ultimate selectivity	80 dB (70 dB for $f_c \ge 25\ kHz$)
Display range	corresponding to display range of selected operating mode

Measurement error[2]
with deviation of measurement frequency from center frequency $<BW_{-3dB}/4$

at center frequency f_c	10 Hz to 100 kHz	100 kHz to 150 kHz
	≤2%	≤5%

Rear-panel outputs

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

Scaling of horizontal markers can be called up via information menu

Ordering information

AF Analyzer/DSP Unit	FMA-B8	0855.9007.55
Model for retrofitting in instruments already supplied	FMA-B8	0855.9007.54

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

[1]) For f_c <25 kHz; for $f_c \ge 25$ kHz: shape factor 3 dB/70 dB
[2]) Error of selective measurement in addition to error specified for selected voltmeter, AM, FM or φM mode

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).

ROHDE & SCHWARZ

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

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:

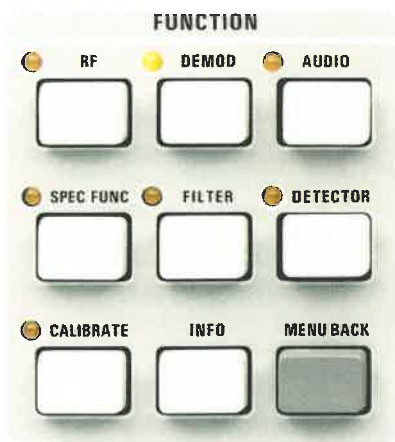
- carrier frequency or power
- modulation depth, deviation or DDM
- modulation frequency, distortion or phase

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?



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

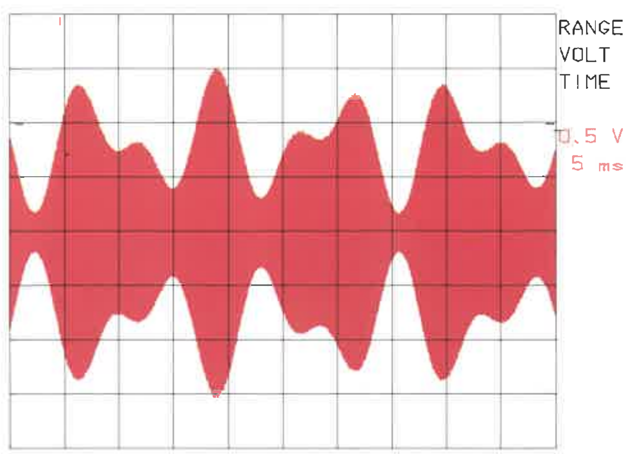
Measurement functions

ILS signals

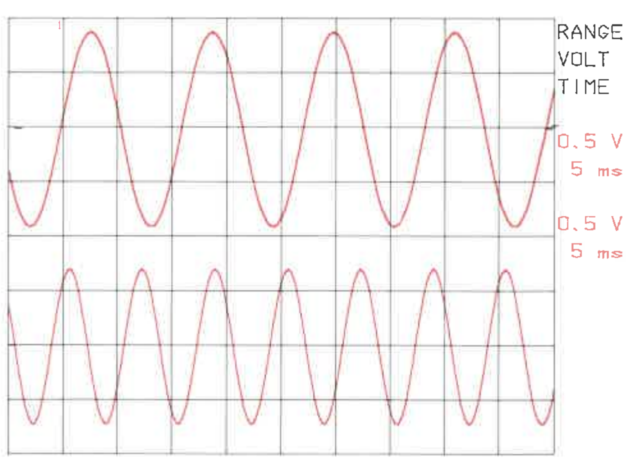
- Selective measurement of 90-Hz, 150-Hz and sum modulation depth without influence from additional signals (identifiers) with an error of less than 0.5% of reading
- Measurement of modulation depth of identifier signal in the range from 300 Hz to 4 kHz without influence from ILS signals
- High-precision 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°)



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*)

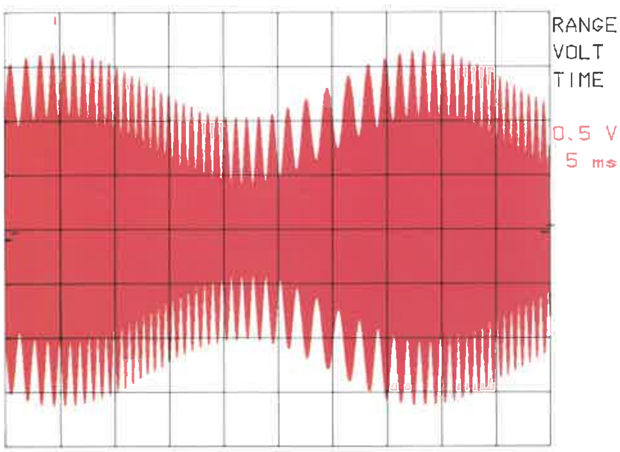
- Selective measurement of 15-Hz, 135-Hz and sum modulation depth with an error of less than 0.5% of reading
- Phase measurement 15 Hz/135 Hz
- Selective measurements of modulation frequency
- Distortion measurement (optional) using the standard analog AM demodulator at all modulation frequencies from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

In-depth AF analysis

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

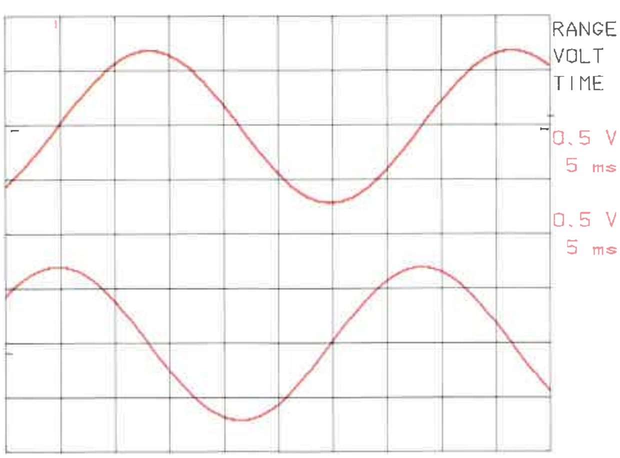
- Selective harmonic distortion measurement of d_2, d_3, ... d_i
- True THD measurement of intermodulation products to IEC 268-3
- Universal measurement of intermodulation products to IEC 268-3
- Scaled display of AF spectrum by direct connection of an oscilloscope
- Selective distortion measurement 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.



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, quasipeak + 50 µs deemph.	≤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 5 digits

Frequency range	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

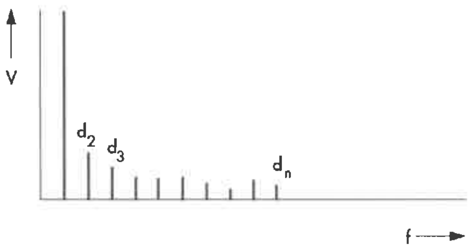
10 Hz ≤ f_1 ≤14 kHz, f_{di} ≤ 42 kHz	≤5% of rdg ± 0.02% absolute

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



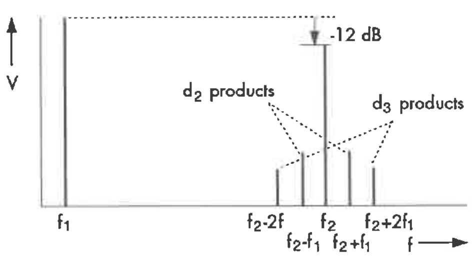
Intermodulation measurement

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 x f_1 ≤42 kHz, f_1 ≥10 Hz	≤5% of rdg ± 0.1% absolute

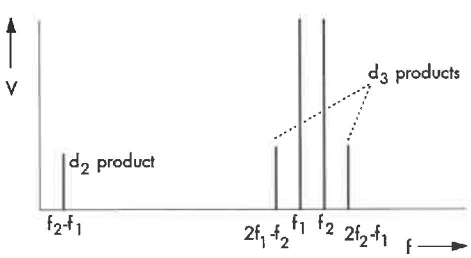


Difference-frequency distortion d_2, d_3 to DIN 45403 and IEC 268-3

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°

Supplement to Data Sheet FMAV

The following corrections compared to data sheet PD 756.9839.21 are to be made.

VOR:

Measuring error with modulation depth ID signal	≤ ± 1.2% (typ ≤ 0.8%)
Measuring error with differential phase measurement at 30 Hz	≤ ± 0.03° (typ ≤ 0.02°)

ILS:

Measuring error with modulation depth ID signal	≤ ± 1.2% (typ ≤ 0.8%)
Measuring error with DDM measurement: m = 18 to 22%	≤ ± 0.0002 DDM ± 0.1% from the measured value 7)
m = 32 to 48%	≤ ± 0.0005 DDM ± 0.1% from the measured value 7)
Measuring error of phase angle 90-150 Hz	≤ ± 0.2 degrees (typ. ≤ 0.1 degrees)

TACAN:

Measuring error of phase angle 15-135 Hz	≤ ± 0.5 degrees (typ. ≤ 0.2 degrees)

7) (footnote as in the Specifications)
In the temperature range of 20 to 30°C, additional error ± 0.3% for total temperature range.

Supplement to Data Sheet FMA/FMB/FMAB/FMAV

The following corrections compared to data sheets PD 756.9300.22 / PD 756.9551.21 and PD 756.9839.22 are to be made.

Supplement to Datasheets:

Power Supply	100 / 120 / **230** / 240 V ± 10%
	47 to 440 Hz (170 VA)

Supplement to Manual to FMA/FMAB/FMAV/FMAS/FMB

Firmware: ≥ 2.30 (FMA/FMAB/FMAS/FMB) or ≥ 2.70 (FMAV)

The following functions were added and known bugs eliminated:

Additional functions:

1. FMA-B4:

1.1 Digital Sweep of AF-Generator:

The AF-Generator is now able to produce additionally to the existing functions a digital swep on fixed frequencies . The frequencies can not be changed.

New menu (key: *CALIBRATE*, softkey: *Generator*):

```
*     AF Sequence    >> -------- << Generator AF-RF *
Seq AF          Start          AF          MPX
Level?                         RF unmod    Avionic
                               AF Units    Destin
```

Switch on this mode with softkey *Seq AF*.

The AF-Generator is waiting now at its start frequency 500 Hz. Set the level of the AF sequence with softkey *Level?*.

Pressing the *Start* softkey starts the sweep, the AF Generator switches with 2 s dwell time successively to the following AF frequencies (phase synchronized) and finally waits at it's end frequency (= start frequency) 500 Hz:

frequency [Hz]:		frequency [Hz]:	frequency [Hz]:	frequency [Hz]:	
500	start frequency				
20		200	2000	20000	
25		250	2500	500	end frequency
32		320	3200		
40		400	4000		
50		500	5000		
63		630	6300		
80		800	8000		
100		1000	10000		
125		1250	12500		
160		1600	16000		

Corresponding IECBUS commands:

command:	data:	units:	comments:
GENERATOR:MODE	SEQ_AF	--	Set the generator to mode AF sequence
GENERATOR:SEQ_AF:START	--	--	Start AF sequence
GENERATOR:SEQ_AF:LEVEL		DBM	Set level of AF sequence. The unit depends on the setting of DESTINATION and UNITS_AF
GENERATOR:SEQ_AF:LEVEL?			Inquiring of level of AF sequence

1.2 MPX Signal L=R - 6 dB

The MPX-Generator additionally to the following channel configurations:
L = R, L= -R, L only, R only and *Off* delivers now the signal: L = R -6 dB. In this setting the level of the right channel is 6 dB below the level of the left channel. This funcion is asked for in ETSI Recommendation "Radio Broadcasting Systems; VHF FREQUENCY MODULATED SOUND BROADCASTING TRANSMITTERS ETS 300 384 ANNEX B.1.

Menu (Key *CALIBRATE*, softkeys *Generator, MPX, Channel*):

```
* Gen MPX Channel >>--<< Gen MPX Channel *
L = R -6 DB           L = R        L = -R
                      L only       R only
                      Off          Preemph
```

Corresponding IECBUS-commands:

command:	data:	units:	comments:
GENERATOR:MPX:CHANNEL:CONFIGURATION	L_HALF_R	--	

2. FMAS/FMA-B9:

2.1 Lower frequency limit of FMAS/FMA-B9: 4 MHz instead of 5 MHz

(Application: Selective modulation measurements on NTSC Sound modules)

Bug eliminations:

1. all FMA models:

1.1 Increased overload range for measurements with deemphasis

Reduction of AF distortion with THD measurements at high AF frequencies, deemphasis switched on.

1.2 IECBUS operation:

The command POWERMETER:RF? now delivers measurement results.

2. FMB:

2.1 Tuning problems at frequency 1363 MHz were eliminated.

3. FMA-B4: AM/FM Calibrator/AF-Generator:

The Total Calibration routine now additionally calibrates the FM DC to typically < 100 Hz offset. Application: Measurement of frequency settling and measurements on FSK modulators for example to ERMES standard.

4. FMAB/FMA-B3 Stereo-Decoder:

4.1 Reference value with relative measurement with FM Stereo External

Making relative measurements with *FM-Stereo, Extern, Auto Pilot On, Channel: Pilot* the changing of the pilot level does no longer influence the reference value.

4.2 Missing IECBUS-commands in manual:

Missing IECBUS-commands in manual to activate the RDS correction factor with measurements on the 57 kHz carrier:

command:	data:	units:	comments:
STEREO_DECODER:**RDS**_CORRECTION	**ON** **OFF**	-- --	Switching ON/OFF the RDS-correction factor with measurement on the 57 kHz subcarrier (factor 1.17 or 1.35 dB).
STEREO_DECODER:**RDS**_CORRECTION?	--	--	Inquiry whether correction factor is active ore not.

5. FMAV:

5.1 Bug eliminated with FM Calibration routine

Starting the FM Calibration routine in Avionics mode (*DEMOD: AM AVIONICS*) caused CAL Error message.

5.2 Measurement of VOR modulation at 9.96 kHz (m 9.96 kHz) at FMAV with FMA-B9.

Up to now the peak AM at 9.96 kHz was measured, which is not always adequate for measurements on DVOR systems due to possibly periodically changing AM, dependant on receiving conditions with measurement at the antenna.
This could cause an increased indication of AM measuring on DVOR systems. The improved measurement routine now averages the AM at 9.96 kHz and thus delivers an adequate result even with measurements on DVOR systems.
Also the sensibility due to insufficient S/N at low receiving levels is now significantly improved.

5.2 Eliminating the possibility of setting SINAD measurement (without option FMA-B2), which caused a crash of the system.

2 Preparations for Use

All data given in this section are for simplified illustration only and not guaranteed. Binding technical data are those as specified in the enclosed Data Sheet.
All figures printed ***boldfaced and in italics*** refer to the front and rear panel views of Fig. 3-1 and Fig. 3-2.

2.1 Initial Start-up

2.1.1 Setting up the Instrument

The instrument may generally be operated in any position as long as the vent holes for air circulation are never covered.

However, note that conditioned by the design of the instrument the LCDs can only be perfectly read from a viewing angle of vertical zero up to about 60° from the vertical.

The contrast of the LCDs can be optimally adjusted depending on this viewing angle (cf. section 3.3.4.3.1).

2.1.2 Mounting in 19" Rack

The instrument can be fitted into any standardized 19"rack using the 19" Adapter ZZA 94.

Fitting instructions are included with the 19" adapter.

In rackmounting, make sure that the air inlet through the perforations in the side panels and the air outlet at the rear are not impeded.

2.1.3 Power Supply

The instrument is designed for operation from sinusoidal ac supply voltages of 100 V, 120 V, 230 V or 240 V (tolerance always ± 10%) and frequencies between 47 and 440 Hz.

The required rated voltage can be adjusted as follows:

- Lift off the cover of the voltage selector at the rear of the instrument using a screwdriver.
- Remove the coding cylinder that is now accessible and reinsert it such that the required voltage value points upwards.
- Lift off the fuse holder marked by an arrow, insert an appropriate fuse and reinsert the holder.

Fuses for

100 V / 120 V:
IEC 127 - T4.0 L /250 V (R&S 009.0578)

230 V / 240 V:
IEC 127 - T2.0 L /250 V (R&S 009.0590)

The fuse values are also printed on the rear of the instrument.

The instrument is connected to the power outlet via the power plug and the power cable supplied.

Note the pertinent regulations according to VDE or DIN.

2.1.4 Switch-on

The instrument is connected to the supply using the power switch on the rear. Depending on the position of the ON key on the front panel at the bottom right, the instrument may then be in STANDBY mode (ON key not pressed, STANDBY LED on) or in switch-on status (ON key pressed, STANDBY LED off).

In STANDBY mode, only the 100-MHz reference oscillator is heated (and also the 10-MHz reference oscillator option, if fitted). This has the advantage that a high frequency accuracy is immediately obtained when the instrument is fully switched on (provided it has been in STANDBY mode for a sufficient period of time).

If the instrument with the 10-MHz reference oscillator option is switched on without previous STANDBY mode, the right-hand STATE display reads OVEN COLD for approximately two to three minutes, until the reference oscillator has reached the rated temperature.

Important note:
The internal temperature checkpoints of the instrument are continuously monitored during operation. When calibration is triggered (Cal All), the current temperature will also be stored together with the correction values. If the deviation from the stored value is greater than 5 °C, a CAL TEMP message is automatically output on the status display. The instrument remains however fully operative and still complies with the data sheet specifications. After recalibration, an enhanced measurement accuracy can be achieved, in particular when using the optional Calibrator FMA-B4. This enhanced measurement accuracy cannot be ensured as soon as the CAL TEMP message is displayed (see also section 3.3.7.1).

2.2 Fitting the Options

The options are generally fitted as follows:

- Disconnect the unit from the AC supply (remove power plug).
- Screw off the feet on the rear panel (loosen 4 Phillips screws).
- Push the top and bottom cover towards the rear of the instrument and remove.

This does not apply for the 10-MHz reference oscillator option:

- Insert the option PC board into the slot marked by the color coding of the guide rails. Use both levers (with same color coding) on the upper edge of the circuit board for arresting in position.

Important note:
The newly assembled option PC board is recognized by the microprocessor, when the instrument is switched on, and the configuration of the respective operating menu suitably adjusted.

Depending on which option is currently fitted, also the following measures are required:

2.2.1 Filter

Remove both covers of the connectors EXT FILTER IN and EXT FILTER OUT at the rear of the instrument.

Mount the two supplied BNC connectors in these locations. Solder the enclosed cable W634 to both connectors according to the labeling (with shield to the ground clamp). Connect the flat plug of the cable to receptacle X634 on the motherboard. Disconnect the male cable connectors W616 and W614 and remove the demodulator module. Unscrew cover and remove jumper X520. Then screw the cover back on again and refit the demodulator module in the instrument in reverse order.

2.2.2 DIST / SINAD Meter

Remove the cover of the connector DIST OUT and screw in the supplied BNC connector instead. Solder cable W654 to the connector (with shield to the ground clamp) and connect the flat plug to receptacle X654 on the motherboard.

2.2.3 10-MHz Reference Oscillator

Screw off the cable W100 on the bottom side of the synthesizer 1 module and remove the module from the instrument using the two levers (color coding black-blue).

When the top cover of the module is screwed off, the 10-MHz reference oscillator PC board can be inserted into the provided slot. However, first slide the supplied laminated paper sheet over the connections of the reference oscillator.

2.2.4 Stereodecoder

1. Unscrew rear panel feet.
2. Remove top and bottom panelling.
3. Unscrew rear panel an remove.
4. Lay cable W678 according to cable an rear panel labelling and solder inner conductor of BNC female connector.
5. Fit cable with 2 clamps to the frame.
6. Plug module into guide rails of the same colour.
7. Plug cable W678 onto module.
8. Secure rear panel with srews, put top and bottom panelling into place, secure rear panel feet with srews and glue non option label.

2.2.5 AM FM Calibrator / RF-Generator

1. Screw off rear feet.
2. Remove top a. bottom panels.
3. Attach labels as shown in drawing.
4. Unscrew rear panel and fold panel out.
5. Disconnect RF cable W689 from motherboard X682 and feed it trough below power supply cable.
6. Mount cable W694 in accordance with markings on cable and rear panel. Solder inner conductors of cable to BNC female connectors and put conductors into cable clips.
7. Screw rear panel on again.
8. Plug module into rail of mating colour.
9. Plug cable W689 to X9 of calibrator; plug cable W694 to X694 of motherboard.
10. Remove filler plates from top of frame. Detach cable clips from bottom of motherboard.
11. Srew front panel off (4 srews in top and bottom of frame). Fold front panel out.
12. Press filler piece in front (at Cal.) out from behind (remove any residual glue).
13. Mount cable W693 in accordance with drawing and solder inner conductors.
14. Srew front panel with cables back to frame (press front panel to frame when doing so but do not pinch any cables). Refit filler plates.
15. Put cable W693 into cable clip and connect it to X13 of calibrator.
16. Fit top and bottom panels an srew rear panel feet on.

2.2.6 AF-Analyzer / DSP Unit

(see mounting instructions enclosed with option)

2.2.7 RF/IF Selection

(see mounting instructions enclosed with option)

2.2.8 5.2-GHz Frequency Extension

(see mounting instructions enclosed with option)

2.3 Functional Test

On power-up, the following text should be read out in the MENU display for a few seconds:

```
***************
****** FMA *****        or FMAB/FMB
** Firmware X.Y **
```

Subsequently, a self-test is performed in the instrument, when the internal configuration (fitting of options) is simultaneously recognized.

On completion of this self-test without any errors detected, the following readout is shown for a few seconds:

```
****************
***** FMA ********      or FMAB/FMB
** Selftest o.k. **
```

When an error is detected during the self-test routine, a respective message appears in the MENU display.

Following regular completion of the self-test sequence, the instrument assumes its previous status valid prior to last switch-off.

If the previous status can no longer be set as a result of a memory error, the instrument PRESET state is set after a respective message in the MENU display.

2.3.1 PRESET Setting

The default status of the instrument after PRESET is as follows:

RF

Frequency readout in RF display	(RF Counter)	◀
Frequency resolution	10 Hz	◀
Automatic frequency and level setting	AUTO TUNE	◀
	AUTO LEV	◀

Demodulation

FM demodulation	FM	◀
Autoranging mode	AUTO RANGE	◀
Modulation measuring time	100 ms	◀
Deemphasis	OFF	◀

Audio

Audio frequency measurement	Audio Freq	◀
AF measuring time	100 ms	◀

Filter

Highpass filter 10 Hz	HP10Hz	◀

No lowpass filter in audio signal path: max. demodulation bandwidth (330 kHz -3dB)

Detector

Readout of arithmetic mean of peak-responding detectors	±Pk/2	◀

3 Operating Instructions

3.1 Preliminary Remarks

The instrument is a universal, fully automatic modulation analyzer featuring high operating convenience.

The measured values are simultaneously displayed in one of the following three top LCDs:

left-hand RF display:
RF frequency or RF power

center MODULATION display:
modulation AM, FM ,PM or AF voltage (AC or DC)

right-hand display:

- left-hand section AUDIO:
  audio frequency or DIST/SINAD value
- right-hand section STATE:
  instrument status information

Additionally, these displays always indicate the currently active main settings (e.g. demodulation mode).

For operation of the analyzer, the main function keys in the FUNCTION panel field to the left and the softkeys in the center MENU panel field (i.e. four softkeys to the left and to the right) are provided.

The keys in the DATA panel field are used for numeric data entries, which are then terminated by the unit multiplication keys (*8*).

3.2 Front and Rear Panel Views

Confer the following pages with Figures 3-1 and 3-2.

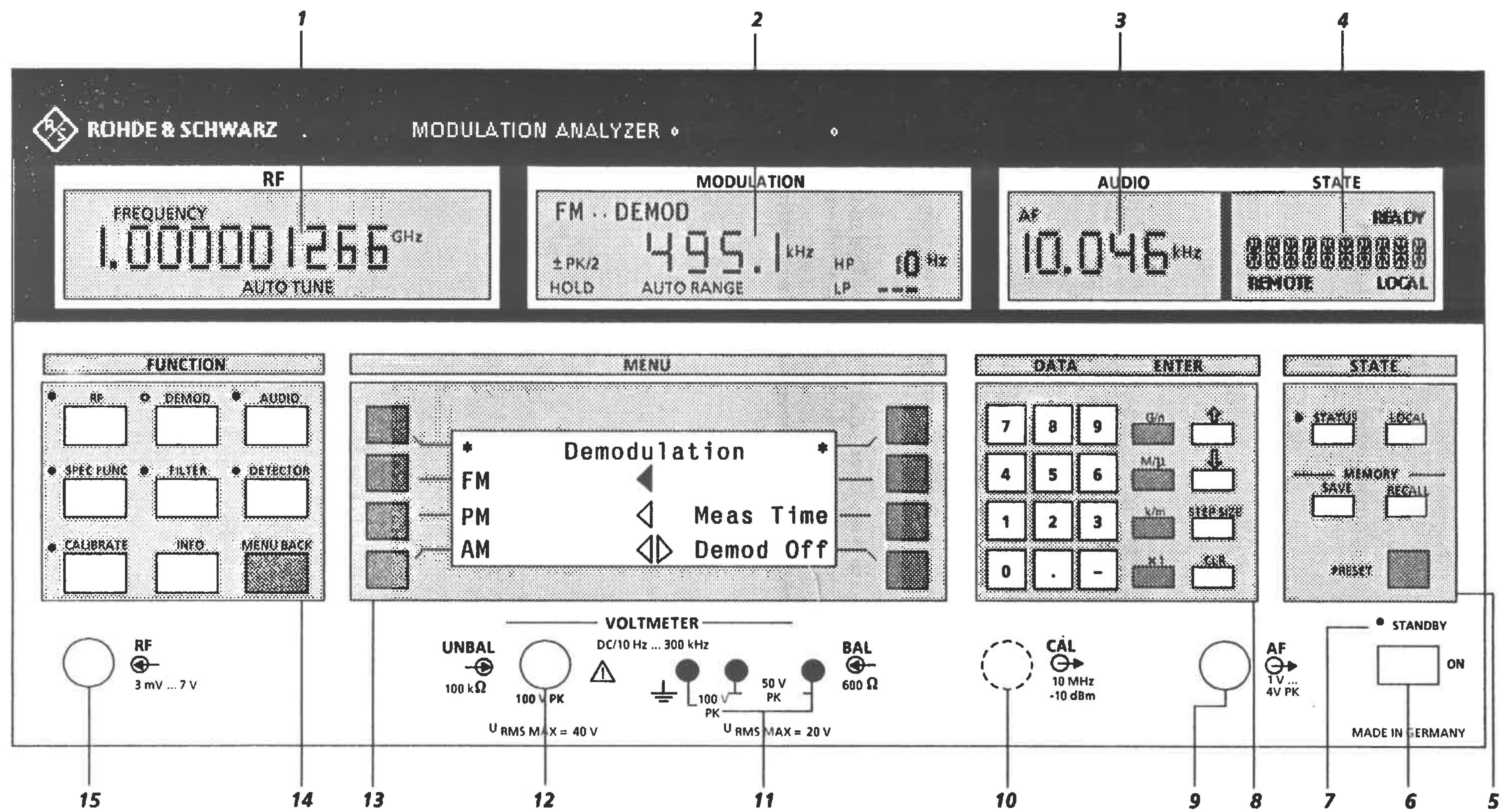


Fig. 3-1 Front panel view

3.2.1 Front Panel View

1 RF Display

Display of measured RF or of tuning frequency.

With power measurement:
display of applied RF power or RF voltage

The respective RF operating mode is also indicated in the display:

TUNE FREQUENCY *(only FMAS)*
Display of measured frequency in receiver mode

TUNE + frequency display *(only FMAS)*
Display of tuning frequency in receiver mode

FREQUENCY
Display of measured frequency in normal mode

only frequency display
Display of tuning frequency in normal mode

TUNE + level display *(only FMAS)*
Display of RF level in receiver mode (selective or broadband)

only level display
Display of RF level at RF input in normal mode

VOLTAGE
Display of RF voltage at RF input.

POWER
Display of RF power at RF input.

RELATIVE
Measured values are displayed relative to a reference value.

OVERLOAD
RF input is or has been overloaded (more than 7 V_{rms} or 10 V_p).
RF input is switched off. Elimination by PRESET key.

ATT CORR
External attenuator has been considered in the displayed RF power or RF voltage value.

MAN TUNE
Instrument is manually set to a carrier frequency.

AUTO TUNE
Instrument is set to automatic RF tuning mode.

MAN LEVEL
Instrument is manually set to an RF input level.

AUTO LEVEL
Instrument automatically adjusts to the RF level.

MHz; % etc.
Associated measurement value unit.

FREQ CORR (only with FMB)
Power meter display is provided with a frequency-dependent correction factor.

2 Modulation Display

Display of measured modulation (AM, FM or PM), or of the AF voltage or DC voltage applied to the voltmeter input in voltmeter operation of the instrument.
Simultaneously, also the currently active modulation mode, the activated detector and the used weighting filters are indicated.
In addition to the digital display, a bargraph is provided for quasi-analog display which is particularly suitable for adjustment procedures. The scaling assigned to the bargraph display has the same unit as the digital display.

495.1
Display of modulation AM, FM, PM or voltage(AC/DC)


Quasi-analog bargraph display with scaling in the respectively selected unit.

QuPK
Quasi-peak responding detector to CCIR-468-4 is switched on.

QuPK*√2
Quasi-peak measurement value is converted to peak value.

SAMPLING
Indication of averaged measured values during the measuring time without previous rectification.

RMS
True rms-responding detector.

RMS*√2
rms value is converted to peak value.

+ PK
Display of positive peak value.

- PK
Display of negative peak value.

± PK/2
Display of arithmetic mean of positive and negative peak value.

PK
Display of the higher of the magnitudes of the two peak values, with sign (maximum peak).

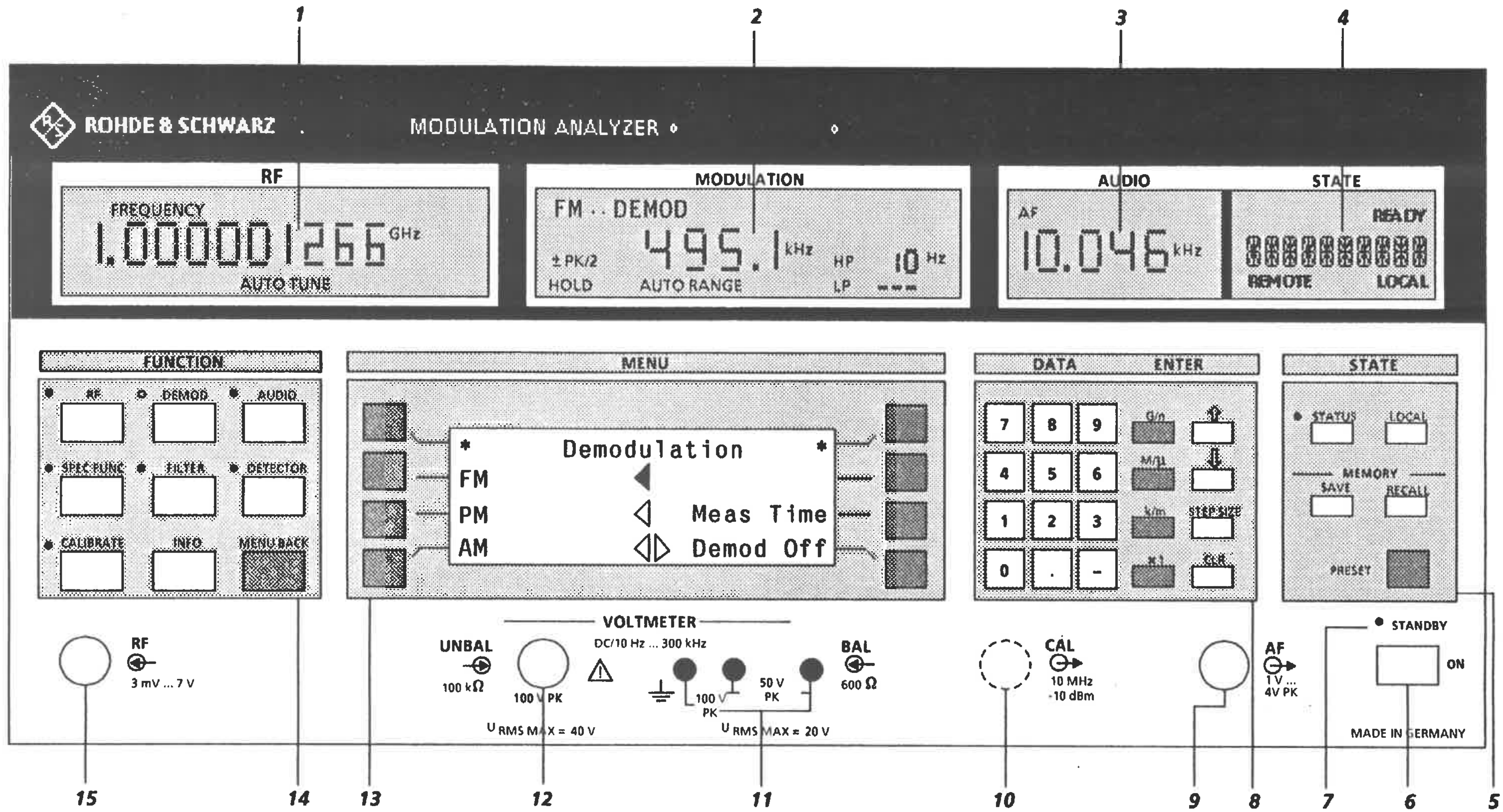


Fig. 3-1 Front panel view

2 Modulation Display

± PK/2

Display of measured value detector for the MODULATION display; default status: arithmetic average value of positive and negative peak values.

HOLD

Modulation display is in PK HOLD mode, i.e. the so far highest peak value (of the currently selected PK detector) is read out.

AUTO RANGE

Instrument is set to AUTO RANGE mode for the MODULATION display.

MAN RANGE

Instrument is set to a specific modulation measuring range (manual range).

RELATIVE

Measured values are displayed in the MODULATION display relative to a reference value.

MHz;mW etc.

Unit assigned to the MODULATION display.

FILTER

The filters switched into the AF measuring path are indicated in this display section (highpass filters, lowpass filters, program filters, external filter or special filters).

3 Audio Display

Display of measured audio frequency, audio distortion or SINAD value (with built-in DIST/ SINAD Meter option). The respective operating state is also indicated.

AF

Display of audio frequency.

DIST

Display of audio distortion.

SINAD

Display of SINAD value.

RELATIVE

Audio frequency value is displayed relative to a reference value.

MAN RANGE

Distortion measuring range is manually set.

AUTO RANGE

Distortion meter operates in AUTO RANGE mode.

MAN TUNE

Distortion meter is manually set to an audio frequency.

AUTO TUNE

Distortion meter automatically tunes to an audio frequency.

4 State Display

Display of current instrument state:

SRQ

Service Request has been generated.

READY

With remote state

Valid measurement values are provided in the Output Buffer.

With local state

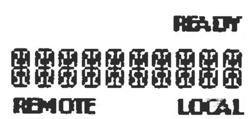
Measured values are read out in the displays.

REMOTE

Instrument is in remote state, i.e. remote-controlled via IEC/IEEE bus.

LOCAL

Instrument is in local state, i.e. manually operated via front panel controls.



This panel field specifies general status information, e.g. error messages or valid IEC bus address.

5 State Control Field

The keys provided in panel field ***5*** serve for modifying the instrument state.

STATUS

Information about the current instrument state is obtained using this key. Illuminated or blinking LED indicates a malfunction or a maloperation of the analyzer. In addition to this brief message in the STATE field, a more detailed message is given in the MENU field.

LOCAL

Instrument is switched from remote to local state.

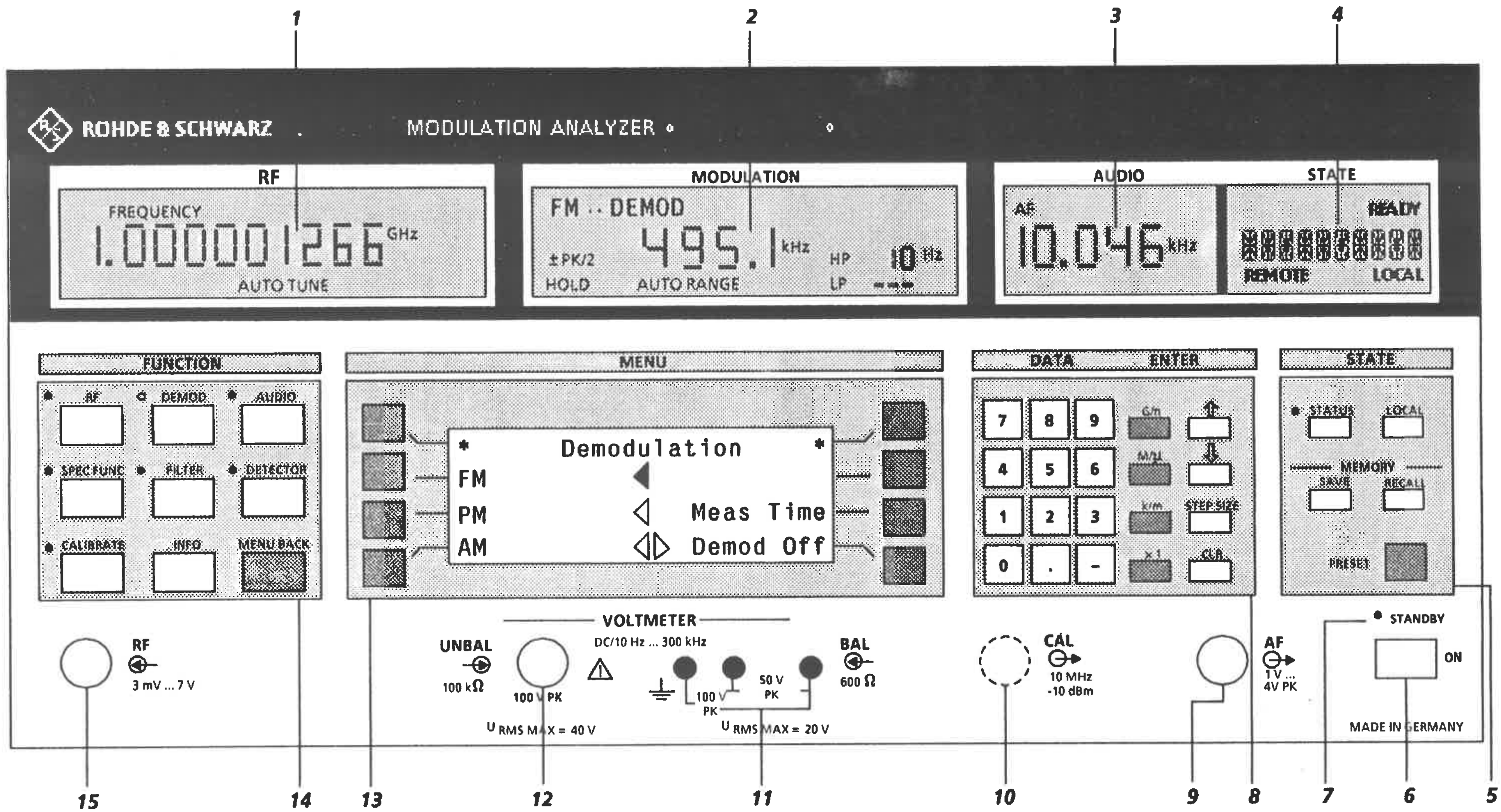


Fig. 3-1 Front panel view

5 State Control Field

MEMORY SAVE

Up to 20 instrument setups can be saved in a memory.
(Max. 2-digit entry, to be acknowledged via the Enter keys).

MEMORY RECALL

Saved instrument setups can be recalled from the memory (max. 2-digit entry, to be acknowledged via Enter keys).

PRESET

Instrument is reset to its defined default status (cf. Section 2.3.1).

6 ON Key

The instrument is switched on when the ON key is pressed (power switch on rear in ON position). When ON key *6* is not pressed, the analyzer is in STANDBY mode.

7 Standby LED

The STANDBY LED indicates STANDBY mode of the analyzer (LED on, ON key not pressed). The power switch on the rear is in ON position.

8 Data Entry Field

The keys in field *8* allow for data entries:

1 2 3 4 5 6 7 8 9 0 . -

Numeric keypad

G/n - M/µ - k/m - x 1

Enter keys and simultaneously unit multiplication keys to acknowledge data entry from the numeric keypad:
Basic unit Hz is converted into MHz using key M/µ, the basic unit Volt into µV using the M/µ key.

⇧ ⇩

STEP keys for stepwise variation of the setting value currently selected in the Menu control field.

STEPSIZE

The step size of the STEP keys can be modified from the MENU display.

CLR

Key to clear the numeric value entered last.

9 AF

Audio output (BNC female)

1 V ... 4 V PK

The demodulated AF signal is available here.
Level in the AUTO RANGE mode:
V_p = 1V ... 4V.

10 CAL

With built-in calibrator option:

10 MHz, -10 dBm

Calibration output (BNC female); 10 MHz, -10 dBm.
Modulation: AM, FM or unmodulated.

11 BAL

Balanced voltmeter input (3-contact female connector).

600 Ω

Input impedance 600 Ω
With DC measurement: positive pole to the right outside.

Observe the following :

Max. peak voltage between the inputs 50 V

Max. peak voltage between one input and ground 100 V

Max. input dc or rms voltage 20 V

12 UNBAL

Unbalanced voltmeter input (BNC female).

100 kΩ

Input impedance 100 kΩ
Max. peak voltage 100 V
Max. dc or rms voltage 40 V

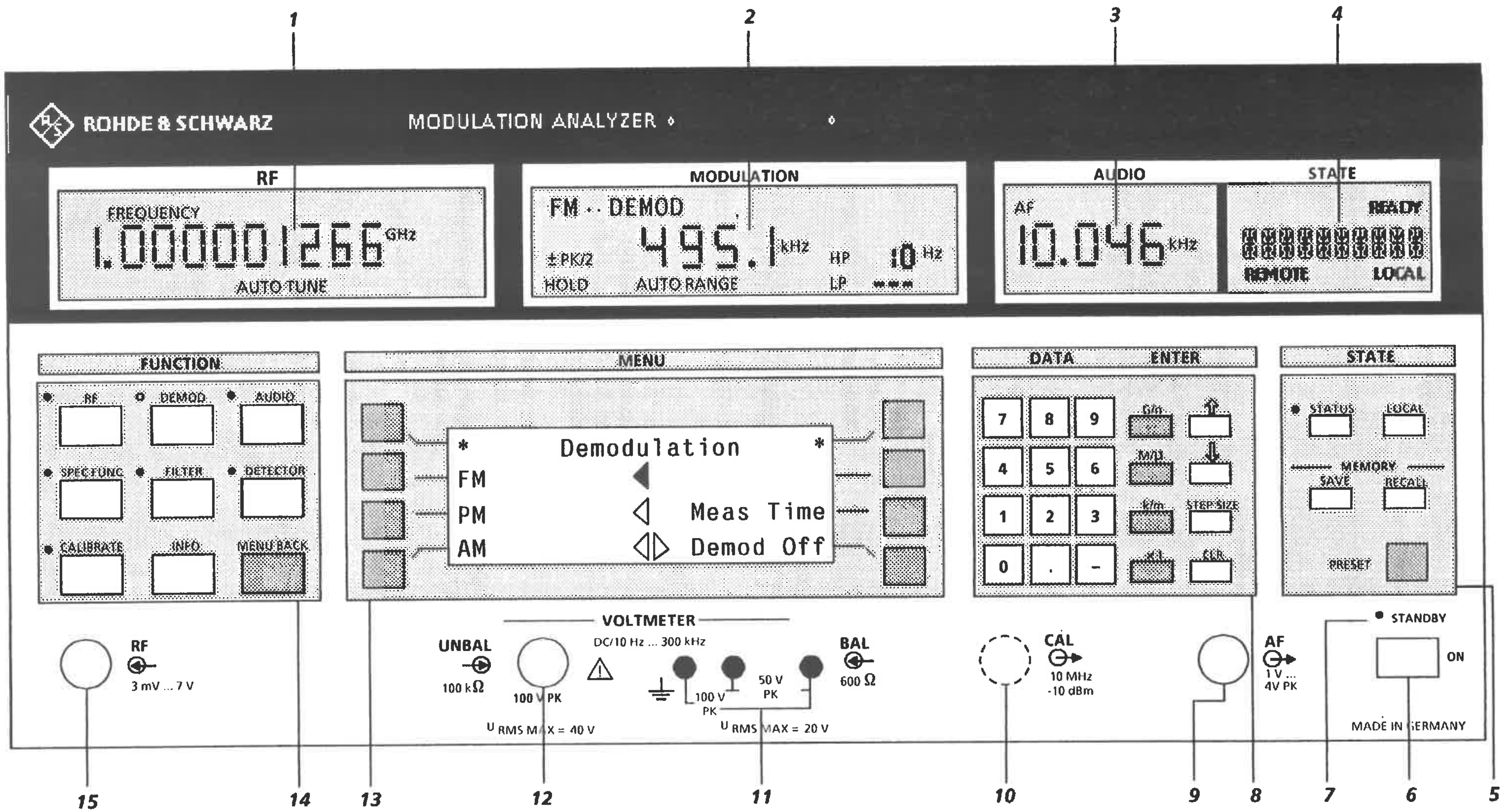


Fig. 3-1 Front panel view

13 Menu Control Field

Menu control field

Various operating modes can be selected on the analyzer via this MENU field and its control keys (4 to the left and 4 to the right of the display field). The display field has four lines with 20 characters per line.
10 characters each are assigned to the menu keys to the left and respectively the right. Also, the MENU field is used for the data entries via the DATA keys.

Menu control keys

Keys for selecting the currently activated setting possibilities, as shown in the display field.

14 Function Field

Function field ***14*** contains the main function keys. On actuation of a key, the respective operating menu is indicated in the MENU display field. The LED of the main function key is on, indicating that the function is active.

RF

Main function key for activating RF frequency settings (AUTO TUNE, MANUAL TUNE, power meter etc.)

DEMOD

Key for setting the required demodulation mode.

AUDIO

Key for selecting the AUDIO operating modes (AF or DIST/SINAD measurement).

SPEC FUNC

Special function key for access to the following special instrument functions:
- voltmeter
- display settings
- service functions
- IEC bus address
- bargraph settings

FILTER

Selection of AF filters.

DETECTOR

Selection of AF detector for the measured value shown in the MODULATION display.

CALIBRATE

Key for access to the calibration possibilities of the analyzer.

INFO

The INFO key is used for activating internal instrument settings, which are not shown in the value displays, in the MENU display field (using the STEP keys ***8***).

MENU BACK

Key to return from a submenu to the respective next higher menu, maximally to the main menu.

15 RF

RF input (N female). Impedance 50 Ω.

3 mV ... 7 V

Max. power 1 W (7 V). The automatic level adjustment in the instrument operates at input levels between 3 mV and 7 V.

With FMB:

3 (6) mV ... 7 mV

The automatic level and frequency adjustment operates at the following levels depending on the input frequency:

f ≤ 1360 MHz: 3 mV ... 7 V
f > 1360 MHz: 6 mV ... 7 V

(only FMAS in receiver mode)

10 µV ... 7 V

Manual frequency setting only.
Automatic level adjustment operates in the frequency range:

5...1000 MHz at input levels of

10 µV...7 V.

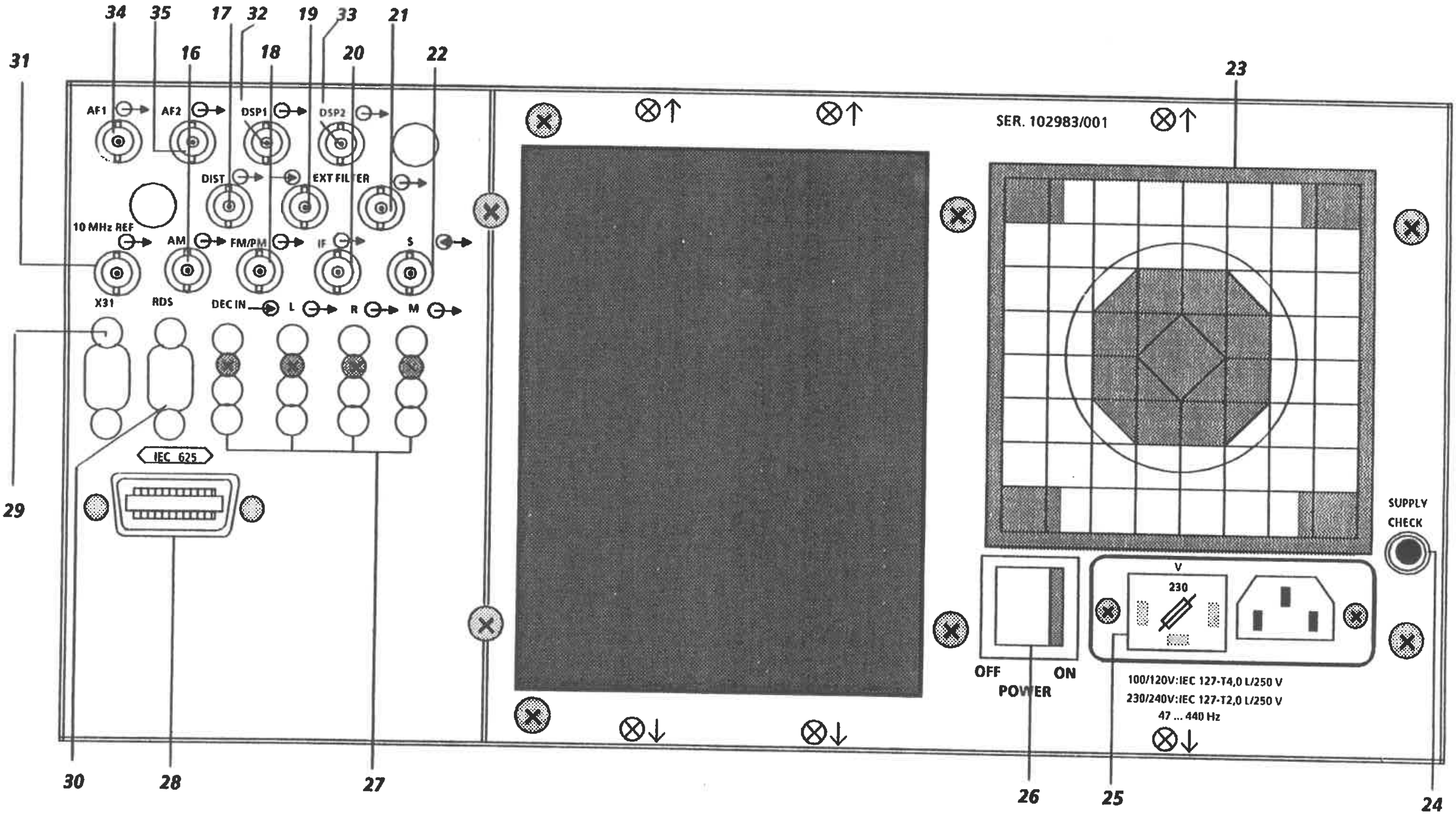


Fig. 3-2 Rear panel view

3.2.2 Rear Panel View

16 AM

AF output of the AM demodulator, max. 1 V; dc-coupling possible; min. terminating impedance 600 Ω. The output level is proportional to the AM modulation depth as well as the applied RF level. The level effect is readjusted in the RF AUTO RANGE mode in steps of 5 dB. (BNC female)

17 DIST

With built-in option DIST/SINAD Meter:

Output for distorted AF signal, i.e. audio signal after removing the fundamental.
Max. 9 V Pk; min. terminating impedance 600 Ω.
(BNC female)

18 FM/PM

AF output of the FM or optionally the PM demodulator.
With ***FM:*** stereo-capable and DC-coupled; min. terminating impedance 600 Ω;

Sensitivity for deviations ≤ 112 kHz :
6 dBm (= 1.545 V) at 40-kHz deviation.

For deviations from 112 to 700 kHz, the sensitivity is reduced to 6 dBm (= 1.545 V) at 160-kHz deviation.

For deviations > 700 kHz, the sensitivity is 6 dBm (= 1.545 V) at 320-kHz deviation.

When ***AM*** demodulation mode is selected or the FMA is set to voltmeter operation, the sensitivity generally amounts to +6 dBm at 40-kHz deviation.

With ***PM:*** The modulation frequency range is from 220 Hz to 330 kHz. The above specified sensitivity values apply correspondingly for phase deviations in rad.
(BNC female)

19 EXT. FILTER

With built-in filter option:

Output for connecting an external filter into the AF measuring path. Min. terminating impedance 600 Ω. (BNC female)

20 IF

IF output.

IF = RF for RF: 50 kHz ... < 2 MHz.
IF = 300 kHz for RF: 2MHz ... < 10 MHz.
IF = 1.5 MHz for RF: > 10 MHz.
Output impedance 50 Ω;
Output level max. 100 mV into 50 Ω. In RF AUTO RANGE mode, the level is adjusted to the peak value of the IF signal in 5-dB steps.
(BNC female)

(only FMAS in receiver mode)
IF = 1.5 MHz for RF = 5 to 1000 MHz

21 EXT. FILTER

With built-in filter option:

Input for connecting an external filter into the AF measuring path. Input impedance > 100 kΩ. (An attenuation of -6.02 dB occurring with a passive filter can be compensated by a switch-selected gain of +6.02 dB, cf. Section 3.3.5.3.5.)
(BNC female)

22 10 MHz REF

Reference frequency output 10 MHz, 7 dBm (int. ref.).
Reference frequency input 10 MHz, -10 dBm to +10 dBm (ext. ref.).
External/internal reference switchover is performed in the Rf Special menu.
(BNC female)

23 DC Blower

The power of the blower is regulated depending on the temperature of the internal power supply heat sink.

24 SUPPLY CHECK

Power supply check when the instrument is switched on:

LED on:	power supply o.k.
LED off:	At least one dc supply voltage has failed.

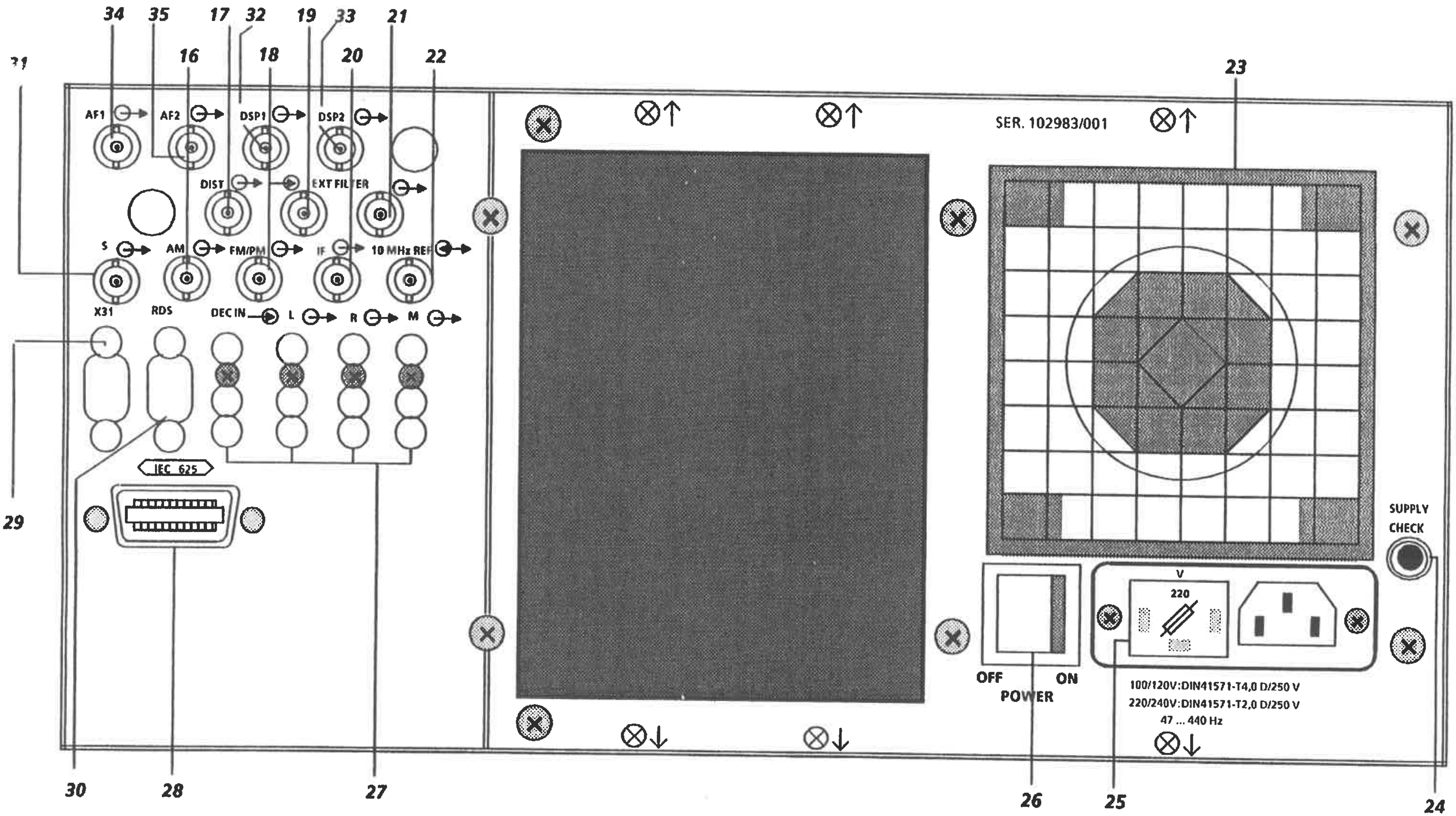


Fig. 3-2 Rear panel view

25 AC SUPPLY

100/120 V
230/240 V

ac supply connector and voltage selector. Prior to initial start-up of the instrument, first check that the correct ac-operating voltage is set with the respective fuse (cf. Section 2.1.3).

26 POWER

Power switch

ON/OFF

Caution! There is hazard of electric shock in ON position of the power switch ***26*** with lines upon which the ac supply could be present when the cabinet is opened!

27

With option Stereo Decoder FMA-B3
standard with FMAB

DEC IN	External stereo decoder input $R_i \geq 40$ kΩ Input level range -12 ... + 12.5 dBm nominal + 6 dBm/40 kHz; $R_L \geq$ 300 Ω symmetrical, 3-contact female connectors DIN 41628
L, R, M	Respective outputs of the stereo decoder (left-hand, right-hand, mid signal) symmetrical, 3-contact female connectors DIN 41628, rated voltage level: + 6 dBm $R_L \geq$300 Ω

28 IEC 625

IEC bus female connector for remote control of the instrument.

29 X31

Serial interface similar to RS232; CANNON female connector.

30 RDS

With option Stereo Decoder FMA-B3;
standard with FMAB

RDS decoder outputs
data clock quality information,
ARI information, 57-kHz carrier (TTL)
CANNON connector.

31 S

With option Stereo Decoder FMA-B3;
standard with FMAB
S-output of the stereo decoder (side signal)
$R_L \geq$600 Ω
unsymmetrical; BNC female connector

32 DSP1

(Only FMAV)
AF output of the digital AM/FM demodulator;
DC coupled; terminating impedance ≥600 Ω;
Sensitivity 4 V/100% with AM independent of the carrier level or 4 V/kHz with FM.

With AM - Avion - VOR

m 30Hz/Dev 9.96/ Phase:	FM-demodulated 30-Hz signal
m 9.96 kHz:	9.96kHz subcarrier (frequency-modulated)
m ID:	Identifier

With AM - Avion - ILS

m 90Hz /m 150Hz/ DDM/Phase:	150-Hz signal
m (90 + 150):	sum signal
m ID:	Identifier

With AM - Avion -TACAN

m 15Hz/m 135Hz/Phase:	135-Hz signal
m (15 + 135):	sum signal

BNC female connector

(Only FMA-B8 AF analysis)

Y-signal 0 to +4 V

With intermodulation, dual-tone factor and selective distortion factor measurements, the FFT signal spectrum is output for representation by an X-Y oscilloscope. The vertical scaling is arranged in 10-dB steps.

33 DSP2

(Only FMAV)
AF output of the digital AM demodulator;
DC coupled; terminating impedance ≥ 600 Ω
Sensitivity 4 V/100% with AM independent of the carrier level.

With AM - Avion - VOR

m 30 Hz/Dev 9.96/ Phase:	AM-demodulated 30-Hz signal

With AM - Avion - ILS

all measurements except m ID:	90-Hz signal

With AM - Avion - TACAN

all measurements	15-Hz signal

BNC female connector

(Only FMA-B8 AF analysis)

Y-signal 0 to +4 V

With intermodulation, dual-tone factor and selective distortion measurements, the FFT signal spectrum is output for representation by an X-Y oscilloscope. The vertical scaling is arranged in steps of 10-dB.

34 AF1

(with calibrator option FMA-B4)

AF output; DC coupled
10 Hz to 100 kHz, MPX signal, Avionic signal,two-tone
Us: 0 to 10 V
Impedance: 10 Ω, 200 Ω, 600 Ω
Output unbalanced or ungrounded balanced to AF2
Can be switched off separately (R_i = 600 Ω)
BNC female connector

35 AF2

(with calibrator option FMA-B4)

AF output; DC coupled
10 Hz to 100 kHz, MPX signal, Avionic signal, two-tone
Us: 0 to 10 V
Impedance: 10 Ω, 200 Ω, 600 Ω
Output identical to AF1 or ungrounded balanced to AF1
Can be switched off separately (R_i = 600 Ω)
BNC female connector

Note:
With Gen AF Destination: AM or FM, an AF signal corresponding to the modulation depth or the deviation is applied to the outputs AF1 and AF2. Note that with Gen AF Destination: AM, the applied AF signal is displaced in phase by 180 ° with respect to the envelope of the 10-MHz Cal signal.

3.3 Operation, Operating Menu Functions and Marker

In light of the manifold measuring and setting facilities of the instrument, the operational concept is characterized by few distinct main function keys combined with a MENU field with associated softkeys.

The readouts in the MENU display field inform the user about the currently active functions of the softkeys in the selected menu.

The menus are clearly structured. The number of submenu levels has been restricted to maximally three levels. The instrument settings normally required have been assigned to the highest possible position in the menu hierarchy to ensure fast access.
"Double click" on main function key:
The "double click" allows for fast access to a function which has already been selected in a submenu. Pressing the main function key first activates the respective main menu, pressing it again leads into the menu last selected.
Marker:

□ ■ ▷ ▶ Four types of markers are used to mark active or non-active functions:

Filled markers mark an active function, non-filled markers mark a non-active function.
▷ ▶ Markers are used, when the respective function selected allows for further settings in a submenu. When a function which was not yet selected is activated, the marker is filled (= function is active). Pressing the respective softkey once again leads to the associate submenu, where further settings can be made.
□ ■ Markers are used for functions, which do not imply further settings.

3.3.1 RF Menu

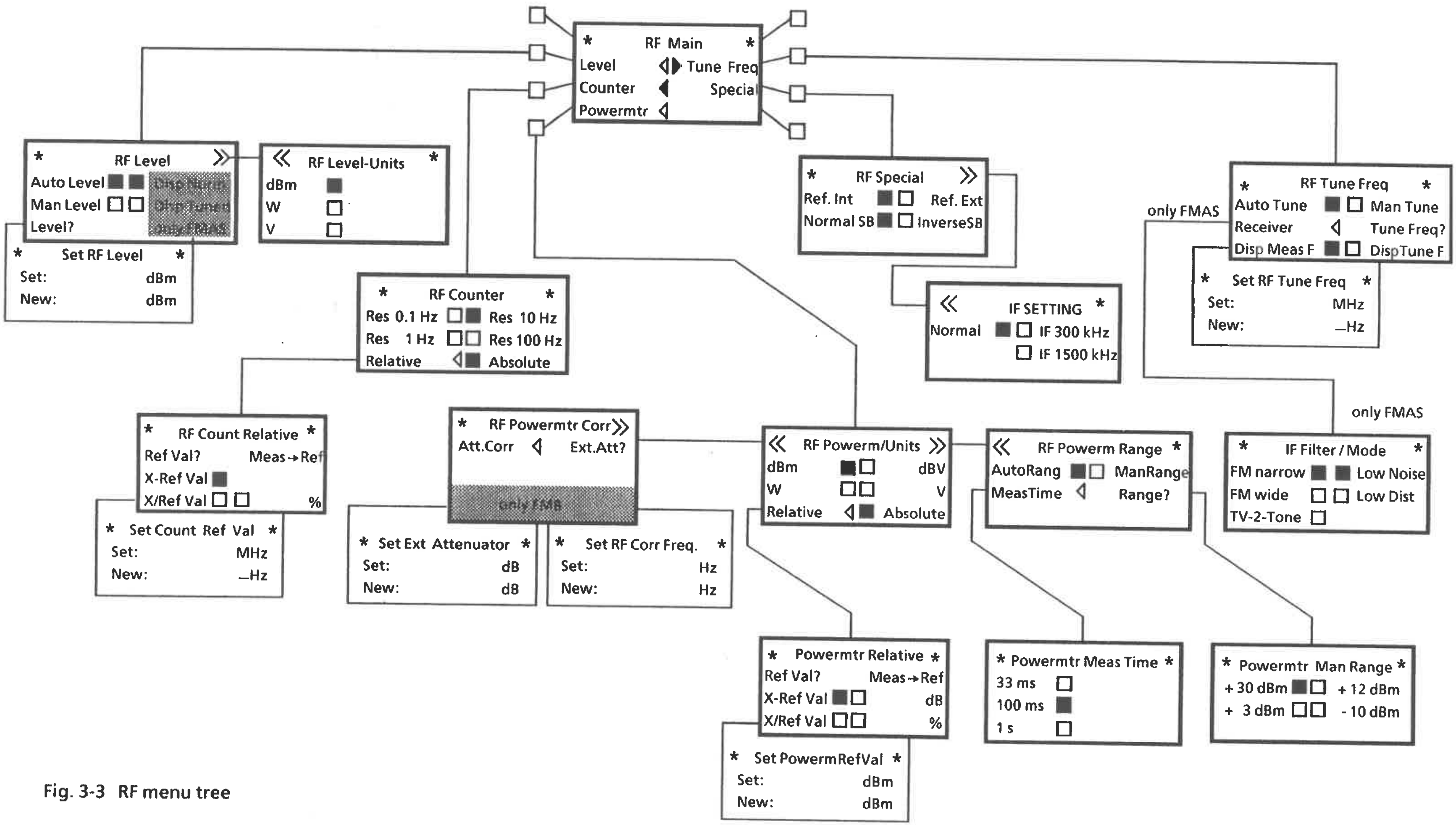


Fig. 3-3 RF menu tree

3.3.1.1 Brief Explanations for the RF Menu

Level		Level setting of instrument; simultaneous switchover to display of the input level present at the RF input.
	Auto Level	Switching on automatic level setting; instrument default status.
	Man Level	If Auto Level mode was active before: The currently valid level value is fixed, otherwise no modification. If no signal within the specifications is applied to the RF input, an error message is given out (STATUS LED blinks) and the instrument maintains Auto Level mode.
	Level?	Actuating this softkey calls the Set Rf Level menu for manual entry of a specific level setting.
	Disp Norm	*(only FMAS)* Display of total level at RF input in Receiver and Normal mode
	Disp Tuned	*(only FMAS)* Display of selectively measured level at RF input. Selectable only in Receiver mode. Default setting in Receiver mode.
>>RF Level Units		Right-hand Level menu
	dBm W V	Selectable display units for the RF level display, or selectable units for input of a manual level setting.
Counter		Selection of the Rf Counter menu; simultaneous switchover to frequency display in the RF display field if level or power values were displayed before.
	Absolute	Absolute display of the applied RF in the RF display; instrument default status.
	Relative	Selection of the Rf Count Relativ menu

Ref Val?	Key to activate entry of a counter reference value in the Set Count.Ref.Val submenu.
Meas→Ref	Currently measured frequency value is defined as reference value; if no measured frequency value is available, an error message is given out (STATUS LED blinks) and the instrument remains set to absolute frequency display.
X-Ref Val	Display of difference of measured value to reference value in the RF display; instrument default status.
X/Ref Val	Display of quotient of measured value/reference value.
%	Display of measured value in percent of deviation.

	Res 0.1Hz Res 1Hz Res 10Hz Res 100Hz	Frequency resolution of RF display; this also includes the measuring time for the automatic level and frequency adjustment of the instrument. The preset counter resolution in the instrument default status is 10 Hz, thus a constant level and frequency adjustment of the instrument is possible for modulation frequencies ≥ 10 Hz. Instrument default status: 10Hz
Powermtr		Switching to power meter operation (which excludes operation as modulation analyzer) and selection of the powermeter menu.
	dBm W dBV V	Selectable display units for the RF display.

Absolute — Absolute display; instrument default status.

Relative — Selection of the Powerm./Relativ menu and switching to relative display.

- Ref.Val? — Key to activate entry of a reference value in the Set Powerm RefVal submenu.
- Meas→Ref — Currently measured value is defined as reference value and relative display is activated. If no valid reference value is available, the instrument remains set to absolute display.
- X-Ref Val — Display of difference of measured value to reference value; instrument default status.
- X/Ref Val — Display of quotient of measured value/reference value.
- dB — Display of measured value as deviation in dB.
- % Error? — Display of measured value in percent of deviation.

≪ Rf Powerm Corr — Left-hand Rf menu.

Att.Corr — Considering an external attenuator in power meter operation; toggle function.

Ext.Att? — Key to activate entry of an external attenuation value.

Only FMB:

Freq.Corr — *Correction of the power meter display depending on the frequency entered.*

Corr Freq ? — *Entry of the frequency for the frequency-dependent correction of the power meter display.*

≫ Rf Powerm/Range — Right-hand Rf menu.

Auto Range — Autoranging mode for power meter amplifier; instrument default status.

Man Range — If Auto Range mode was active before: holding the setting, otherwise no modification.

Range? — Selection of the Powerm. Man Range menu.

- + 30 dBm — Measuring ranges for power meter operation.
- + 12 dBm
- + 3 dBm
- -10 dBm

Meas Time — Selection of the Powerm. Meas. Time menu.

- 33 ms — Selection of possible measuring times.
- 100 ms — Instrument default status 100 ms.
- 1 s

Tune Freq — Frequency tuning of instrument (*only FMAS*: access to receiver function)

Auto Tune — Switching to automatic tuning; intrument default status.

(*only FMAS:* switching to Normal mode when Receiver was active before).

Man Tune — If Auto Tune mode was active before: holding the last setting, otherwise no modification.
(only FMAS) Switching to Normal mode when Receiver was active before.

Receiver — *(only FMAS)*

When Normal mode was active before: Switching the Receiver mode on. At the same time, switchover to manual frequency tuning and acceptance of the last frequency setting.
When Receiver mode was active before:
Calling the IF Filter / Mode menu.

FM narrow — Switching on the narrow-band IF filter for FM

FM wide — Switching on the wide-band IF filter for FM

TV-Sound	Switching on the IF filter for TV (two-) tone signals
Low Noise	Switching on the Low Noise mode
Low Dist	Switching on the Low Distortion mode
Tune Freq?	Selection of the Set Rf Tune Freq menu to activate entry of specific frequency value via keypad and Enter keys.
Disp Meas F	**Display of Measured Frequency** in the RF display; instrument default status.
Disp Tune F	**Display of Tuning Frequency** in the RF display.
Special	Selection of the Rf Special menu.
Ref.Int	Internal reference (instrument default status).
Ref.Ext	Switching to external reference.
Normal SB	(Normal sideband). Frequency transformation to normal position of IF.
Inverse SB	(Inverse sideband). Frequency transformation to inverted position of IF.
IF SETTING	
Normal	Automatic selection of the IF depending on the tune frequency.
IF 300 kHz	300-kHz IF; increased DC accuracy of the FM demodulator; basic instrument setting. Limited measuring bandwidth and deviation measuring range.
IF 1500 kHz	1.5-MHz IF; total measuring bandwidth and total deviation measuring range; if RF $<$ 10 MHz, interferences due to spurious signals increase.

3.3.1.2 The Rf Level Menu

The Rf Level menu allows to set the RF level in modulation analyzer mode of the instrument. When the instrument is in default status, it is in autoranging "Auto Level" mode, i.e. the level is automatically set depending on the measured peak level.

In the default status the measuring time is 100 ms, so that the Auto Level mode can even be used with heavily modulated AM signals down to modulation frequencies of 10 Hz.

In specific cases, when faster measuring times or lower modulation frequencies are required, the measuring time can be varied to 33 ms or 1 s (cf. Section 3.3.1.3).

For certain operating modes, e.g. if a level is only temporarily applied, the level can also be manually set to a fixed value using the functions Man Level or Level? so as to accelerate the measuring operation of the instrument. (Simultaneously, it is then also recommended to manually set the frequency as well the modulation measuring range, cf. the respective information in Sections 3.3.1.4 and 3.3.2).
By acutating the softkey `Man Level`, the currently valid RF level divider setting can be maintained (when Auto Level mode was active before).

The softkey function `Level?` permits manual setting of the level to any value within the given specifications.

See the following example for setting a specific carrier level of + 10 dBm:

`Level?`	Softkey
1	Keypad
0	Keypad
x1	Enter keys

(only FMAS)
In Receiver mode, the RF level can also be measured selectively in addition to the wideband measurement.

Disp Norm = Display Normal: Wideband measurement of RF level via the diode at the RF input. The level display does not depend on the tuning frequency.

Disp Tuned = Display Tuned: Selective measurement of RF level via diode in IF section. The level around the tuning frequency within the IF bandwidth is displayed. Disp Tuned is selectable only with the Receiver mode switched on. (Default setting in Receiver mode).

3.3.1.3 The Rf Counter Menu

The Rf Counter menu allows to set the operating mode of the RF counter.

Absolute or relative measurements, as well as the frequency resolution of the RF display can be selected.

When the analyzer is set to its default status, the RF resolution is set to 10 Hz and a corresponding measuring time of 100 ms. Correct level and frequency adjustment is thus possible for modulation frequencies down to 10 Hz (with AM, FM or PM-modulated signals).

The counter resolution can be varied depending on the current requirements (shorter measuring times or higher counter resolutions). Confer the following table.

Table 3-1 Relationship of counter resolution and automatic level and frequency adjustment

RF counter resolution	Gate time RF counter	Automatic level and frequency adjustment with AM and FM for modulation frequencies down to minimally:
100 Hz	10 ms	30 Hz
10 Hz *)	100 ms *)	10 Hz *)
1 Hz	1 s	1 Hz
0.1 Hz**)	10 s	1 Hz

*) Instrument default status

**) For frequencies < 100 Hz or relative measurement x - ref value

In mere RF counter operation, i.e. without modulation measurement, it is possible to switch off modulation measurement and modulation frequency measurement in order to achieve minimal measuring times (cf. Demodulation menu in Section 3.3.2).

Also relative measurements are possible. Softkey `Meas→Ref` can be used to define the instantaneous frequency as reference value for subsequently measured frequencies, or a new reference value can be entered with softkey `Ref.Val`.

See the following example for entering a reference of 10 MHz from the RF-Main menu:

Counter	Softkey
Relativ	Softkey
Ref Val	Softkey
1	Keypad
0	Keypad
xM/µ	Enter keys

In default status of the analyzer, the difference of measured value to reference value is indicated in the RF display (x - Ref.Val).

The softkey function

X/Ref Val — can be used to have the quotient of measured value/ reference value displayed (without unit).

The function

% — calls display of the difference of measured value to reference value in percent of deviation.

The letters RELATIV are shown in the RF display to identify relative measurement.

3.3.1.4 The Rf Tune Freq Menu

The Rf Tune Freq menu allows to set frequency tuning mode on the analyzer. In default status, the analyzer tunes automatically to input levels and input frequencies within the given specifications (AUTO TUNE is shown in the RF display, cf. also Table 3-1). In specific cases of operation when automatic tuning is not desired or not possible, a fixed carrier frequency can be set on the instrument. This is for instance the case:

- with heavily modulated AM signals, when the frequency counter can no longer function properly (cf. the FMA Data Sheet about automatic frequency tuning), or
- if several signals are simultanously applied, or
- if a signal is not continuously applied.

The softkey functions

Man Tune — to hold the currently measured frequency as fixed value, or

Tune Freq? — to set a new fixed carrier frequency value

are available.

See the following example for setting a fixed carrier frequency of 100 MHz from the RF-Main menu:

Tune Freq	Softkey
Tune Freq?	Softkey
1	Keypad
0	Keypad
0	Keypad
*M	Enter keys

The letters MAN TUNE in the RF display indicate that fixed (manual) frequency setting mode is active.

In default status, the instrument is set to Displ.Meas F. mode (Display Measured Frequency), i.e. the measured frequency is read out in the RF display. It is also possible to select display of the tuning frequency in the RF display using the softkey DISPL.TUNE.F. (= Display Tune Frequency).

The tuning frequency can also be displayed in normal Auto Tune mode.

Note that the resolution is then different from the set counter resolution (cf. Section 3.3.1.3), as another, more suitable counting method is applied in frequency tuning mode.

For frequency tuning, the mean value of the applied carrier frequency is determined. This is important for carrier signals which are frequency-modulated at low modulation frequencies, when a conventional frequency measurement would give highly inconsistent results and thus cause continuous retuning with respective interruptions or demodulation errors.

In default status, the instrument can average FM modulation frequencies down to 10 Hz.

The frequency measurement accuracy is approximately ± 4 kHz, i.e. the IF is correspondingly set to the nominal IF ± 4 kHz.

However, a reselection is possible in the Rf Counter menu depending on the current requirements. This is for instance the case if faster automatic frequency adjustment or frequency adjustment for low-frequency-modulated carrier signals down to 1-Hz modulation frequencies is needed (cf. Table 3-1).

Note as to automatic frequency tuning

The analyzer uses single down-conversion for input frequencies > 2 MHz. Input frequencies in the range from 2 MHz to 10 MHZ are converted to an IF of 300 kHz, input frequencies > 10 MHz to an IF of 1.5 MHz. The analyzer has the same sensitivity on the image frequency (with normal sideband: f_I- 2xIF) as on the normal tune frequency f_I.
With an RF signal applied and the local oscillator switched off, the input frequency is measured by an automatic frequency search process. The local oscillator is then set to a value down-converted by the IF. The IF frequency is subsequently measured serving as a basis for calculation of the input frequency.
The RF in the input section is checked (switch-off of the local oscillator is required) when
the IF level strongly varies (> 6 dB)
or the IF varies by more than about 1 MHz with an IF of 1.5 MHz or by more than 250 kHz with an IF of 300 kHz.
(In this case lines are briefly read out in the RF display).

This process guarantees high tuning accuracy for all measurement spheres that might occur in practice.
Problems may arise when the input frequency is changed very fast by bounds or, in Single Step mode (IEC bus mode) reduced (increased with Inverse Sideband) by 2 x IF (ie by 600 kHz or 3 MHz).
As the IF signal remains the same, the analyzer does not notice the changed RF signal and continues to display the previous frequency, which, of course, deviates from the correct value by 2 x IF.

This can be prevented by briefly (for >200 ms with default measurement times) switching off the level after or during the frequency change or, avoiding frequency changes by about 2 x IF, if possible.

(only FMAS) Receiver Mode

All information given below refer to Receiver mode.
The IF filters as well as the Low Noise and Low Distortion modes are not effective in Normal mode.

With the Receiver mode activated, the instrument can be used as a selective modulation analyzer.
It allows measurements to be performed with several signals being applied simultaneously. In addition, reception on the image frequency is suppressed considerably and the local oscillator voltage is reduced at the RF socket.

Switching on the Receiver mode:

By pressing the Receiver softkey, the Receiver mode is switched on and at the same time manual frequency tuning is selected, the last frequency setting being adopted. Automatic frequency setting is not possible in Receiver mode. When the Receiver mode is activated, TUNE is read out in the RF display.

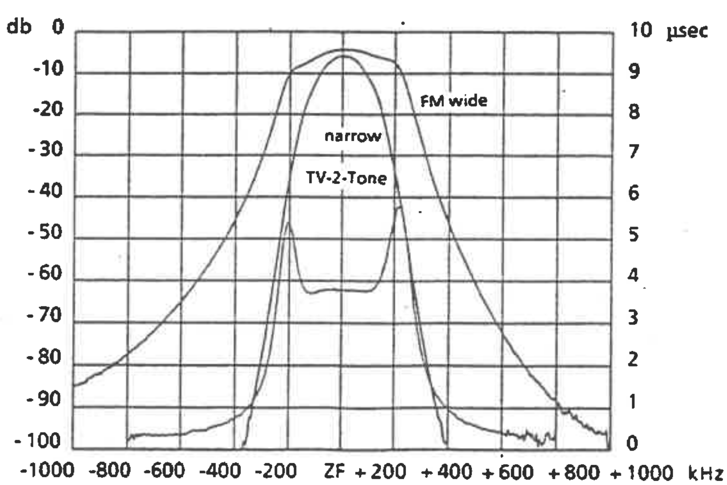
Tuning:

Tuning to a different receive frequency is made by pressing the Tune Freq? softkey and entering the frequency.

RF preselection
The RF preselection filters are automatically selected and tuned with the frequency tuning.

IF filters:

The IF filters determine the selection properties.
When the Receiver mode is ON, press the Receiver softkey to enter a submenu in which the following IF filters are offered for selection. See also the figures illustrating the filter characteristics.



FM narrow 3-dB bandwidth 150 kHz, -60 dB at ± 280 kHz especially for FM stereo ball reception

FM wide 3-dB bandwidth 350 kHz, -60 dB at ± 600 kHz for other selective FM stereo measurements.

TV-Sound as FM narrow for measurements on TV-(two) tone signals and TV tone subcarriers.

Important!

The IF filters are specifically designed for measurements on FM stereo signals (MPX) and TV (two-) tone signals and TV tone subcarriers. For other FM measurements, note that the measurement error increases for modulation frequencies > 53 kHz.

IF filters	typ. **deviation measurement** error for deviations < 100 kHz
FM wide	-10% with f_{mod} = 75 kHz, -3dB with 85 kHz
FM narrow /TV	-10% with f_{mod} = 65 kHz, -3dB with 74 kHz

For deviations > 100 kHz, additional measurement errors and considerable non-linear distortions occur.

In the case of AM demodulation in Receiver mode, frequency response correction of the IF filters is not effective. Additional modulation depth errors are to be expected (expressed in percent of the measured value):

f_{mod}:	10 kHz	20 kHz	30 kHz	50 kHz	70 kHz
IF filters					
FM wide	-0.2%	-0.6%	-1.2%	-3.5%	-7.5%
FM narrow /TV	-0.8%	-2.6%	-6%	-17%	

Operating modes:

The operating modes influence intermodulation ratio and signal-to-noise ratio. By pressing the Receiver softkey in Receiver mode, a submenu is entered, offering the following operating modes for selection:

Low Noise In this mode, the maximum S/N ratio is obtained with an intermodulation ratio which is about 10 dB less than in Low Distortion mode. With Auto Level, the RF preamplifier is always switched on, with Man Level, it depends on the level setting. All internal levels are 5 dB higher than in Low Distortion mode.

Low Dist. In this mode, the maximum intermodulation ratio is obtained with a S/N ratio about 3 dB worse than in Low Noise. With Auto Level, the RF preamplifier is always switched off, with Man Level it depends on the level setting.

Return to Normal mode:

By pressing the Auto Tune or Man Tune softkeys, Normal mode is entered.

3.3.1.5 Power Measurement

In addition to the normal operation as modulation analyzer, the FMA can also be used as power meter. This operating mode is accessed from the RF-Main menu via the softkey `Powermtr`.

The modulation analyzer function is then switched off, and the RF display reads out the RF power or RF voltage present at the input.

For the power measurement, the RF voltage is directly measured at the input of the attenuator of the instrument using a diode and converted into power or rms-voltage.

To obtain good matching, the attenuator is set to a minimum attenuation of 20 dB in the power meter mode (or higher depending on the measured voltage).

Due to the level and temperature correction of the diode, power measurements of high precision are achieved.

Using the softkey function `Att.Corr.` (Attenuation Corrected) in the left Rf Powerm.Corr. menu, external power attenuators can be considered in the display for power measurements > 1 W.

FMB or FMA with option FMA-B12
Level measuring accuracy with known frequency can be considerably increased by switching on frequency correction (function "FREQ. Corr").

The frequency must be entered in the menu "Set Rf-Corr. Freq".

Frequency correction is possible as individual correction values for each level measurement diode in the FMB and FMA-B12 are determined during separate calibrations. The correction values can be defined at various levels for the complete specified frequency range.

The power applied to the analyzer input can be read out in the units Watt (W) or dBm, or also as RF voltage into 50 Ω in Volt (V) or dBV.

In default status of the instrument, the measured results are displayed as absolute values. However, the measured power or voltage can also be indicated relative to a previously measured value, that has been defined as reference value using the function `Meas→Ref`, or a value key-entered before via the function `Ref.Val?`. The following possibilities are available for relative display:

X-Ref Val: Display of difference of measured value to reference value in the selected unit.

X/Ref Val: Display of quotient of measured value/reference value (without unit).

dB: Display of quotient of measured value/reference value in dB:
20∗lg (measured value/reference value).

%: Display of deviation of measured value and reference value in %.
100 ∗ (measured value - reference value/ reference value.

The letters RELATIV appear in the RF display informing the user when relative display is active.

In the submenu Powerm Meas.Time, the measuring time of 100 ms set in the default status of the instrument can be extended to 1 s in view of better averaging, or reduced to 33 ms to accelerate the measurement.

In default status, the powermeter amplifier is in autoranging mode. For specific applications, e.g. for measuring powers applied to the input only shortly, the analyzer can also be set to manual selection of the measuring range using the Man Range function. The letters MAN RANGE are read out in the RF display when this mode is selected.
The offset voltages of the power meter amplifier are automatically determined in the " Calibrate Offset " menu (softkey " Powermtr ") and taken into account with further power measurements.

3.3.2 Demodulation Menu

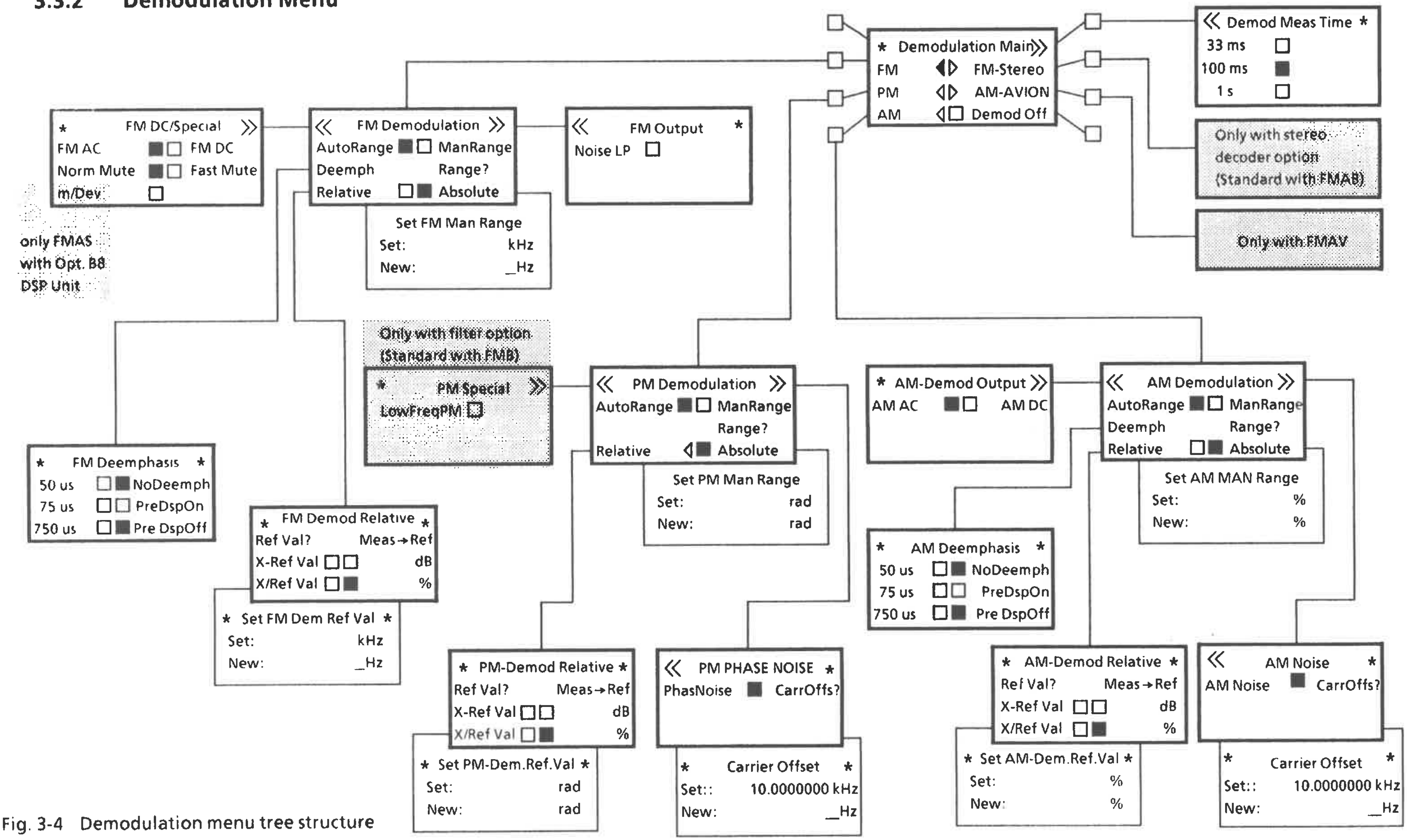


Fig. 3-4 Demodulation menu tree structure

3.3.2.1 Brief Explanations for the Demodulation Menu

In the main menu of function key DEMOD, the demodulation modes of the analyzer can be set. The following types of demodulation are available:

amplitude demodulation,
frequency demodulation,
or phase demodulation.

The modulation factor is displayed in the MODULATION display in the respective unit, depending on which type of demodulation is selected.

The modulation measurement result is conditioned by the filter weighting (cf. Section 3.3.5) and the type of detector used (cf. Section 3.3.6).

In default status, a 10-Hz highpass filter and the peak-responding detector ± Pk/2 are switched on. Both settings are additionally indicated in the MODULATION display.

The AM-demodulated signal is always available at the AM demodulator output on the rear of the instrument, irrespective of the current setting. The FM-demodulated signal is present at the FM/PM output when AM or FM demodulation is selected.

When phase demodulation is selected, the phase-demodulated signal is available at the FM/PM output (cf. information about AM output *16* and FM/PM output *18* in Section 3.2.2).

Using the softkey `MeasTime`, the measuring time for the selected type of demodulation can be reduced from the default value of 100 ms to 33 ms so as to accelerate the measurement, or extended to 1 s for a lower minimal modulation frequency.

FM Frequency demodulation; simultaneous selection of the FM menu.

PM Phase demodulation; simultanous selection of the PM menu.

AM Amplitude demodulation; simultaneous selection of the AM menu.

Meas Time Measuring Time; selection of the menu for setting the measuring time for the demodulator.

- 33 ms — Selection of the possible measuring times.
- 100 ms — Instrument default status 100 ms
- 1 s

Demod Off Switching off the demodulator function; mere frequency counter operation.

FM Demodulation

≪ FM DC/Special — Left-hand FM Demodulation menu.

FM DC — dc coupling of FM measuring path.

FM AC — ac coupling of FM measuring path; instrument default status.

Norm Mute — Microprocessor-controlled mute circuit in addition to the hardware-controlled mute circuit of the FM demodulator branch; instrument default status

Fast Mute — Only hardware-controlled mute circuit of the FM demodulator branch; suitable for transient measurements.

m/Dev *(only FMAS with FMA-B8)*
Ratio measurement
%AM / kHz FM deviation
Toggle function: Switchover between FM demodulation and ratio measurement

≫ FM Output Right-hand FM Demodulation menu.

- **Noise LP** Selectable phase-compensated lowpass filter with cutoff frequency of 95 kHz (- 3 dB) for the FM output on the rear to block noise interference; toggle function.

Auto Range Automatic selection of the modulation measuring range; default status.

Man Range If Auto Range mode was active before: holding the instantaneous deviation measuring range, otherwise no modification. Switching to relative display of results.

Range? Key to activate specific entry of the measuring range of the FM demodulator using the keypad and the Enter keys.

Absolute Absolute display of the modulation measurement results; default status.

Relative Selection of the FM-Demod Relativ menu.

- **Ref Val?** Key to activate entry of a reference value using keypad and Enter keys.
- **Meas→Ref** Currently measured modulation value is defined as reference value.
- **X-Ref Val** Display of difference of measured value to reference value.
- **X/Ref Val** Display of quotient of measured value/reference value.
- **dB** Display of deviation of measured value in dB.
- **%** Display of measured value in percent of deviation; default status.

Deemph Selection of the menu for setting the FM deemphasis.

- **50 µs** -
- **75 µs** - Deemphasis time constants.
- **750 µs** -
- **No Deemph** Switching deemphasis off; instrument default status.
- **PreDspOn** Activating deemphasis for frequency deviation display. An activated deemphasis is in any case effective for the AF output.
- **PreDspOff** Deemphasis not effective for frequency deviation display.

PM Demodulation

≪ PM Demodulation Left-hand PM Demodulation menu (only with built-in FILTER option).

- **LowFreqPM** Special phase demodulation; lower cutoff frequency 10 Hz.

Auto Range Automatic selection of the modulation measuring range; default status.

Man Range If Auto Range mode was active before: holding the instantaneous deviation measuring range, otherwise no modification. Switching to relative display of results.

Range? Key to activate specific entry of the measuring range of the PM demodulator using the keypad and the Enter keys.

Absolute Absolute display of the modulation measurement results; default status.

Relative	Selection of the PM-Demod Relative menu.	
	Ref Val?	Key to activate entry of a reference value using keypad and Enter keys.
	Meas → Ref	Currently measured modulation value is defined as reference value.
	X-Ref Val	Display of difference of measured value to reference value.
	X/Ref Val	Display of quotient of measured value/reference value.
	dB	Display of deviation of measured value in dB.
	%	Display of measured value in percent of deviation; default status.
PMDemodulation	Right-hand PM menu (only with optional AF Analyzer FMA-B8)	
Phase Noise	Activating phase noise measurement	
Carrier Offset?	Enabling entry of the RF carrier loop for phase noise measurement. Frequency range: 10 Hz to 150 kHz	

AM Demodulation

≪ AM-Demod-Output	Left-hand AM Demodulation menu.	
	AM AC	ac coupling of AM output; instrument default status.
	AM DC	dc coupling of AM output.
Auto Range	Automatic selection of the modulation measuring range; default status.	
Man Range	If Auto Range mode was active before: holding the instantaneous deviation measuring range, otherwise no modification. Switching to relative display of results.	
Range?	Key to activate specific entry of the measuring range of the AM demodulator using the keypad and the Enter keys.	
Absolute	Absolute display of the modulation measurement results; default status.	
Relative	Selection of the AM-Demod Relative menu.	
	Ref Val?	Key to activate entry of a reference value using keypad and Enter keys.
	Meas → Ref	Currently measured modulation value is defined as reference value.
	X-Ref Val	Display of difference of measured value to reference value.
	X/Ref Val	Display of quotient of measured value/reference value.
	dB	Display of deviation of measured value in dB.
	%	Display of measured value in percent of deviation; default status.
Deemph	Selection of the menu for setting the AM deemphasis.	
	50 µs -	
	75 µs -	Deemphasis time constants.
	750 µs -	
No Deemph	Switching deemphasis off; instrument default status.	
PreDspOn	Activating deemphasis for modulation depth display. An activated deemphasis is in any case effective for the AF output.	

PreDspOff	Deemphasis for modulation depth indication switched off (Pre Display Off)
≫ AM-Demodulation	Right-hand AM menu (only with optional AF Analyzer FMA-B8)
AM-Noise	Activating amplitude noise measurement
Carrier Offset	Enabling entry of the carrier offset for amplitude noise measurement. Frequency range: 10 Hz to 150 kHz

3.3.2.2 FM Demodulation

When FM demodulation mode is switched on, the center display MODULATION reads out the frequency deviation of a carrier signal present at the RF input.

Due to the extremely wide dynamic range, also very large frequency deviations (broadband FM, for example for measuring useful modulation) as well as very small deviations (e.g. residual FM) can be precisely demodulated and evaluated.

The maximally measurable frequency deviation and the modulation frequency range are determined by the carrier frequency and specified in the Data Sheet.

The following three carrier frequency ranges are possible:

50 kHz... < 2 MHz: no frequency conversion

2 MHz... < 10 MHz: IF of 300 kHz

> 10 MHz: IF of 1.5 MHz

The full deviation measuring range as well as the full test bandwidth are reached with carrier frequencies above 10 MHz.

In default status of the analyzer, the deviation measuring range is automatically selected (Auto Range mode). In specific cases, however, it can also be held at the instantaneous range using the softkey `Man Range`, or set to a defined value via softkey `RANGE?` and its respective setting menu. The MODULATION display then reads out MAN RANGE.

Using the softkey `Auto Range`, the instrument can be reset to its default status.

See the following example for setting a deviation measuring range of 100 kHz:

`Range?`	Softkey
`1`	Keypad
`0`	Keypad
`0`	Keypad
`*k`	Enter keys

The measured frequency deviation results are normally displayed as absolute values. However, they can also be indicated as relative values, e.g. for S/N ratio or frequency response measurements. The following four softkey functions are available for relative display:

X - Ref Val: Difference of measured value to reference value in basic unit Hz.

X/ Ref Val: Quotient of measured value / reference value without unit.

dB: Quotient of measured value / reference value in dB:
20*lg (meas. value/ref. value).

%: Deviation of measured value and reference value in %:
100* (meas. value/ref. value)/ref. value.

Either the currently measured value is defined as reference value via the `Meas→Ref` softkey or the `RefVal?` softkey is used to enter a specific value in its submenu `Set FM Dem RefVal`.

See the following example for S/N ratio measurement in dB with a reference deviation value of 40 kHz from the FM Demodulation menu:

`Relativ`	Softkey
`Ref Val?`	Softkey
`4`	Keypad
`0`	Keypad
`*k`	Enter keys
`dB`	Softkey

The required detector for measuring unwanted modulation (generally rms-responding or quasi-peak responding) can be selected from the DETECTOR menu, see Section 3.3.6.

Deemphasis

To offset preemphasis by the transmitter, deemphasis can be switched into the measuring path. Three deemphasis time constants can be set:

50 µs
75 µs
or 750 µs

When the softkey function `PreDspOn` is selected, the set deemphasis affects both the measurement evaluation display and the AF output (monitor output).

In the setting of softkey `PreDspOff`, a selected deemphasis is effective only at the AF output but does not influence the frequency deviation display.

A selected deemphasis never influences the FM output on the rear, so that for example an external stereo decoder connected to this output can operate unaffectedly. (In this case, a deemphasis is appropriate only after decoding. However, the AF output can be simultaneously used as equalized mono-monitor output).
Please also refer to section 3.3.4.1 (voltmeter).

The left-hand FM Demodulation menu permits switching the FM path to dc coupling via the softkey `FM DC`.

In the right-hand FM Demodulation menu (FM Output), a noise LP can be selected for the FM output on the rear in order to increase the S/N ratio for FM stereo signals if a stereo decoder is connected.

The -3-dB bandwidth is 95 kHz . When the noise LP is switched on, the stereo channel crosstalk is slightly higher in particular with higher AF frequencies.

Mute

The mute function (mute circuit) of the FM demodulator branch prevents, above all in the case of switching operations such as frequency changes, an overload of the FM demodulator branch.
This effectively eliminates or limits in amplitude peaks caused by switching at the FM/PM output (at the rear of the instrument) as well as at the AF measuring path.

In the instrument default status **Normal Mute** the mute circuit is hardware-controlled (mute circuit due to an IF level which is too low) as well as computer-controlled (the device control processor only enables the mute circuit when FM demodulation capability is possible without interferences, e.g. after the instrument has had the frequency retuned).
For certain measurements, e.g. when measuring the frequency settling in the case of instruments tuned manually, the longer switching to mute function in the case of Normal Mute is disturbing.
The **Fast Mute** function blocks the computer-controlled mute circuit. Switching to mute function is exclusively effected due to a missing IF level. The delay time of the enabling of the mute circuit is optimally adapted to the settling time of the FM demodulator. Especially measurements of frequency settling are possible using the Fast Mute function.

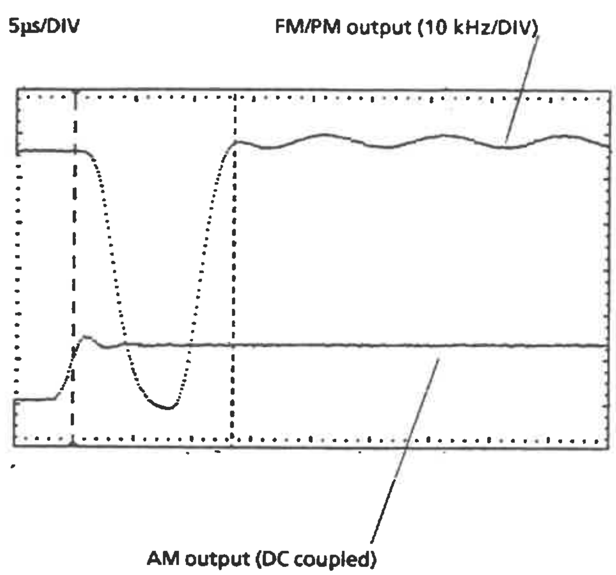


Fig. 3-4.1 Measuring curve of the frequency settling of a radiotelephone (Fast Mute)

3.3.2.3 Phase Demodulation

When phase demodulation mode is selected, the center display MODULATION reads out the phase deviation of a carrier signal present at the RF input in the unit Radian.

Internally, a weighting filter is switched in series to the FM demodulator. The filter shows an increase of - 6 dB per octave for modulation frequencies above 200 Hz (cf. Fig. 3-5) and thus achieves phase demodulation.

For modulation frequencies ≤ 200 Hz, the weighting filter increases the attenuation in order to suppress unwanted components close to the carrier (noise and hum lines). Except for the 300-kHz HP filter, no other highpass filter is suitable. Therefore, the 10-Hz HP or the 20-Hz HP cannot be switched on for PM mode.

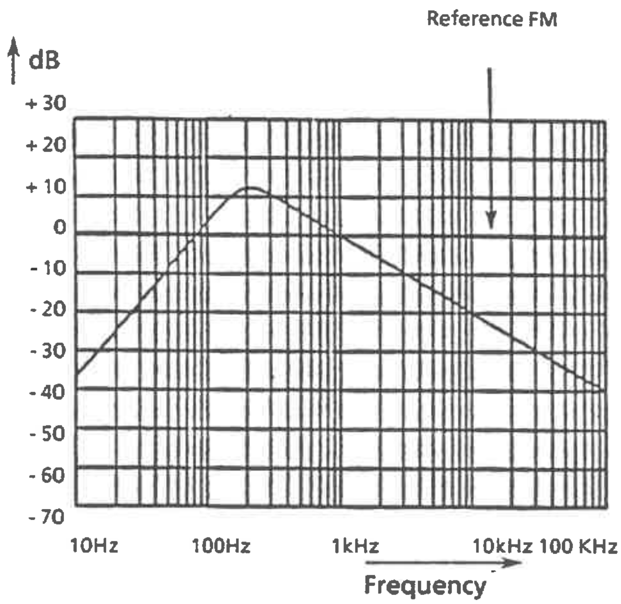


Fig. 3-4.1 PM Filter

As with FM demodulation, the PM mode also has three ranges depending on the carrier frequency, which differ with regard to the maximally measurable phase deviation and the modulation range (cf. Data Sheet).

The full deviation measuring range as well as the maximal modulation range also apply for carrier frequencies ≥ 10 MHz.

Concerning absolute and relative display of the measured results and the automatically or manually set measuring range, the information in Section 3.3.2.2 for FM demodulation applies correspondingly.

With PM mode, the phase-demodulated AF signal is available at the FM/PM output (see Section 3.2.2, item ***18***).

Low Frequency PM Filter

As an alternative to normal phase demodulation, which is meant for modulation frequencies >200 Hz (thus effectively suppressing interference lines close to the carrier), the optional Low Frequency PM Filter is available with modulation frequencies above 10 Hz.

Square wave modulation can be correctly demodulated (i.e. no overshoot) starting from 300-Hz repetition frequency in combination with LP⎍ 30 kHz or LP⎍ 120 kHz (cf. Section 3.3.5.3.4).

3.3.2.4 Amplitude Demodulation

When amplitude demodulation is selected, the center display MODULATION reads out the modulation depth in %.

The test bandwidth depending on the carrier frequency is analagous to that of FM demodulation (see Section 3.3.2.2).

The modulation depth to be measured is independent of the carrier frequency.

Note that the automatic frequency tuning is limited when measuring very high modulation depths (see Data Sheet about automatic frequency tuning). This is because the internal frequency counting on which automatic frequency tuning is based can then no longer supply useful count results (i.e. carrier is switched off in the valley of the modulated oscillation).

Therefore, the carrier frequency must be manually set in this case, see Section 3.3.1.4 about frequency tuning.

The results can again be displayed as absolute or relative values, see Section 3.3.2.2. Refer also to the FM Demodulation section for information about the types of relative display and entry of a reference value.

The AM Demodulation menu also allows switching from normal Auto Range to Man Range mode.

3.3.2.5 FM Stereo (Option)
(Standard with FMAB)

3.3.2.5.1 General

The stereo decoder option permits both internal FM stereo demodulation or decoding and, via the external decoder input at the rear of the instrument, stereo decoding of a multiplex signal. The stereo decoder meets maximum quality requirements.

The AF evaluation facilities of the instruments such as

- Psophometric filters and detectors (with filter option)
- Distortion measurement (with DIST/SINAD meter option)
- AF frequency measurement

are provided for measurements on channels L, R, M, S. In addition to the internal measurement capability of the instrument, these channels are additionally taken outside at the rear of the instrument (balanced outputs, except for the S-channel).
In addition, measurement of the complete MPX signal is possible as well as selective measurement of the pilot-tone signal via a 19-kHz bandpass filter. Likewise, a 57-kHz bandpass filter for selective measurement of the RDS/traffic broadcast subcarrier is provided.
Thus, almost all quality parameters of an FM stereo transmitter can be easily measured without any additional aids, and the relative measurement capabilities of the instrument, in particular, can also be made use of.

An RDS demodulator circuit is provided for external RDS decoding; the clock and data signal and the respective auxiliary signals are applied with TTL level at the RDS socket at the rear of the instrument.

Table 3-1.1 Signals at the RDS socket

Pin	Name	Level	Signal description
1	GND		Ground
2	RDSC	HCT	RDS clock
3	Qual	HCT	High with acceptable receive quality
4	HT57A	$\leq 3.1\ V_{pp}$)*	Output signal of 57-kHz filter
5			Not assigned
6	F57	HCT	RDS carrier
7	RDSD	HCT	RDS data
8	ARI	HCT	ARI indication, High with ARI
9	ARIAM	$\leq 1.5\ V_{pp}$)*	ARI modulation

* With standard signal applied to the input

3.3.2.5.2 Stereo Chanal L, R, M, S

Identical steep-edged lowpass filters with a cutoff frequency of 16 kHz (-3 dB) each are connected in series with the lefthand and righthand channel.
The 19-kHz pilot tone as well as higher-frequency spurious signals are efficiently suppressed in order to permit interference-free measurements without additionally switching in lowpass filters in the filter menu.

Both filters serve at the same time for correct stereo decoding and selective RDS demodulation. In order to obtain a possibly low steepness of the phase and thus high phase stability at 19 kHz, the 19-kHz filter is designed as overcritically coupled double-tuned-circuit bandpass filter.
Using a new, automatiç phase adjustment method, the pilot-tone filter can be exactly tuned to a phase of 0 degree.
This can be initiated in the calibrator menu using the softkey "StereoDec".

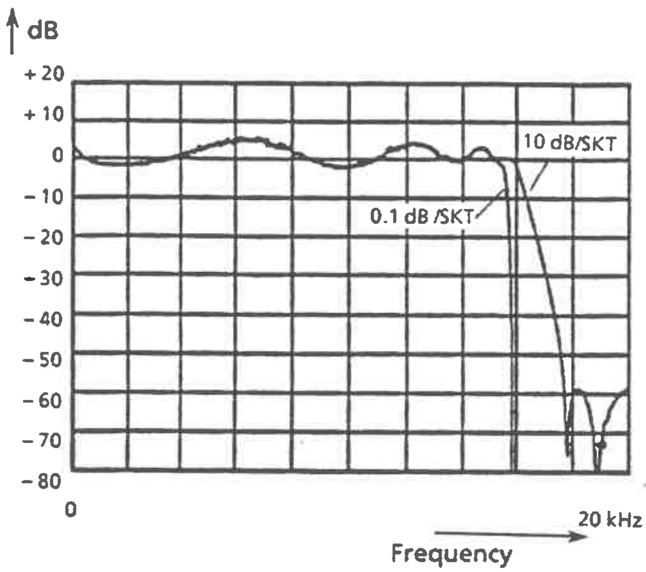


Fig 3-5.1 Filter characteristic L, R filter

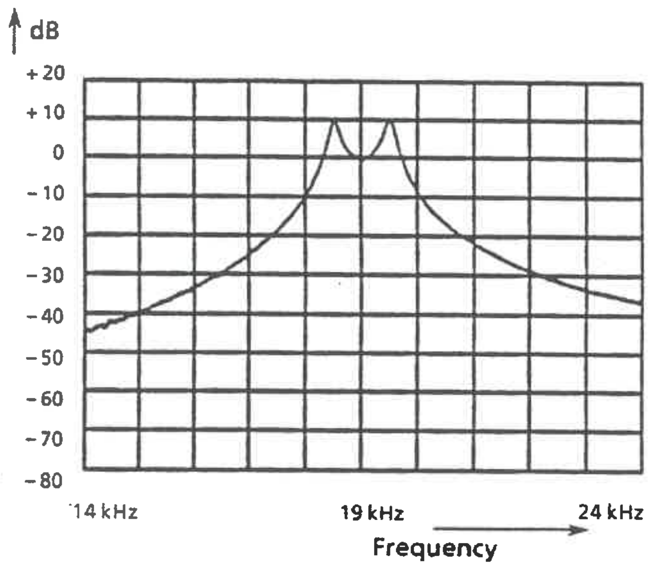


Fig 3-5.2 Filter characteristic pilot-tone filter

The channels M = (L + R)/2 and S = (L - R)/2 are obtained from the filtered L and R channels using a matrix connection so that the same band limiting is effective in this case.

For standard noise voltage measurements on the stereo channels, it is also possible to select deemphasis (50 or 75 µs) in the FM stereo menu and the respective standard filters CCIR-Unweighted or CCIR-Weighted (accessible via filter main function key, righthand side menu).
The standard CCIR detector (quasi-peak) is automatically connected in; if required, it is also possible to cut in another detector, e.g. the RMS detector.

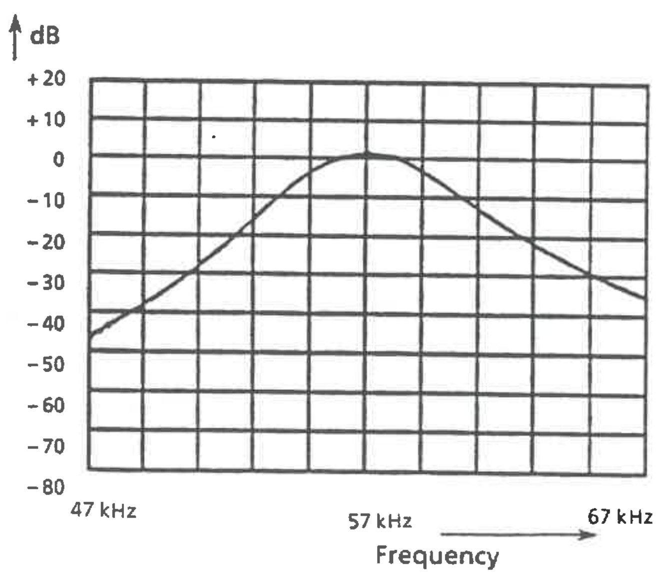


Fig 3-5.3 Filter characteristic 57-kHz filter

3.3.2.5.3 Pilot-tone Filter,57-kHz (traffic announcement carrier) Filter

For selective measurement of pilot-tone and RDS signal level or deviation, appropriate bandpass filters can be selected.

3.3.2.5.4 FM-Stereo Menu

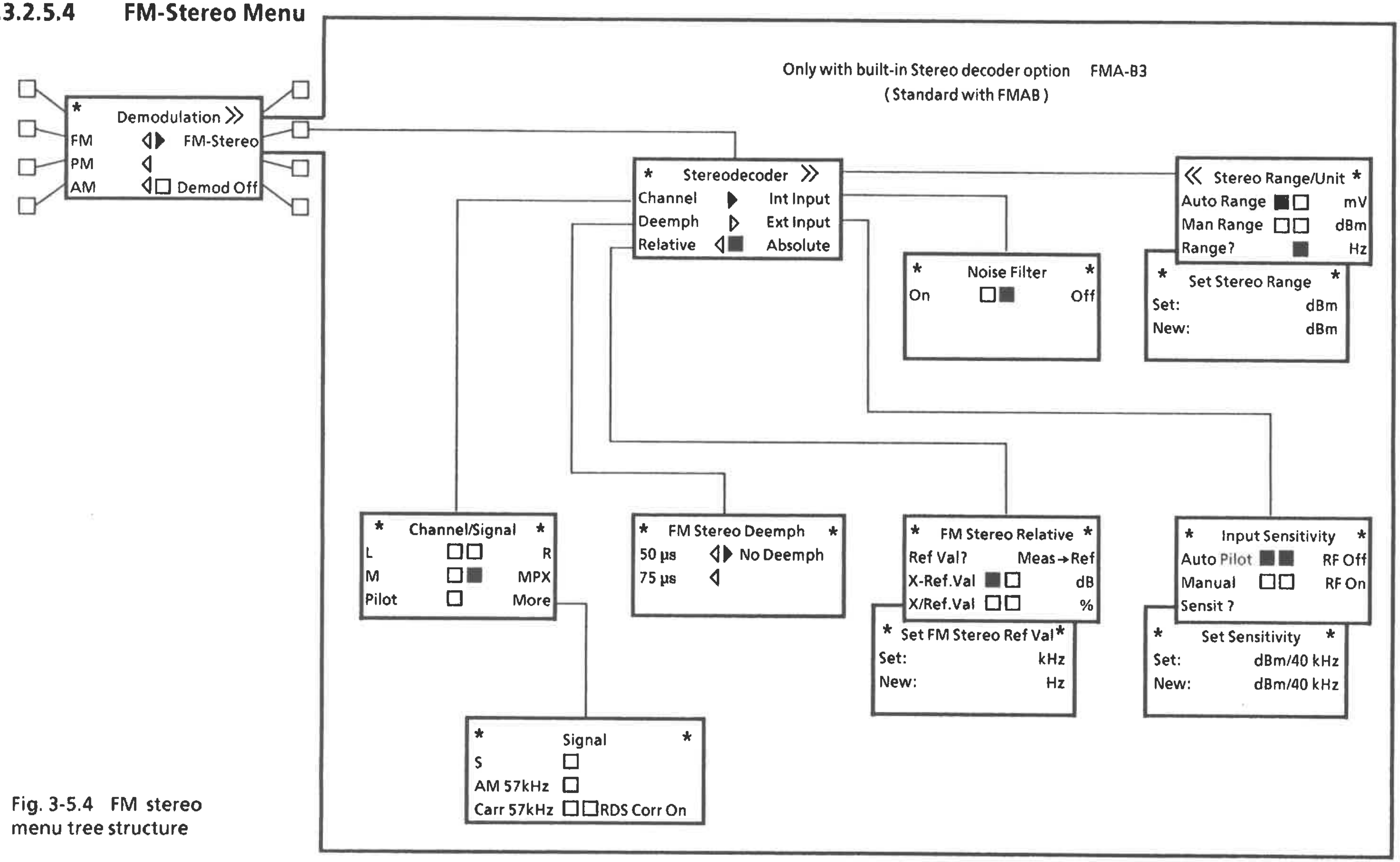


Fig. 3-5.4 FM stereo menu tree structure

3.3.2.5.5 Brief Explanations for the FM Stereo Menu (Only with Option Stereo Decoder) (Standard with FMAB)

FM Stereo Selection of the FM stereo menu

Channel Selecting the desired stereo channel for indication in the MODULATION display.

L Level of the left-hand stereo channel is indicated in the MODULATION display; the level is displayed together with the selected unit (cf. right-hand FM stereo menu) and weighted by the AF filters selected in the filter menu and by the detector chosen in the detector menu.

R Level of the right-hand stereo channel is indicated in the MODULATION display.

M Level of the M signal (L + R)/2 is indicated in the MODULATION display.

MPX Level of the MPX signal is indicated in the MODULATION display (AF lowpass filter is switched off).

Pilot Level of the bandpass-filtered 19-kHz pilot tone is indicated in the MODULATION display (AF lowpass filter is switched off).

More Selecting additional channel measurement capabilities.

S Level of the S signal (L-R)/2 is indicated in the MODULATION display.

AM 57kHz AM 57kHz The modulation depth of the 57-kHz traffic program carrier is indicated on the modulation display. Precondition for correct measurement: no RDS signal.

Carr 57kHz Carr 57kHz The selectively measured deviation caused by the 57-kHz traffic program carrier is indicated on the modulation display; lowpass filters in the AF measurement path are switched off.
Precondition for correct measurement: no RF signal present.
Mit der Funktion Carr 57kHz kann auch der Hub verursacht vom 57-kHz-RDS-Signals bestimmt werden.
Voraussetzungen dazu:
- No traffic program signal present
- Stationary modulation, ie RDS data at logic 0 (or logic 1)
- RDS CorrOn (see RDS CorrOn)

If traffic program and RDS signals are simultaneously present, no useful measurement can be performed with the *Carr 57kHz* and *AM 57kHz* functions.

RDS CorrOn EThe attenuation of the 57 kHz bandpass filter with RDS of stationary modulation is taken into account for the deviation indication (Carr 57 kHz). The correction factor is 1.17 corresponding to 1.36 dB.

Deemph Selecting a stereo deemphasis effective for indication of L, R, M, S channels as well as for the corresponding outputs on the rear of the instrument.

50µs
75µs Deemphases with corresponding time constants.

No Deemph Switching off deemphasis

Relativ Selecting relative display of measured values concerning the FM stereo modulation display. In particular relative measurements concerning the relations of the channels L, R, M, S to each other, frequency response measurements as well as S/N measurements of the channels are possible.

Ref Val? Entering a reference level for the measurement channel selected in the submenu "Channel" in the unit mV, dBm, Hz selected in the right-hand menu.
Default setting: Hz

Meas → Ref Current measured value is adopted as reference value.

X-Ref Val Display of difference of measured value to reference value.

X/Ref Val Display of quotient of measured value/reference value.

dB Display of measured value as deviation from the reference value in dB.
Default status with relative measurement

% Display of measured value as deviation in per cent from the reference value.

Absolut Absolute display of measured values in the MODULATION display

Ext Inp External stereo decoder input at the rear of the instrument is switched on, display of measured values of the channel selected under "Channel". Access to the menu "Input Sensitivity" for setting the input sensitivity of the decoder input.

Auto Pilot The sensitivity of the external decoder input is varied to the pilot tone level within the possible setting range and with a pilot tone of 19 kHz applied. The nominal pilot tone level is -9.5 dBm corresponding to 6.72 kHz. The possible control range is -9.5 dBm -12 dB + 6 dB. When the pilot tone level is not within this range, an error message is read out in the status display. Default setting

Manual If "AutoPilot" was previously selected, the determined sensitivity is made the fixed setting, otherwise no modification.

Sensitiv? (Sensitivity) Entering the external decoder input sensitivity in dBm/40 kHz (dBm relating to 600 ohm). Default setting: 6 dBm/40 kHz corresponding to 1.545 V/40 kHz

RF Off RF section of instrument is switched off; default setting

RF On RF section of the instrument is on. If RF signal is applied, RF display as well as AM demodulation and FM demodulation are on (AM and FM outputs on the rear panel can be used).

Int Inp Internal FM-demodulated signal is switched to the decoder input; the FM noise lowpass filter can be switched on. Default setting

Noise Filter On A phase-compensated lowpass filter 95 kHz -3 dB is switched between the internal connection of FM demodulator -stereo decoder in order to improve the FM stereo S/N. Slightly increased channel crosstalking between channel L and R as well as M and S may occur. (typ. 3 dB at 15 kHz)

Noise Filter Off Noise suppression filter is switched off. Minimum channel crosstalk and slightly reduced FM stereo S/N may occur. (typ. 2 dB) Default status.

<< Stereo Range/ Unit Right-hand FM stereo menu

Auto Range The channel selected under "Channel" is indicated in the MODULATION display with automatic range selection; default status

Man Range If auto ranging was previously selected, the currently set measuring range is made the fixed setting.

Range? Entering the desired measuring range in the unit Hz/mV/dBm selectable in the same menu.

mV
dBm
Hz

Selecting the measuring unit in the MODULATION display.
Default unit: external: dBm
FM internal: Hz

The default detector with dBm and Volt is the rms detector, at Hz: ± PK/2

3.3.2.5.6 Demodulation Menu (only FMAV)

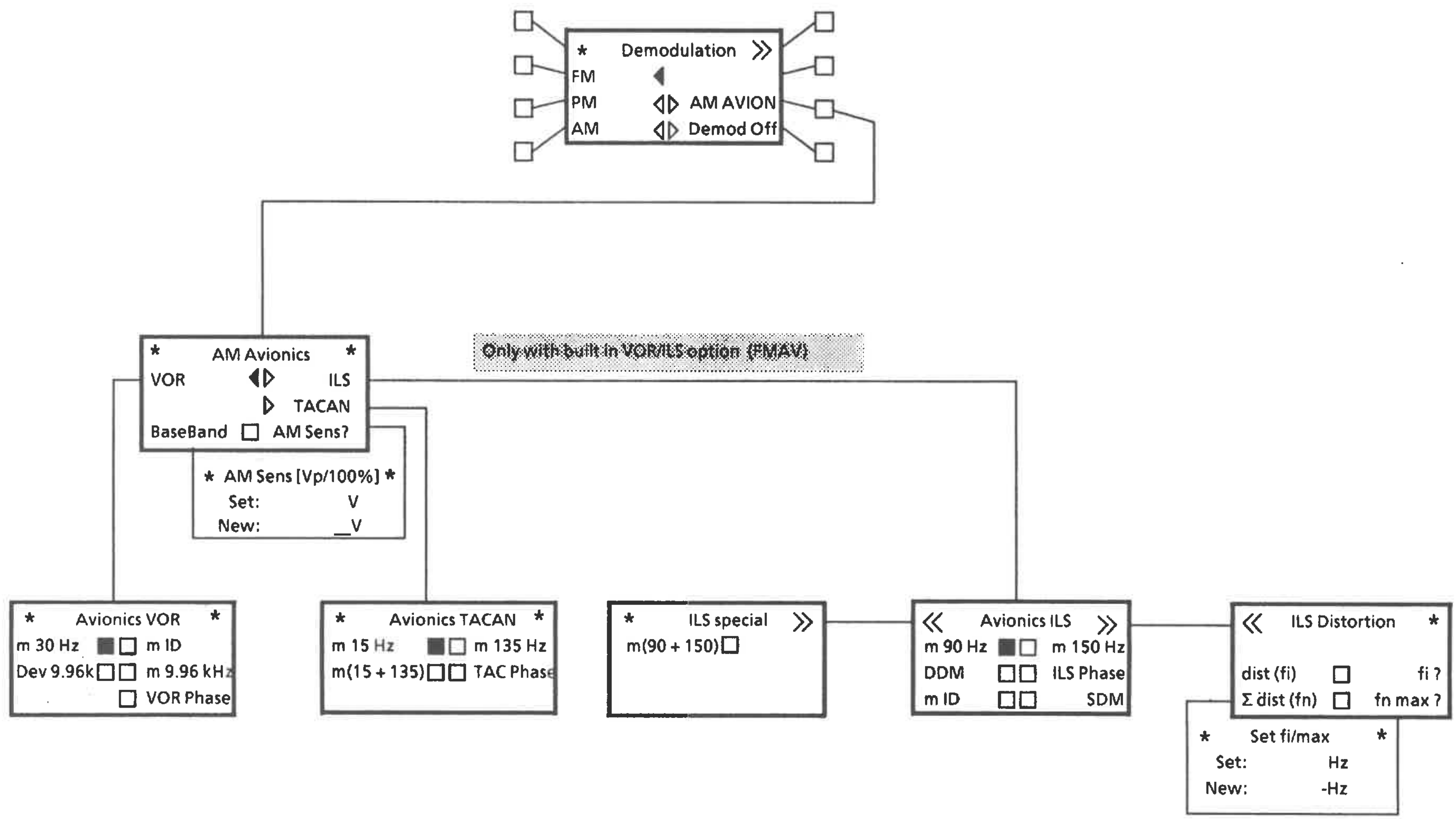


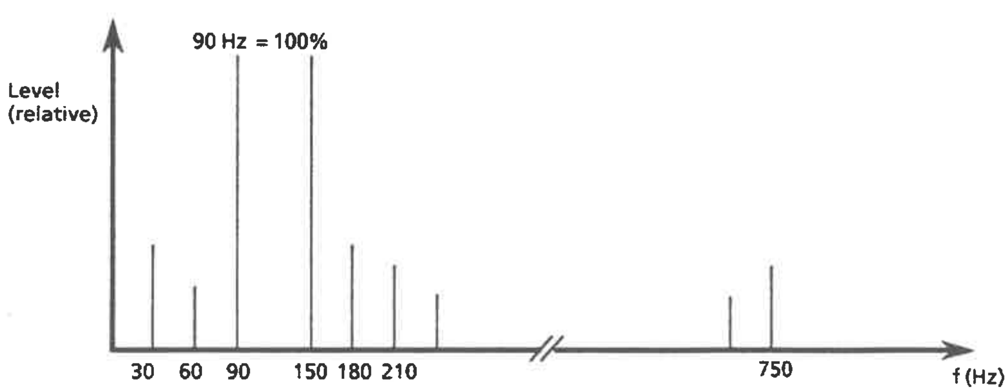
Fig. 3-5.5 Demodulation menu tree structure

3.3.2.5.7 Brief Explanations for the Demodulation Menu (only FMAV)

AM Avion	Access to Avionics measurement capabilities (VOR/ILS/TACAN) of the analyzer (amplitude demodulation)
AM Avionics	Submenu for selection of VOR/ILS/TACAN measurement capabilities
VOR	Access to VOR menu
Avionics VOR	Submenu for selection of VOR measurement capabilities
m 30Hz	Selective modulation depth measurement of VOR 30-Hz signal component; at the same time AF frequency measurement (or phase measurement) in the audio display.
m 9.96kHz	Selective modulation depth measurement of (FM modulated) 9.96-kHz VOR subcarrier; at the same time frequency measurement of 9.96-kHz subcarrier in the audio display. (Phase measurement cannot be switched on).
m ID	Modulation depth measurement of VOR identification signal (1.02 kHz) and of speech band 300 Hz to 4 kHz without any influence by the actual VOR signal; at the same time AF frequency measurement in the audio display. (Phase measurement cannot be switched on).
Dev9.96kHz	Frequency deviation measurement at 9.96-kHz subcarrier of VOR signal; at the same time frequency measurement at subcarrier modulation signal 30 Hz (or phase measurement) with indication in the audio display.
VOR Phase	Phase measurement between 30-Hz AM signal and 30-Hz signal (= reference signal) FM-demodulated by the 9.96 kHz subcarrier; indication in the audio display; measurement range 0 to 360° at the same time switching on of frequency deviation measurement (Dev 9.96 kHz), if mID or m9,96 kHz have been switched on before.
<<Avionics ILS>>	Submenu for selection of the ILS measurement capabilities
ILS	Access to ILS menu
Avionics ILS	Submenu for selection of ILS measurement capabilities
m 90Hz	Selective modulation depth measurement of 90-Hz signal component of ILS signal; at the same time AF frequency measurement (or phase measurement) in the audio display
m 150Hz	Selective modulation depth measurement of 150-Hz signal component of ILS signal; at the same time AF frequency measurement (or phase measurement) in the audio display
m ID	Modulation depth measurement of ILS identification signal (1.02 kHz) and of speech band 400 Hz to 4 kHz without any influence by the actual ILS signal; at the same time AF frequency measurement in the audio display (phase measurement cannot be switched on)
D DM	DDM measurement between 90-Hz and 150-Hz signal (DDM = difference in depth of modulation = (m90 Hz[%] - m150 Hz [%])/100; AF frequency measurement is not possible; phase measurement can be switched on.

ILS Phase	Measurement of phase angle between 90-Hz and 150-Hz component (= reference signal 90 Hz); at the same time switch-over to DDM measurement; indication in the audio display; measurement range ± 60°
SDM	Selective measurement of the sum-modulation depth (SDM = Sum in Depth of Modulation; unit: %); arithmetic sum of the modulation depth of the 90-Hz and the 150-Hz components, without any influence by the phase of the two components. Measurement can be switched on with measurement of m 90 Hz, M 150 Hz, m(90 + 150) Hz or DDM measurement; (if ILS Phase is switched on with m ID measurement, DDM measurement is automatically performed in the modulation display) readout in the audio display; toggle function
*ILS Special>>	Left-hand supplementary menu of Avionics ILS
m (90 + 150) Hz	Measurement of total modulation depth of the 90 Hz and the 150 Hz taking into account the phase angle; AF frequency measurement cannot be switched on; phase measurement or SDM measurement can be switched on
<<ILS Distortion>>	Right-hand supplementary menu of Avionics ILS Distortion measurement (for measurement of the 90 Hz, 150 Hz intermodulation products) in % of the 90-Hz reference signal(= 100%); readout in the audio display
dist(fi)	Relative level measurement of the signal with the frequency fi in %; (90-Hz component = 100%); permitted frequency range of fi = 30 Hz - 750 Hz
Σdist(fn)	Relative rms measurement of the sum of all intermodulation products. k * 30 Hz, with k = 1.2 to n in % (90-Hz component = 100%); This implies evalution of frequencies up to f max.
fi?	Calls entry of the measuring frequency fi for measurement of dist(fi)
fn max?	Calls entry for fn max, which is just still taken into account with measurement of Σdist(fn).

Illustration of the ILS intermodulation products:
(ILS distortion measurement):



TACAN : Access to Avionics TACAN menu

Note:
The FMAV is not suitable for measurement of pulsed signals as they occur in TACAN systems. Conventional, amplitude-modulated RF signals are required for all measurements.

Avionics TACAN	Submenu for selection of TACAN measurement capabilities
m 15Hz	Selective modulation depth measurement of 15-Hz component of TACAN signal; at the same time AF frequency measurement (or phase measurement) in the audio display
m 135Hz	Selective modulation depth measurement of 135-Hz component of TACAN signal; at the same time AF frequency measurement (or phase measurement) in the audio display
m(15 + 135)	Measurement of total modulation depth of 15-Hz- and 135-Hz ILS signal AF frequency measurement is not possible; (phase measurement can be switched on, indication in the audio display)
TAC Phase	Measurement of phase angle between 15-Hz and 135-Hz TACAN signal components (= reference signal 15 Hz); indication in the audio display; measurement range ± 180° (135Hz)
BaseBand	Switching VOR/ILS baseband measurement on/off (Not possible for TACAN measurements) Instead of the RF signal (present at the RF input of the FMAV), the AF signal at the unbalanced voltmeter input is analyzed. The voltmeter range (Range) is fixed to the value entered under AM Sens? (AM sensitivity). (The "AF Underrange" message output on the status display for low voltages is meaningless for the VOR/ILS baseband measurement.). In all VOR/ILS modulation depth measurements, the selectively measured voltages are converted into modulation depths and read out in % AM, the sensitivity entered under AM Sens? [Vp/100%] being used as a reference. This applies also to the ILS measurements DDM, SDM, m (90 + 150) Hz derived from m90 Hz and m150 Hz. If baseband measurement is selected, the RF input is switched off (RF Off) and AF measurements cannot be carried out (AF Off).
AM Sens?	Enabling entry of the sensitivity of an (external) AM modulator that could be or is to be driven by the measured baseband signal. The entered sensitivity [Vpeak/100%AM] is used to convert the respective voltages into modulation depths. Default status: 5 V peak voltage corresponding to 100% AM.

Readout of Measured Values and Assignment of the Rear-panel Analog Outputs

VOR

Central display		Right-hand display		Analog output	
Measured value	Unit	Measured value	Unit	Channel A (DSP1)	Channel B (DSP2)
m (30 Hz)	%	Freq. (30 Hz)	Hz	30 Hz	30 Hz
m (9.96 kHz)	%	Freq. (9.96 kHz)	Hz	9.96 kHz	Zero
m (ID)	%	Freq. (ID)	Hz	ID	Zero
Deviation (9.96 kHz)	Hz	Freq. (30 Hz*)	Hz	30 Hz	30 Hz
Deviation (9.96 kHz)	Hz	Phase	Degree	30 Hz	30 Hz

30 Hz = Base band, 30 Hz* on 9.96 kHz subcarrier
= reference for phase measurement

ILS

Central display		Right-hand display		Analog output	
Measured value	Unit	Measured value	Unit	Channel A (DSP1)	Channel B (DSP2)
m (90 Hz)	%	Freq. (90 Hz)	Hz	150 Hz	90 Hz
m (150 Hz)	%	Freq. (150 Hz)	Hz	150 Hz	90 Hz
m (90) - m (150)/100%	DDM	Phase	Degree	150 Hz	90 Hz
m (90 Hz + 150 Hz)	%	- - -	-	90 Hz + 150 Hz	90 Hz
m (ID)	%	Freq. (ID)	Hz	ID	Zero

TACAN

Central display		Right-hand display		Analog output	
Measured value	Unit	Measured value	Unit	Channel A (DSP1)	Channel B (DSP2)
m (15 Hz)	%	Freq. (15 Hz)	Hz	135 Hz	15 Hz
m (135 Hz)	%	Freq. (135 Hz)	Hz	135 Hz	15 Hz
m (15 Hz + 135 Hz)	%	- - -	-	15 Hz + 135Hz	15 Hz
m (15 oder 135 Hz) (as above)	%	Phase	Degree	135 Hz	15 Hz

3.3.2.6 Ratio Measurement
(only FMAS with FMA-B8, AF Analyzer/DSP Unit)

Application: FM radio coverage measurements

With ratio measurement m/Dev selected, the ratio of AM modulation depth and frequency deviation is indicated in the modulation display (unit: % / kHz)

Display	AM / FM
	0.000 %kHz

In the ratio measurement, the AM modulation depth is measured at the same time interval as the analog FM deviation measurement. The calculated ratio is then displayed.
The time interval is identical with the selected demodulation measurement time 30 ms, 100 ms or 1 s (see 3.3.2.1).

Important!
Modulation depth measurements (AM) are always based on peak value measurements with a bandwidth of 1/10/30 Hz (with a measuring time of 1 s/100 ms/30 ms) up to 150 kHz. Selection of the AF filters and detector influences only the deviation measurement (FM). We therefore recommend the ±pk/2 detector and only the AF filters HP--/10/20 Hz, LP100kHz (LP120 kHz with Filter option) be switched on in order to ensure that AM and FM are weighted identically.

3.3.2.7 Amplitude and Phase Noise Measurement
(Only with optional AF Analyzer/DSP Unit FMA-B8)
(Required firmware version: 2.20 or higher)

The wide measurement range of the demodulators (low spurious modulation) and the low-noise local oscillator of the FMA (FMB, FMAB, FMAS) in conjunction with the FMA-B8 option (AF analyzer/DSP unit) allow easy measurement of the amplitude and phase noise of RF signals over the whole frequency range of the instrument.

A special advantage is that the FMA need not be synchronized with the signal to be measured. Automatic frequency tuning is usually sufficient. For measurements on strongly drifting, free-running oscillators it may advantageous to select manual frequency tuning to avoid continuous retuning and hence interruption of the measurement.

Measurements are based on the FFT analysis of the AM demodulator output signal (for amplitude noise measurement) and of the FM demodulator output signal for phase noise measurement.
Note:
The output signal of the FM demodulator is used for the phase noise measurement since the FM demodulator of the FMA features a better dynamic range than the PM demodulator, the 1/f characteristic of the FM demodulator being taken into account for the readout.

Another advantage of using the AM and FM demodulators for the measurement is that the amplitude and the phase noise can be measured separately. This is achieved by AM suppression of the FM demodulator and PM suppression of the AM demodulator. The FM demodulator is however only able to suppress true AM (noise) modulation of the RF carrier. The prerequisite for this is a sufficiently high RF signal/noise ratio. For full utilization of the dynamic range of the FMA, the RF input level therefore should not fall below -17 dBm. In the case of an insufficient RF signal/noise ratio, the noise referred to the carrier may be considered as a combination of equal AM and PM components so that the dynamic range of both the amplitude and phase noise measurement will be affected.

3.3.2.7.1 Fundamentals

Definition of the phase noise and AM noise of an RF carrier:

Phase noise:

Definition of phase noise $L(f_{mod})|_{1\,Hz}$:

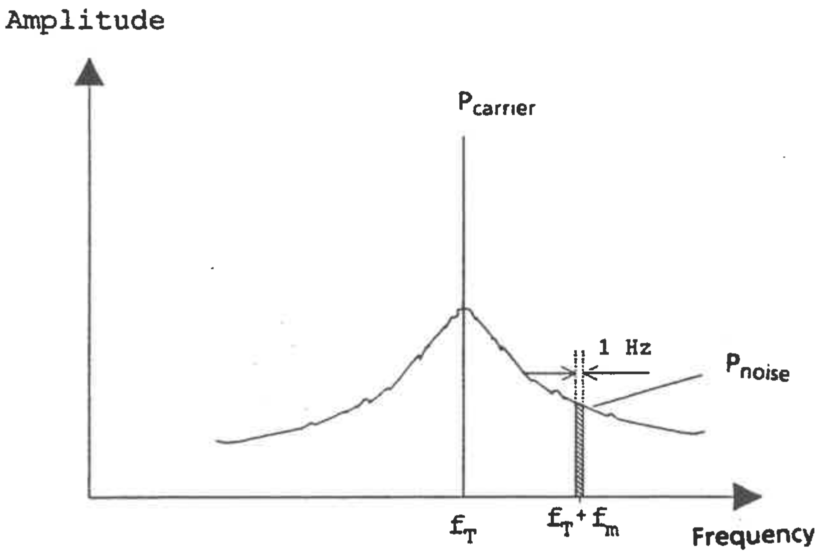


Fig. 3-5.6 **Phase noise:** $L(f_{mod})|_{1\,Hz} = P_{noise}/P_{carrier}$

Correlation between RF spectrum and phase modulation (modulation index η):

With sinusoidal phase modulation of a carrier signal of the frequency f_c and a modulation index η at the modulation frequency f_{mod}, the following RF spectrum is obtained at sufficiently low modulation index η:

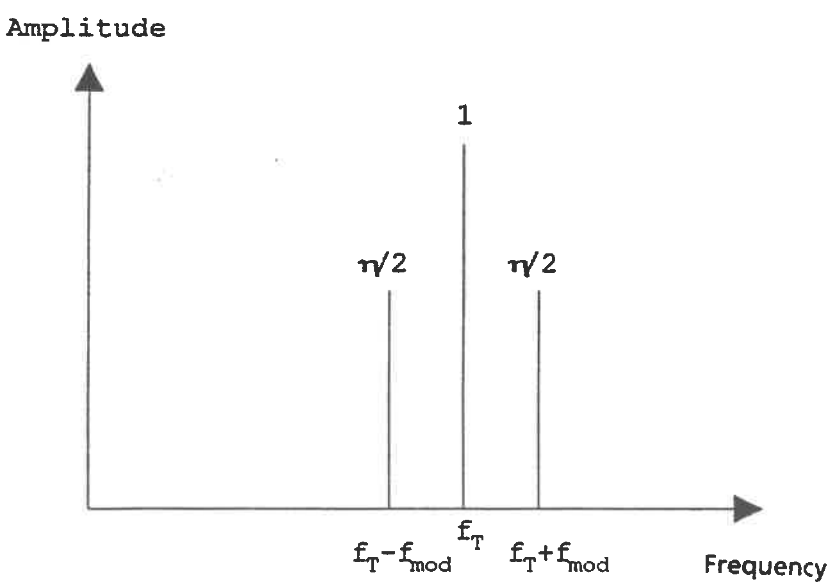


Fig. 3-5.7 PM spectrum at modulation index η

An RF carrier of the modulation index η, which is phase modulated with the (sinusoidal) modulation frequency fmod, has lines spaced at $\pm f_{mod}$ and a level of $\eta/2$ (with a normalized RF carrier of level 1 and a sufficiently low modulation index η approximation: $\eta \leq 0.1$).
The part of the carrier spectrum that has been produced by phase modulation can be determined by a selective measurement of the phase-modulation deviation.

Example:
$\eta = 0{,}01$ (0,01 rad)
$f_{mod} = 1$ kHz
→ The modulation spectrum lines have a level of $\eta/2$ = 0,05 (-46 dB)

AM noise:

Analog zum Phasenrauschabstand $L(f_{mod})|_{1\,Hz}$ kann der Amplitudenrauschabstand $A(f_{mod})|_{1\,Hz}$ definiert werden (AM-Modulation eines Trägers mit Rauschsignal):

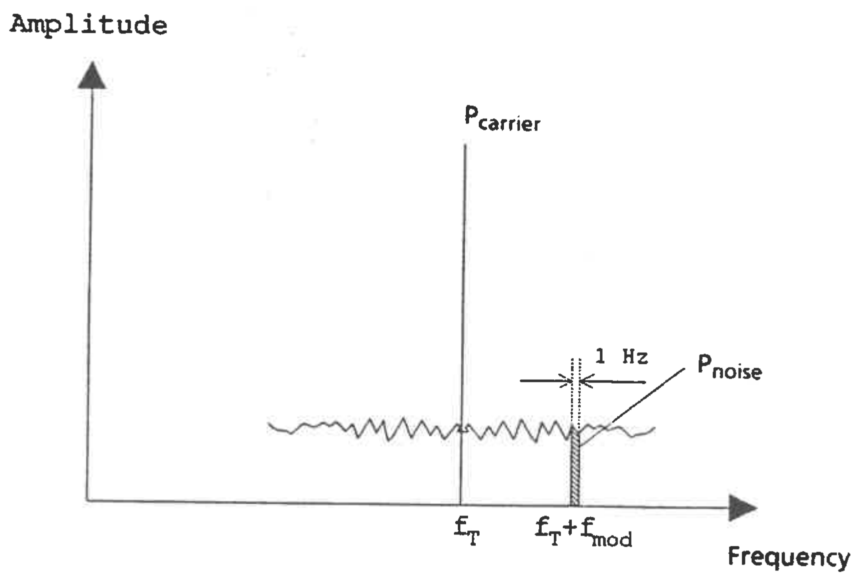


Fig. 3-5.8 AM noise $A(f_{mod})|_{1\,Hz} = P_{noise}/P_{carrier}$

Correlation between RF spectrum and amplitude modulation (modulation depth m):

When a carrier signal is sinewave-modulated with a modulation depth m at the modulation frequency fmod, the following RF spectrum is obtained:

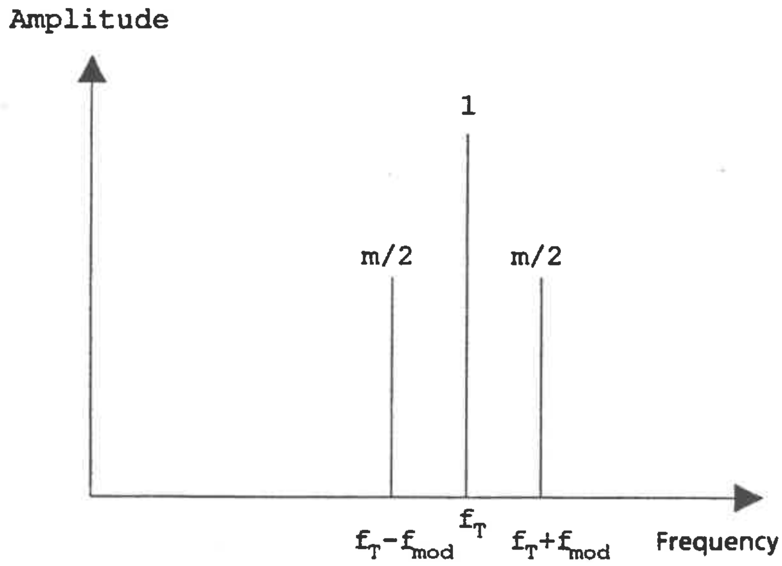


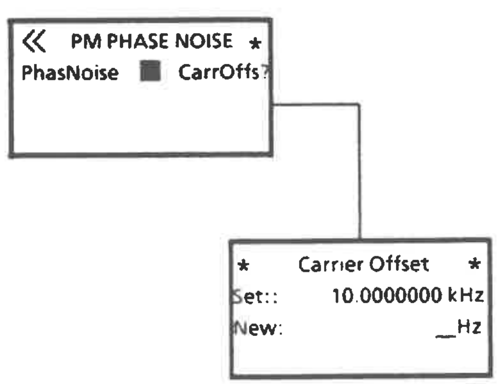
Fig. 3-5.9 AM spectrum for modulation depth m

An RF carrier of modulation depth m, which is amplitude-modulated with the (sinusoidal) modulation frequency f_{mod}, has modulation lines spaced at $\pm f_{mod}$ and a level of m/2 (with normalized RF carrier of level 1).
The part of the carrier spectrum that has been produced by amplitude modulation can be determined by a selective measurement of the amplitude-modulation depth.

Example:
m = 0,01 (1% AM)
f_{mod} = 1 kHz
→ The modulation spectrum lines have a level of m/2 = 0.05 (-46 dB)

3.3.2.7.2 Measurement using AF Analyzer/DSP Unit FMA-B8, Operation

The phase noise measurement function is activated by pressing the *PHASE NOISE* softkey displayed under *DEMOD, PM,* → (right-hand side menu), and deactivated by pressing the softkey again.

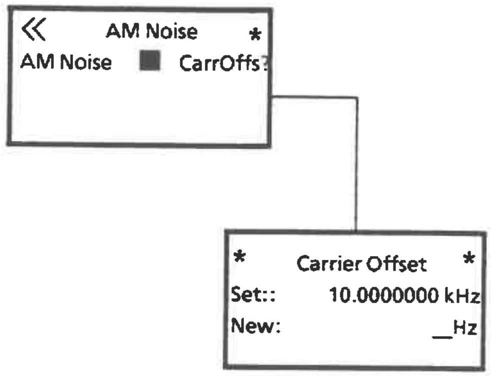


Right-hand side menu: phase noise measurement activated

The entry field for the carrier offset is called up with *Carr Offs*
The permissible carrier offset range is 10 Hz to 150 kHz.

The phase noise is indicated in dBc/Hz in the modulation display. The carrier offset is displayed in addition.

The AM noise measurement function is activated by pressing the AM-NOISE softkey displayed under *DEMOD, AM,→* (right-hand side menu) and deactivated by pressing the softkey again.



Right-hand side menu: AM noise measurement activated

The entry field for the carrier offset is called up with *Carr Offs*
The permissible carrier offset range is 10 Hz to 150 kHz.

The AM noise is indicated in dBc/Hz in the modulation display. The carrier offset is displayed in addition.

FFT parameters and therefore the possible resolution and noise bandwidth are determined as a function of the test frequency (carrier offset). The RF carrier is normalized to a bandwidth of 1 Hz by means of the noise bandwidth. Since the measured noise-signal values strongly vary, the following averaging algorithm (rms averaging) is used with amplitude- and phase-noise measurements.

$AF[n] = SQR[1/n*(f[1]^2 + f[2]^2 + ...f[n]^2)]$

with:

AF[n] = average of n spectra

n = number of spectra (versus time)

f[1], f[2],...f[n] = Einzelspektren

The number of spectra n used for averaging also depends on the carrier offset according to the following table:

Table 3-1.2

Carrier offset	Resolution/ 80 dB	-3 dB bandwidth	Noise bandwidth B_R	Scaling in Hz/DIV	Measurement time for FFT	Number of averaging procedures	Spacing of points in Hz
10 to < 50 Hz	7,3 Hz	2,27 Hz	2,194 Hz	49	2,2 s	5	0,53
≥ 50 to 500 Hz	21,9 Hz	6,8 Hz	6,582 Hz	148	0,72 s	10	1,59
≥ 500 to ≤ 5000 Hz	73,1 Hz	22,7 Hz	21,94 Hz	492	0,22 s	20	5,3
≥ 5000 Hz to ≤ 25 kHz	658 Hz	204 Hz	197,46 Hz	4600	0,15 s	20	47,7
≥ 25 kHz to 150 kHz	2632 Hz	816 Hz	789,83 Hz	18400	0,14 s	20	190,7

FFT frequency resolution, -3-dB bandwidth, noise bandwidth, scaling (with oscilloscope connected to rear outputs DSP1, DSP2 for spectrum display), measurement time, number of averaging procedures and point spacing are dependent on the carrier offset.

AM and phase noise measurement limits of FMA (FMB, FMAB, FMAS):

The measurement limits of the FMA modulation analyzers are determined as shown below:

AM noise measurement:

Determining factors are the S/N ratio of FMA (FMB, FMAB, FMAS) and the inherent spurious modulation of the AM demodulator.

With sufficiently high input level of FMA (FMB, FMAB, FMAS) of typ. >-17 dBm, a value of
$A(f_{mod}) = < -130\ dBc|_{1\ Hz}$ is obtained
irrespective of the carrier-frequency offset fmod or of the carrier frequency.

Phase noise measurement:

Determining factors are the carrier-frequency-dependent phase noise of the local oscillator and the inherent spurious modulation of the FM demodulator, which depends on the carrier frequency and the carrier offset. With an input level of >-17 dBm, the RF S/N ratio of the FMA can be neglected.

The carrier-frequency-dependent phase-noise of the FMA and the carrier-frequency offset fmod are specified in the table below in dBc/Hz (level >-17 dBm):

f_{RF} = 100 MHz:

f_{mod}	10 Hz	100 Hz	1 kHz	5 kHz	10 kHz	20 kHz	100 kHz	150 kHz
$L(f_{mod})$ [dBc/Hz]	–	<-75	<-100	<-120	<-130	<-130	<-130	<-130

f_{RF} = 1 GHz:

f_{mod}	10 Hz	100 Hz	1 kHz	5 kHz	10 kHz	20 kHz	100 kHz	150 kHz
L (f_{mod}) [dBc/Hz]	–	-75	-100	-120	-123	-125	-125	-125

With higher carrier frequencies (>1.36 GHz for FMB or FMA with frequency-range extension option FMA-B12) the obtainable measurement limits are reduced typically by the value 20*lg(f_{RF}/f [1 GHz]).

Example:
L(10 kHz) [dBc/Hz] at f_{RF} = 4 GHz: -123 dBc/1 Hz + 12 dBc/1 Hz = -111 dBc/1 Hz

3.3.3 Audio Frequency Menu

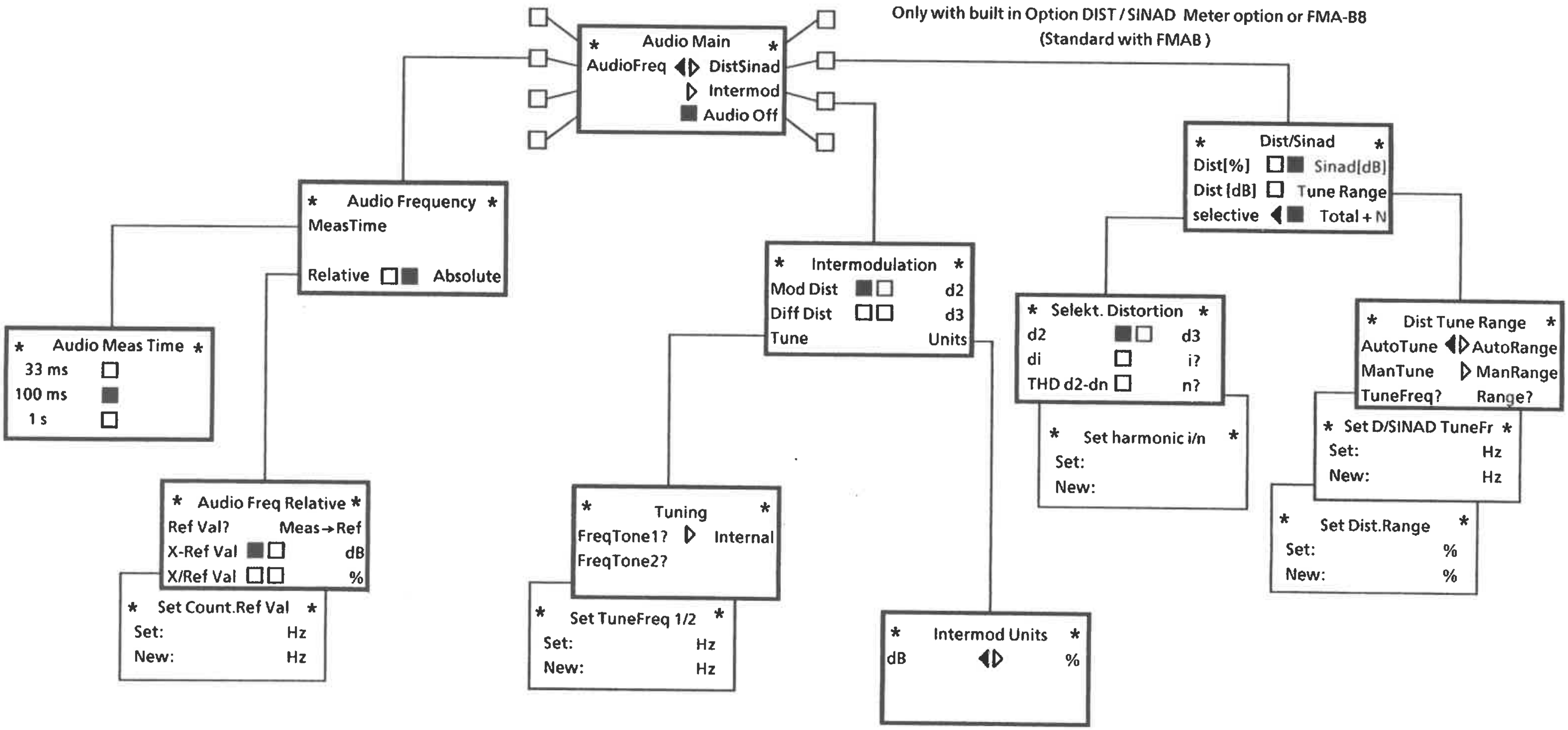


Fig. 3-6 Audio frequency menu tree structure

3.3.3.1 Brief Explanations for the Audio Frequency Menu

The menu of function key AUDIO sets the operating modes for the AUDIO display section of the right-hand display field. It permits AF measurements as well as DIST / SINAD measurements if the option DIST / SINAD Meter is installed in the analyzer.

To enhance the measurement rate with mere modulation or voltage measurements, the AUDIO display can be switched off using softkey AUDIO OFF in the Audio Main menu.

Audio Freq — Selection of the Audio Frequency menu and indication of the audio frequency in the AUDIO display; instrument default status.

- MeasTime — Selection of the menu for setting the AF measuring time.
  - 33ms — Selection of the possible measuring times for the audio frequency counter.
  - 100ms — Instrument default status: 100 ms
  - 1 s
- Relative — Selection of the AudioFreqRelativ menu.
  - Ref Val? — Key to activate entry of a reference value using keypad and Enter keys.
  - Meas→Ref — Currently measured modulation value is defined as reference calue.
  - X-Ref Val — Display of difference of measured value to reference value; instrument default status.
  - X/Ref Val — Display of quotient of measured value/reference value.
  - % — Display of measured value in percent of deviation.
- Absolute — Absolute display of audio frequency; instrument default status.

Audio Off — Switching off audio frequency counting.

DIST/SINAD — Access to the measuring capabilities for harmonic distortions (only with option FMA-B2 'DIST/SINAD Meter' or FMA-B8 'AF Analyzer/DSP Unit')

- Dist[%] — Measurement of distortion of AF signal; readout in %.
- Dist[dB] — Measurement of distortion of AF signal; readout in dB.
- Sinad[dB] — Measurement of SINAD (= Signal to Noise and Distortion) value; readout in dB (only with FMA-B2 option, Dist/SINAD meter). Automatic switchover to THD + N measurement.
- Total + N — Switching on the broadband distortion/SINAD measurement mode (only with FMA-B2 option, Dist/SINAD Meter). A broadband analog measurement is performed. Total harmonic distortion including noise and other spuriae are measured.
- selective — Switching on the selective distortion measurement (only with FMA-B8 option AF Analyzer/DSP Unit). In contrast to the broadband distortion/SINAD measurement (with Dist/SINAD meter), this measurement is selective by way of digital signal processing. Both individual distortion factors and total harmonic distortion (THD) can be measured. With SINAD measurement switched on, selective mode is not possible.
  - d2 — Selective measurement of K2 (distortion factor by 2nd harmonic) with the unit selected in the Dist/SINAD main menu.

d3	Selective measurement of K3 (distortion factor by 3rd harmonic)
di	Selective measurement of Ki (distortion factor by i - th harmonic)
i?	Free selection of the harmonic of i-th order to be measured
THD d2-dn	Selective measurement of the total harmonic distortion (THD). The harmonics from i = 2 to n are evaluated.
n ?	Free selection of the top harmonic of nth order, which is still taken into account with measurement of the total harmonic distortion THD K2-Kn.

TuneRange

Auto Tune	Automatic frequency tuning of the DIST/SINAD meter (instrument default status)
Man Tune	If Auto-Tune mode was active before: holding the currently measured tuning frequency of the DIST / SINAD meter. Otherwise, no modification, if no valid test frequency is available.
TuneFreq?	Key to activate entry of tuning frequency value using keypad and Enter keys. Legal input range: 10 Hz to 100 kHz (For FMAV: 10 Hz to 45 kHz)
Auto Range	Automatic adjustment of the distortion amplifier; instrument default status.
Man Range	Holding the instantaneous distortion measuring range.
Range?	Key to activate entry of the distortion or SINAD measuring range.

Intermod — Access to intermodulation measurement capabilities: intermodulation factor and differential-tone factor (only if AF analyzer/DSP Unit option is fitted or FMAV)

ModDist — Measurement of the modulation distortion according to DIN 45403 (modulation distortion acc. to IEC268-2)

DiffDist — Measurement of the difference frequency distortion acc. to DIN45403. (Difference Frequency Distortion acc. to IEC 268-2).

Tune — Access to tuning menu for intermodulation measurement

FreqTone1?	Key to activate entry of a frequency for tone 1 (f1)
FreqTone2?	Key to activate entry of a frequency for tone 2 (f2) (for frequency range see data sheet)
Internal	Free selection of internal automatic frequency tuning using the internal AF generator of the instrument (only if AM/FM calibrator/AF generator FMA-B4 is fitted) or manual tuning on an external 2-tone signal; toggle function.

d2 — Measurement of the modulation distortion or difference frequency distortion of 2nd order

d3 — Measurement of the modulation distortion or difference frequency distortion of 3rd order

Units — Access to selection of units for display of the modulation distortion or difference frequency distortion

dB	Indication in dB
%	Indication in %

3.3.3.2 Audio Frequency Measurements

AF measurements are performed by way of a combined frequency/period measurement, which ensures high frequency resolution with short measuring times.

The AF signal from the selected demodulator, or the AF signal fed into the voltmeter input in voltmeter operation of the instrument is applied to the AF counter.

The AF filters (see Section 3.3.5) are in any case connected into the signal path and can be used to suppress unwanted signals.

Too small or noisy signals may lead to a faulty AF result.

AF measuring time

In default status, the AF measuring time is 100 ms and thus suitable for measuring AF frequencies down to 10 Hz.

Setting the measuring time to 1 s allows to measure AF frequencies down to 1 Hz and also ensures higher averaging with noisy AF signals compared to the default measuring time.

To accelerate the measurement, the AF measuring time may also be reduced to 33 ms, which permits AF measurements down to 30 Hz.

Absolute or relative measurement

The measured AF results are normally displayed as absolute values. The AudioFreqRelativ submenu is available for relative display of the results.
The following universal softkey functions are available:

X-Ref. Val: Difference of measured value to reference value in Hz or kHz.

X/Ref. Val: Quotient of measured value/ reference value.

%: Deviation of measured value and reference value in percent:

100* (meas. value/ref. value) / ref. value.

The instantaneous absolute value can be defined as reference value by softkey `Meas→Ref`.

Also, the softkey `Ref.Val?` can be used to enter a new value via keypad and Enter key.

The letters RELATIVE light up in the AUDIO display indicating that relative display mode is active.

See the following example for setting a reference value of 1 kHz and subsequently activating relative display of the measured value in Hz/kHz as difference from this reference value. The example starts from the Audio Frequency menu:

`Relativ`	Softkey
`Ref.Val?`	Softkey
1	Keypad
*k	Unit keys
`X-Ref.Val`	Softkey

3.3.3.3 AF Analysis: Distortion, SINAD and Intermodulation Measurements (optional)

The option FMA-B2 DIST /SINAD Meter and the option FMA-B8 AF Analyzer/DSP Unit are provided for distortion and SINAD measurement. (Both options may be fitted individually or in parallel). The versatile measuring capabilties are described, subsequently. The corresponding measured values are always displayed in the audio menu.

The option FMA-B2 (Dist/SINAD meter) generally performs broadband measurements. The theory of operation is to filter out the fundamental (Notch filter). The remainder of the AF signal without the fundamental is related to the total signal (THD + N) and displayed in the audio display according to the selected function:

Dist[%], Dist[dB] or SINAD[dB] is read out in the audio display ("total" selected in the Dist/Sinad menu):

Dist [%] = (THD + N/total signal) * 100[%]
Dist[dB] = 20 * log (THD + N/total signal)
SINAD[dB] = 20 * log (total signal/THD + N)

The measuring bandwidth can be limited using an AF filter. However, noise and interference signals such as humming or spurious signals will influence the display, if they occur within the AF bandwidth (highpass and lowpass filters).
This is normally wanted and also required for the SINAD measurement. It is, however, a disadvantage, that a correct THD (Total Harmonic Distortion) measurement will become incorrect with insufficient signal/noise ratio. Besides, selective measurement of individual distortion factors (e.g., K2, K3) is not possible.
The Dist/SINAD Meter option covers the fundamental range from 10 Hz to 100 kHz, harmonics are evaluated up to max. 300 kHz.The measuring bandwidth can be limited using an AF filter. However, noise and interference signals such as humming or spurious signals will influence the display, if they occur within the AF bandwidth (highpass and lowpass filters).
This is normally wanted and also required for the SINAD measurement. It is, however, a disadvantage, that a correct THD (Total Harmonic Distortion) measurement will become incorrect with insufficient signal/noise ratio. Besides, selective measurement of individual distortion factors (e.g., K2, K3) is not possible.
The Dist/SINAD Meter option covers the fundamental range from 10 Hz to 100 kHz, harmonics are evaluated up to max. 300 kHz.

The option AF Analyzer/DSP Unit (FMA-B8), which is based on digital signal processing (A/D conversion of the AF signal and evaluation using a FFT = Fast Fourier Transformation) allows for selective measurement.

Distortion measurement; ("selective")

Both, measurement of individual distortion factors (K2, K3, Ki) and also correct THD measurement with minimum influence by the signal/noise ratio and by non-harmonic spuriae are enabled. The order n of the harmonics which are just still evaluated, is freely selectable. The THD display results from the following arithmetic evaluation:

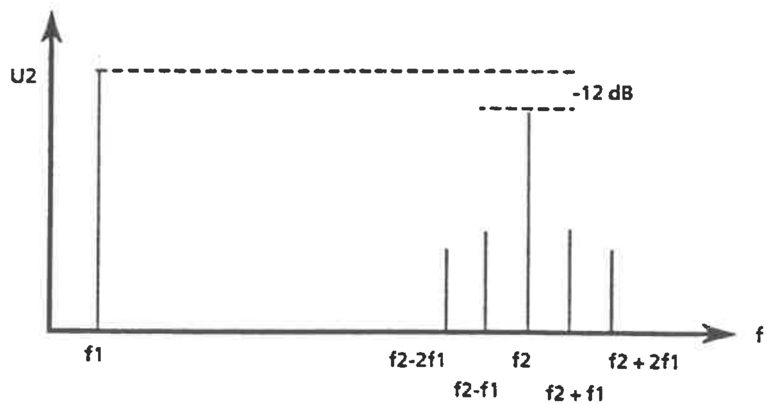
$$THD[\%] = \frac{\sqrt{\left(\sum_{i=2}^{n} U_i^2\right)}}{\sqrt{\left(\sum_{i=1}^{n} U_i^2\right)}} * 100\% \text{ bzw. } THD[dB] = 20 * \lg\left(\frac{\sqrt{\left(\sum_{i=2}^{n} U_i^2\right)}}{\sqrt{\left(\left(\sum_{i=1}^{n} U_i^2\right)\right)}} \right)$$

If the frequency of the fundamental is <= 14 kHz and, simultaneously, the frequency of the max. permitted harmonic n is <= 42 kHz with THD measurement (or the frequency of the selected Ki is <= 42 kHz with individual distortion measurement), the A/D converter operates in 16-bit mode and thus enables maximum dynamic range. If this condition is not met, the A/D converter operates in the 12-bit mode and the measuring range is limited accordingly. The measuring bandwidth is then 150 kHz, which means in practical operation: a THD measurement with a fundamental up to 50 kHz is performed with correct evaluation up to K3. SINAD measurement using the option AF Analyzer/DSP Unit is not possible.

Intermodulation measurement:

Apart from the selective distortion measurement, the option AF Analyzer/DSP Unit also enables selective measurement of intermodulation products of 2nd and 3rd order. Measurement of intermodulation products can be performed to obtain the modulation distortion acc. to DIN 45403 (corresponding to the "Modulation Distortion" acc. to IEC 268-2) or to obtain the difference frequency distortion acc. to DIN 45403 (corresponding to the "Difference Frequency Distortion" acc. to IEC 268-2).

Definition of the modulation distortion:



f1 and f2 represent the frequencies or two sine-wave signals.
f2 should be at least 8 * f1. The level of f2 should be 1/4th of the level of f1.
The modulation factors of 2nd and 3rd order (dm2, dm 3) are defined as follows:

$$d_{m}2 = \frac{U_2(f_2 + f_1) + U_2(f_2 - f_1)}{U_2(f_2)} * 100\%$$ for percentage indication or

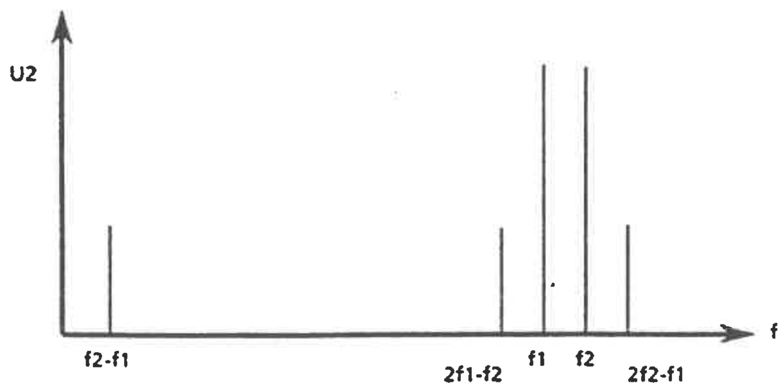
$$d_{m}2 = 20 * \lg\left(\frac{U_2(f_2 + f_1) + U_2(f_2 - f_1)}{U_2(f_2)} \right)$$ for indication in dB

$$dm3 = \frac{U_2(f_2 + 2f_1) + U_2(f_2 - 2f_1)}{U_2(f_2)} * 100\%$$ for percentage indication or

$$dm3 = 20 * \lg\left(\frac{U_2(f_2 + 2f_1) + U_2(f_2 - 2f_1)}{U_2(f_2)} \right)$$ for indication in dB

Definition des Differenztonfaktors:

Definition of the difference frequency distortion:
f1 and f2 represent the frequencies of two sine-wave signals with the same level.
The frequencies should preferably differ by 80 Hz. The difference-frequency distortion factors of 2nd and 3rd order (dd_2, dd_3) are defined as follows:



$$d_{d2} = \frac{U_2(f_2 - f_1)}{2 * U_2(f_2)} * 100\%$$ for percentage indication or

$$d_{d2} = 20 * \lg\left(\frac{U_2(f_2 - f_1)}{2 * U_2(f_2)}\right)$$ for indication in dB

$$d_{d3} = \frac{U_2(2 * f_2 - f1) + U_2(2 * f_1 - f_2)}{2 * U_2(f_2)}$$ for percentage indication or

$$d_{d3} = 20 * \lg\left(\frac{U_2(2 * f_2 - f1) + U_2(2 * f_1 - f_2)}{2 * U_2(f_2)}\right)$$ for indication in dB

Frequency tuning with distortion, SINAD and intermodulation measurement:

Dist/SINAD measurement:

Frequency tuning with distortion or SINAD measurement is performed automatically in the instrument default status in "total" and "selective" mode, caused by the result of the AF counter. (letters AUTO TUNE light up in the audio display)
In specific cases, e.g., SINAD measurement on transceivers, where only 12-dB SINAD values are measured according to the standard, manual entry of the tuning frequency may be required, since the AF counter can no longer supply stable measured values.
When softkey ManTune is pressed, the Dist/SINAD Meter is tuned to the instantaneous value of the AF frequency counter. A tuning frequency can be definitely set via the submenu called by the softkey TuneFreq? with subsequent entry of a value using the numeric keypad and one of the Enter keys.

The letters MAN TUNE light up in the audio display, indicating that the instrument is set to manual tuning.
See the following example for manual tuning to a frequency of 1 kHz, starting from the DIST/SINAD menu:

Tune	Softkey
Tune Freq?	Softkey
1	Keypad
*k	Enter keys

Frequency tuning with intermodulation measurement:

If the option AM/FM Calibrator/AF Generator is fitted, internal tuning also allows for automatic internal frequency tuning to a dual-tone signal provided that a corresponding dual-tone signal is set on the internal AF generator (which is applied to the AF measuring path of the instrument!).

The Internal Tuning mode cannot be used with measurement of a dual-tone signal which is generated by an external source, which is why manual entry of the two measuring frequencies f1, f2 is then required.

3.3.4 Special Function Menu

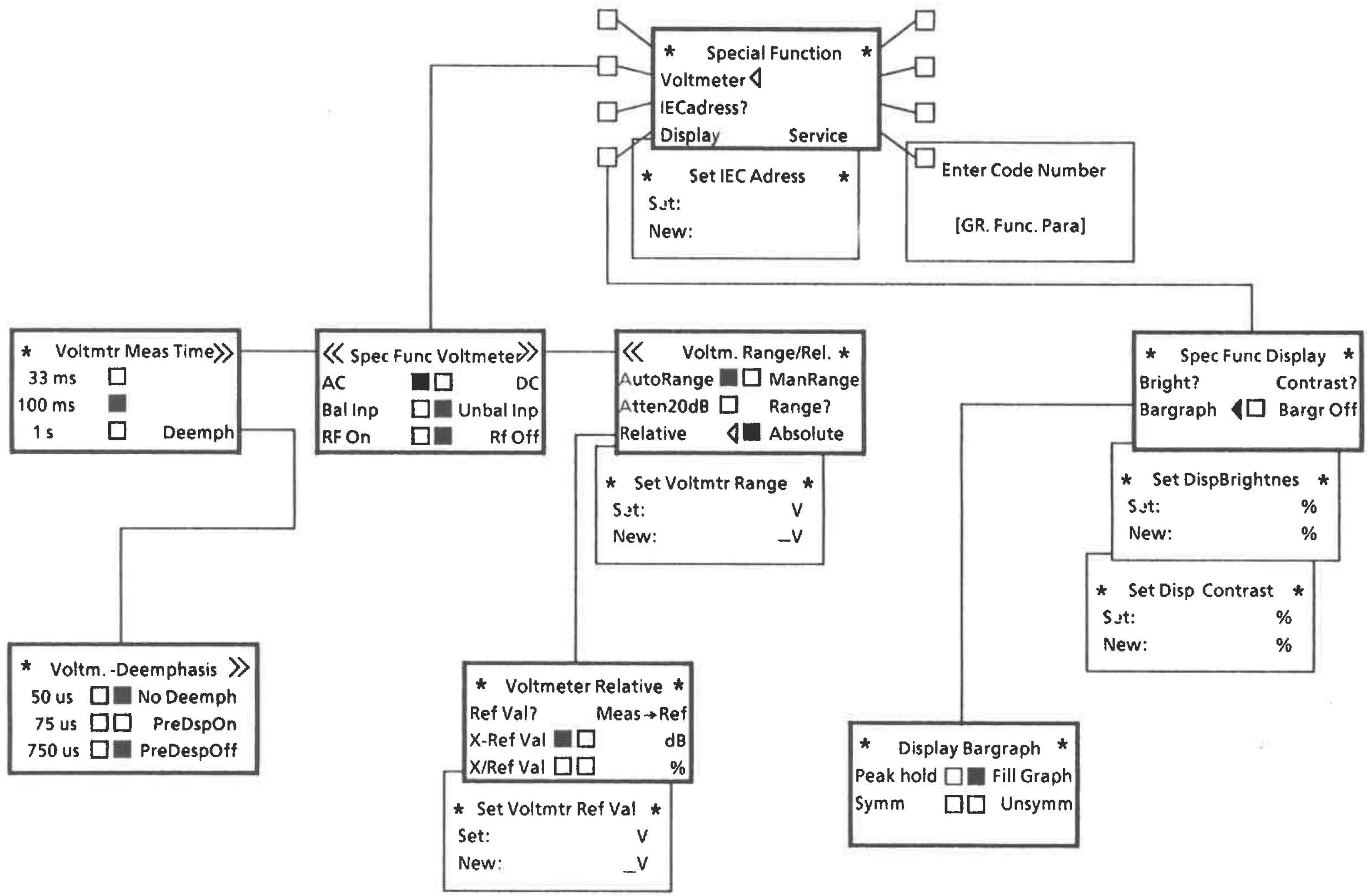


Fig. 3-7 Special menu tree structure

3.3.4.1 Brief Explanations for the Special Function Menu

The main function key SPEC FUNC gives access to this menu, which enables voltmeter operation of the FMA and sets the displays and the IEC bus address for remote-control operation.

Voltmeter	Selection of the Spf Voltmeter menu and switching to voltmeter operation; operation as modulation analyzer is automatically disabled.	
AC	ac voltage measurement; default status.	
DC	dc voltage measurement.	
Bal Inp	Balanced input used.	
Unbal Inp	Unbalanced input used; default status.	
RF On	RF function still on.	
RF Off	RF function off; default status.	
≪ Voltmtr Meas Time	Left-hand voltmeter menu to set the measuring time of the voltmeter.	
	33 ms	Selection of the Voltm. Meas.Time.
	100 ms	Default status 100 ms.
	1 s	
	Deemph	Calling the voltmeter deemphasis menu
	50 µs -	
	75 µs -	Deemphasis with respective time constants.
	750 µs -	
NoDeemph	Deemphasis switched off; default status	
PreDspOn	Deemphasis effective for voltmeter display; An activated deemphasis is always effective for the AF output (Pre Display on).	
PreDspOff	Deemphasis for voltmeter display is not effective (Pre Display off).	

≫ Voltmtr Range/Rel Right-hand voltmeter menu containing Range and Absolut/Relativ functions.

- **Auto Range** — Automatic selection of the voltage measuring range (def.).
- **Man Range** — If Auto Range mode was active before: holding the instantaneous voltage range, otherwise no modification. Also no modification if no valid measurement value is available.
- **Atten20dB** — Switch on the 20 dB input devider with Man Range Mode.
- **Range?** — Key to activate entry of specific voltage measuring range using keypad and Enter keys.
- **Absolute** — Display of measured voltage results as absolute values (def.).
- **Relative** — Selection of the Voltm. Relativ menu.
  - **Ref Val?** — Key to activate entry of a reference value using keypad and Enter keys.
  - **Meas→Ref** — The absolute currently measured voltage is defined as reference value.
  - **X-Ref Val** — Display of difference of measured value to reference value; default status.
  - **X/Ref Val** — Display as quotient.
  - **dB** — Display as deviation in dB.
  - **%** — Display as deviation in percent.

IEC adress? Key to activate setting of the IEC bus address.

Display Selection of the menu for setting the displays.

- **Bright?** — Key to activate setting of brightness of the displays (0 to 100%) using keypad and Enter keys.
- **Contrast?** — Key to activate setting of contrast of the displays (0 to 100%) using keypad and Enter keys.
- **Bargraph** — Selection of the Display Bargraph menu.
  - **Peak hold** — Display of the instantaneous maximal and minimal measurement value in addition to the normal analog display (toggle function).
  - **Fill Graph** — Bargraph display is filled up from the left with bars, or only single bars are displayed (toggle function).
  - **Symm** — Symmetrical bargraph display, suitable for relative display of results or Voltmeter DC settings.*)
  - **Unsymm** — Asymmetrical bargraph display.*)

    *) automatic switching to currently convenient mode if neither symm nor unsymm is selected
- **Bargraph Off** — Switching off bargraph display.

3.3.4.2 Voltmeter

The FMA analyzer is equipped with a high-quality precision ac and dc voltmeter. A high-impedance unbalanced as well as a balanced voltmeter input (input impedance 600 Ω) of wide dynamic range are available for the voltmeter operation. Also, the FMA completely fulfills the psophometer function, since all the AF weighting highpass and lowpass filters (plus program filters like CCITT P.53 and CCIR 468-4 filter, weighted and unweighted measurement, if the filter option is fitted) and all rectification functions can be used (peak-responding detectors of short response time, true rms-responding detector and quasi-peak-responding detector with built-in filter option).

Because the RF section (function Rf On) including the demodulators and the voltmeter can be simultaneously used, it is also possible to connect external devices, e.g. a stereo decoder.

Voltmeter inputs BAL - UNBAL

As voltmeter inputs, the high-impedance unbalanced input (BNC female connector) and the balanced input (3-contact female connector) are provided. The balanced input has an imput impedance of 600 Ω and shows high-common mode rejection.

Also note for the balanced input that its normally high common-mode rejection is abruptly reduced without input voltage devider at a common-mode drive of more than ± 10 V. Manually switching on the input voltage divider (menu Voltm.Range/Rel; Atten20dB) and switching to manual range helps in this case.
With differential voltages > 4 V the input voltage divider is automatically switched on in Auto Range mode; in Man Range mode with the input $V_p \geq 4V$.

AC voltage measurements

When AC voltage measurement is switched on, the rms detector is automatically activated; subsequently, any other of the detectors can be selected from the menu of function key DETECTOR.

In any case, autoranging of the measuring amplifier is performed dependent on the Pk detectors. (Exception: quasi-peak-responding detector with built-in filter option, cf. Section 3.3.5.3).

It is thus ensured that not even AC voltages with high crest factor may cause overloading of the measuring path.

DC voltage measurements

When DC voltage measurement is selected, the lowpass filter with the lowest cutoff frequency is automatically cut in (LP 3 kHz, or LP 5 Hz with built-in filter option). In default status, no detector is used for the measured-value display. In specific cases, however, any of the lowpass filters as well as any detector can be switched on.

Example:

Peak-value measurement of a square wave signal with superposed dc voltage (with built-in filter option):

Special Function Menu	Hardkey
↓	
Voltmeter	Softkey
↓	
DC	Softkey
↓	
Filter Menu	Hardkey
↓	
>	Softkey
↓	
More	Softkey
↓	
LP⎍ 30 kHz or LP⎍ 120 kHz	Softkey
↓	
Detector Menu	Hardkey
↓	
Peak	Softkey
↓	
± Pk/2	Softkey

The display indicates the arithmetic mean of the positive and negative peak values.

RF ON - RF OFF

In default status, the RF section is deactivated in voltmeter operation of the FMA (i.e. Rf Off).

With the function Rf On, the RF section of the instrument including the demodulators remains activated irrespective of the set voltmeter operation, i.e. the frequency of an applied RF signal is continued to be counted and the AM and FM signal is available at the modulation outputs on the rear.

This double use of the instrument allows to connect external devices, e.g. a stereo decoder into the measuring path.

3.3.4.2.1 Deemphasis

In particular when an external stereo decoder is used, a deemphasis with an appropriate time constant can be switched on also with measurements at the channels L, R, M, S via the voltmeter input.
In the operating mode Pre Disp On (Deemphasis Pre Display) a switched-on deemphasis is effective for the display; respectively with Pre Disp Off it is not effective. An activated deemphasis is always effective for the AF output.

3.3.4.3 Display

3.3.4.3.1 Brightness, Contrast

The brightness of the displays *1* to *4* and of the display in the MENU field can be adjusted between 0% (brightness off) and 100%. 100% brightness is set in the default status.

Also the contrast of the displays can be varied between 0 to 100% and thus be set to optimum view.

In default status, the contrast is adjusted to 30%, which is the optimum contrast for the normal angle of view (i.e. 30° to 45° from above). For steeper angles of view, it is recommended to set a higher percentage. Respectively, a lower percentage is suitable for a direct front view.

3.3.4.3.2 Quasi-analog Display of the Bargraph

In addition to the digital display, a bargraph consisting of 101 bars is available in the MODULATION display as quasi-analog display. The bargraph has a 1-2-5 scale division, its unit corresponding to the digital display.

- Bargraph with absolute display

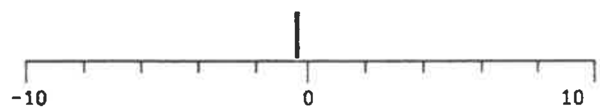
Fill Function:

With the function of softkey `Fill Graph`, the bargraph display is as follows:

- Bargraph with absolute display and Fill Graph function

In relative readout of the MODULATION display, the scaling can be switched between +/-.

- Bargraph with relative display in % and +/-

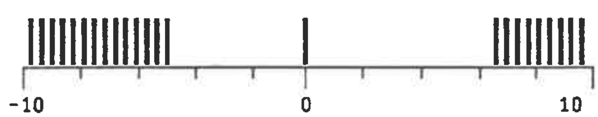


This is particularly suitable for adjustment procedures as functions of a previously entered reference value.

Peak hold function of the bargraph:

When the Peak hold function of the bargraph is selected, the instantaneous maximal and minimal measurement values are displayed in addition to the currently measured value.

- Bargraph with relative display in % and +/-



3.3.5 Filter-Menu

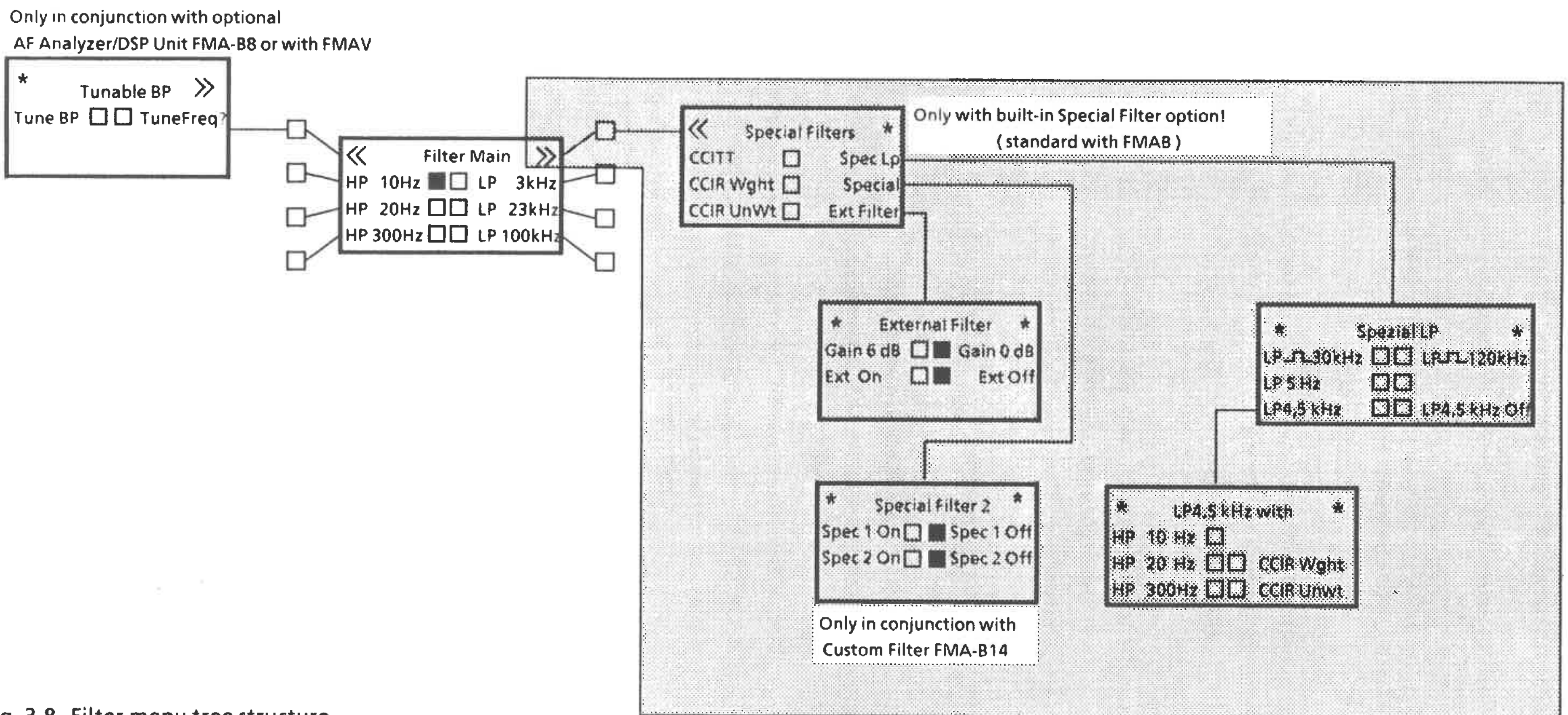


Fig. 3-8 Filter menu tree structure

3.3.5.1 Brief Explanations for the Filter Menu

Cut-in filters influence the measured modulation or voltage value displayed in the MODULATION display, as well as the AF output.

The demodulator outputs AM and FM/PM on the rear are not affected by the filters, but always the maximally possible demodulation bandwidth is available.

HP 10Hz	Highpass filter 10Hz $_{-3dB}$; toggle function (default status).
HP 20Hz	Highpass filter 20Hz $_{-3dB}$; toggle function.
HP 300Hz	Highpass filter 300Hz $_{-3dB}$; toggle function.
LP 3kHz	Lowpass filter 3kHz $_{-3dB}$; toggle function.
LP 23kHz	Lowpass filter 23kHz $_{-3dB}$; toggle function.
LP 200kHz	Lowpass filter 200kHz $_{-3dB}$; toggle function.

≫ Special/Filters	Right-hand filter menu.	
CCITT	Program filter to CCITT Rec. 53.	
CCIR Wght	Program filter to CCIR 468-4 weighted.	
CCIR Unwt	Program filter to CCIR 468-4 unweighted.	
Spec Lp	Selection of the More Filter Menu.	
	LP⎍ 30kHz	Lowpass filter 30kHz $_{-3dB}$ with Bessel characteristics.
	LP⎍ 120kHz	Lowpass filter 120kHz $_{-3dB}$ with Bessel characteristics.
	LP 5Hz	Lowpass filter 5Hz $_{-3dB}$ (automatically cut-in with DC voltmeter function).
	LP 4.5kHz	Lowpass filter 4.5kHz $_{-3dB}$, high skirt selectivity.
	LP 4.5kHz Off	
Special	Calling up menu of special filter 2	
	Special 1 On/Off	Switching custom filter special 1/2 on and off
	Special 2 On/Off	(only with optional Custom Filter FMA-B14)
Ext Filter	Selection of the External Filter menu.	
	Gain 6dB	Additional gain of 6.02 dB is switched in to compensate for the attenuation of an external passive filter (default status).
	Gain 0dB	0-dB gain between filter output and input.
	Ext On	Switching on the filter output and input on the rear.
	Ext Off	Switching off the filter output and input on the rear.

3.3.5.2 Standard Filters

The following highpass and lowpass filters are available as standard filters for limiting the test bandwidth.

3.3.5.2.1 Highpass Filters

The standard highpass filters HP 10 Hz, HP 20 Hz and HP 300 Hz are slightly modified Butterworth filters characterized by essentially flat amplitude response in the passband.

HP 10 Hz and HP 300 Hz are second-order filters (attenuation rate of 12 dB per octave), HP 20 Hz is a third-order filter (attenuation rate of 18 dB per octave). Figures 3-9 to 3-11 show the respective filter curves.

Always the - 3 dB cutoff frequency is indicated.

After three times the - 3 dB cutoff frequency, the amplitude response with regard to the specified measuring accuracy is negligible.

Example:

HP 10 Hz ensures maximum accuracy in line with the specifications in the Data Sheet for frequencies above 30 Hz.

In combination with filter LP 23 kHz, HP 20 Hz complies with the CCIR standard 468-4 "Unweighted Measurement", which corresponds to the DIN 45 405 noise voltage filter.

In default status of the instrument, HP 10 Hz is switched on.

Caution: *In phase demodulation mode, no highpass filters can be switched on except HP 300 Hz, see also Section 3.3.2.3 about phase demodulation and Fig. 3-11.*

3.3.5.2.2 Lowpass Filters

Also the standard lowpass filters LP 3 kHz, LP 23 kHz and LP 200 kHz are slightly modified Butterworth filters so as to ensure essentially flat amplitude response in the passband, cf. the filter curves of Figures 3-12 to 3-14.

These filters are fourth-order filters (i.e. with an attenuation rate of 24 dB per octave). Again, the - 3 dB cutoff frequency is given.

Maximum measuring accuracy in line with the specifications is obtained up to half the cutoff frequency. .

As to LP 23 Hz, refer also to previous Section 3.3.5.2.1 about HP 20 Hz.

In modulation analyzer operation, the demodulation bandwidth is dependent on the carrier frequency. Therefore, the higher-frequency lowpass filters are not suitable for use with low carrier frequencies.

See also Table 3-2:

f_{RF}	-3 dB test bandwidth w/o LP	Suitable LPs	Suitable option filters
50 kHz to 300 kHz	11.5 kHz	LP 3 kHz	CCITT, LP 4.5 kHz
≥ 300 kHz to 10 MHz	85 kHz	LP 3 kHz LP 23 kHz	CCITT, CCIR LP⎍⎍ 30 kHz
≥ 10MHz	AM: 310 kHz FM,PM: 330 kHz	LP 3 kHz, LP 23 kHz, LP 100 kHz	CCITT, CCIR LP⎍⎍ 30 kHz LP⎍⎍ 120 kHz

Table 3-2: Test bandwidths and weighting filters depending on the input frequency

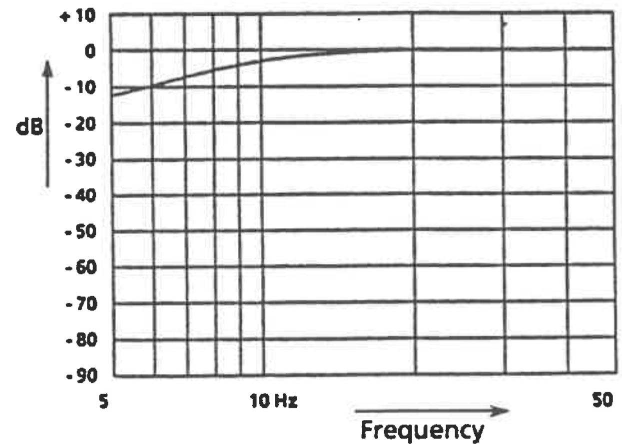


Fig. 3-9 HP 10 Hz

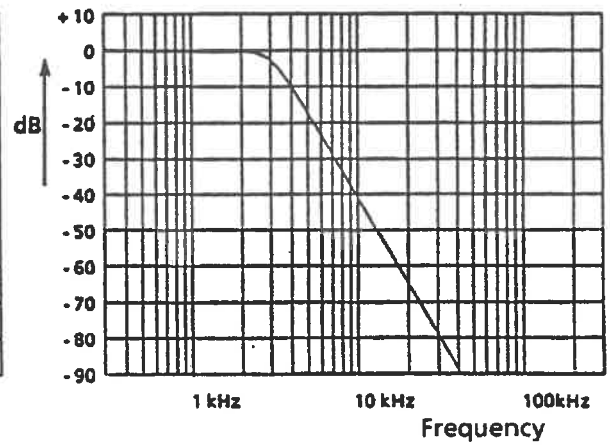


Fig. 3-12 LP 3 kHz

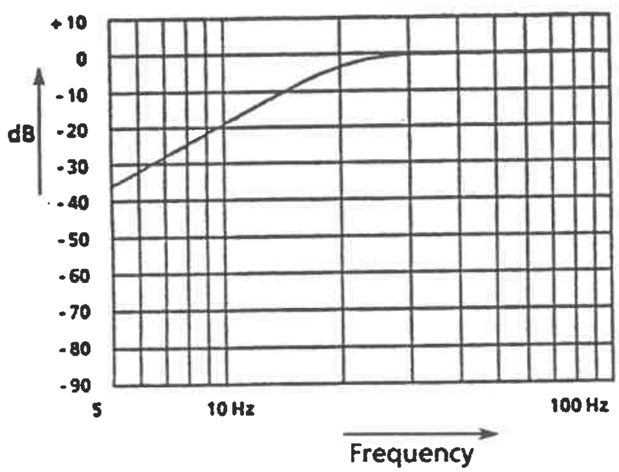


Fig. 3-10 HP 20 Hz

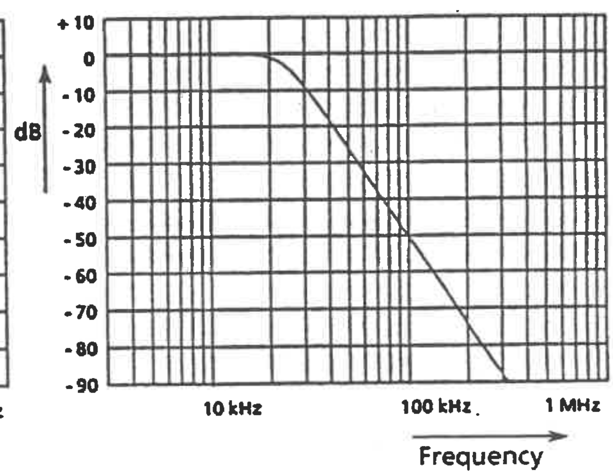


Fig. 3-13 LP 23 kHz

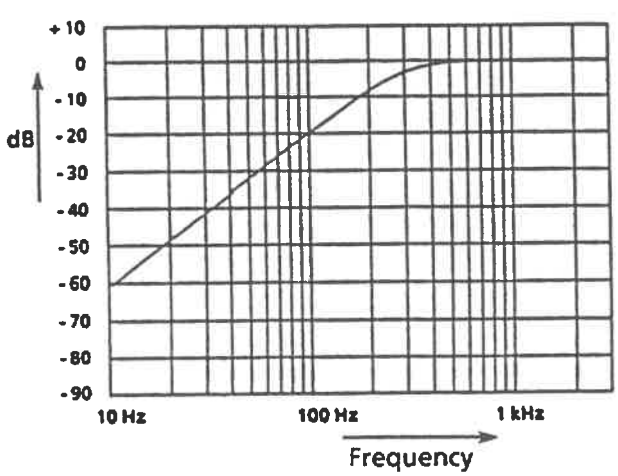


Fig. 3-11 HP 300 Hz

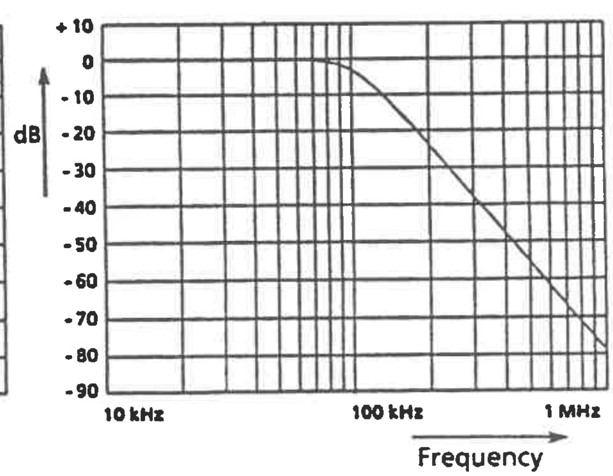


Fig. 3-14 LP 100 kHz

3.3.5.3 Filter Option
(Standard with FMAB)

Additional special filters are available for use with built-in filter option.

3.3.5.3.1 CCITT Program Filter

This filter corresponds to standard CCITT P53 (telephone filter) and is mainly used for noise measurements to the respective standard (Fig. 3-15).

When the CCITT filter is switched on, the rms detector prescribed by the standard is automatically activated while all other highpass or lowpass filters are switched off.

The CCITT program filter is automatically switched off again if a highpass or lowpass filter is selected and the respective standard LP or HP according to the default status is cut in.

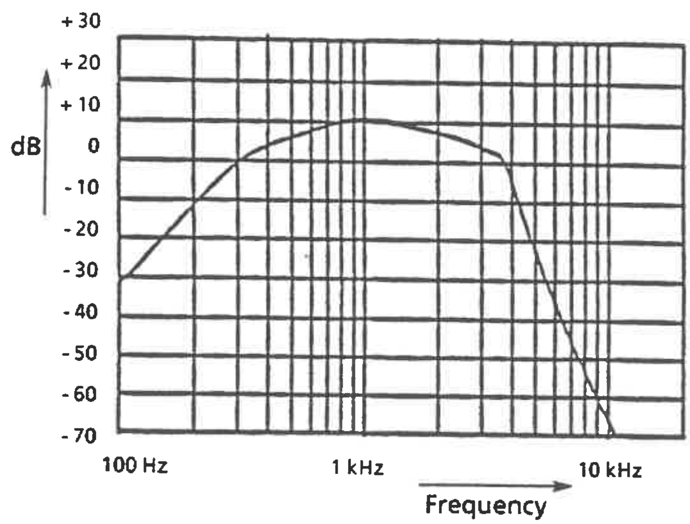


Fig. 3-15 CCITT filter

3.3.5.3.2 CCIR Weighted Program Filter

This filter corresponds to the CCIR 468-4 standard, weighted measurement (DIN 45 405 weighted) (Fig. 3-16).

When this program filter is selected, the quasi-peak responding detector prescribed by the CCIR standard is automatically activated. Subsequently, any other detector may be selected for use (cf. Section 3.3.6).

With the CCIR weighted filter, no other highpass or lowpass filter is selectable.

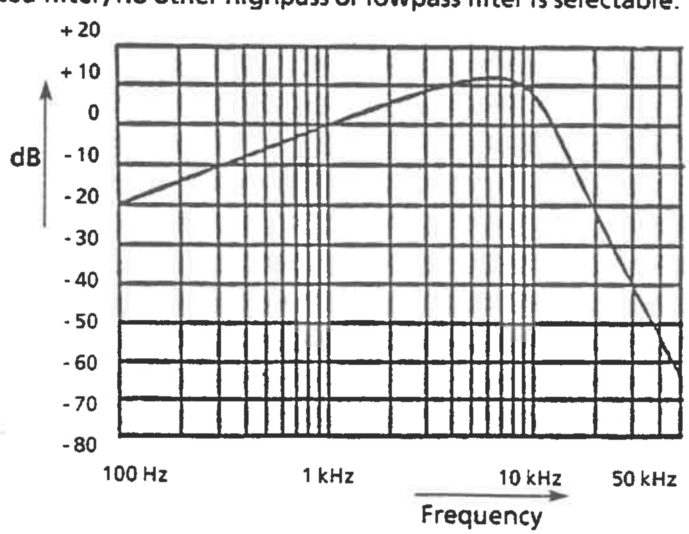


Fig. 3-16 CCIR weighted filter

3.3.5.3.3 CCIR Unweighted Filter

This filter corresponds to the standard CCIR 468-4 "Unweighted" (unweighted measurement to DIN 45 405). Automatically, HP 20 Hz combined with LP 23 kHz is switched on, as well as the CCIR detector prescribed by standard CCIR. Confer Section 3.3.6.

Subsequently, any other detector may be selected for use.

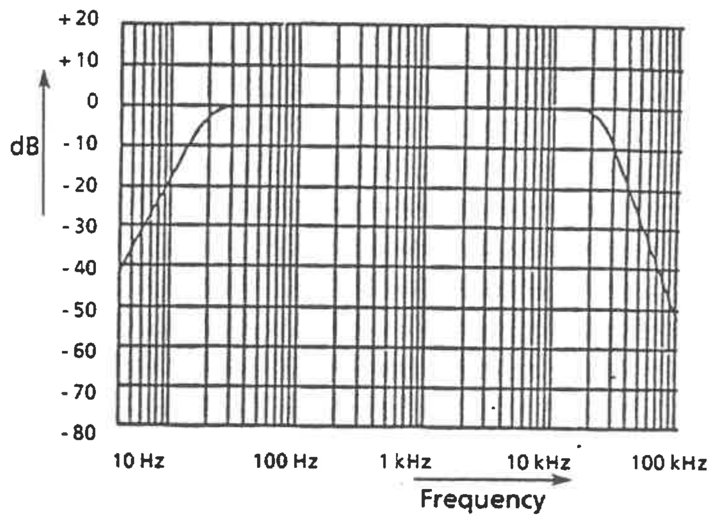


Fig. 3-17 CCIR unweighted filter

3.3.5.3.4 More Filter Menu

The More Filter menu provides additional lowpass filters:

LP ⎍ 30 kHz and LP⎍ 120 kHz are slightly modified Bessel filters optimized to minimal overshoot with squarewave signals (Fig. 3-18 and Fig. 3-19).

Combined with the peak-responding detectors, they are useful to accurately determine the peak value of squarewave-modulated signals (AM or FM).

Since also highpass filters may cause overshooting (pulse tilts), a previously selected HP is switched off when LP⎍ 30 kHz or LP⎍120 kHz are selected.

As the upper demodulation cutoff frequency is limited depending on the carrier frequency, LP⎍30 kHz is suitable for use only with carrier frequencies >300 kHz and LP ⎍ 120 kHz with carrier frequencies >10 MHz.

The low cutoff is then at about 1.5 Hz. A special compensation circuit ensures that amplitude errors caused by the occurrence of pulse tilts at a 5-Hz square wave signal are < 10%.

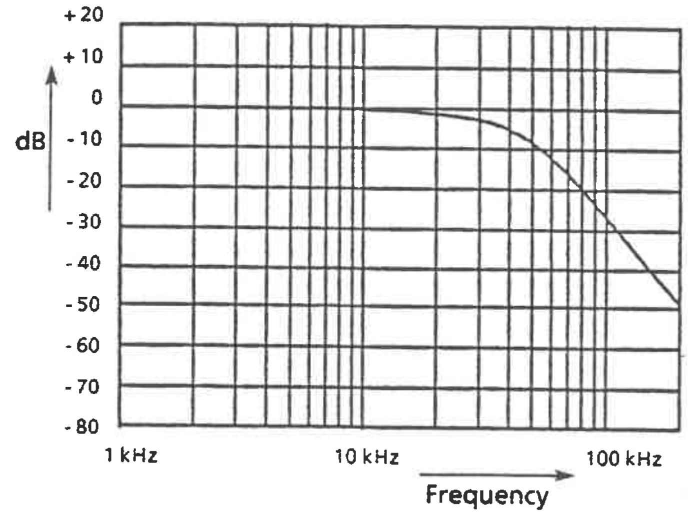


Fig. 3-18 LP ⎍ 30 kHz

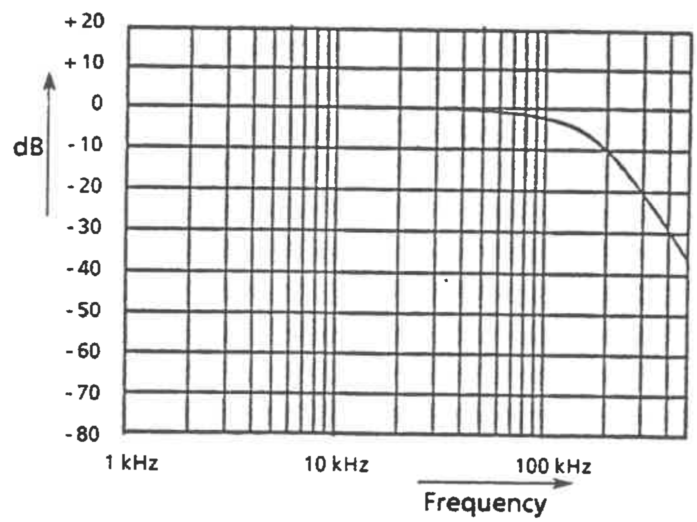


Fig. 3-19 LP ⎍ 120 kHz

LP 4.5 kHz

Special Chebyshev lowpass filter for measurements on AM radio transmitters (according to Performance Specification No. 5/4.1 IRT). See Fig. 3-20.

LP 5 Hz

Lowpass filter 5 Hz is used in DC voltmeter operation and serves to suppress AC interfering voltages (hum and noise). It is selectable only in this operating mode. See Fig. 3-21.

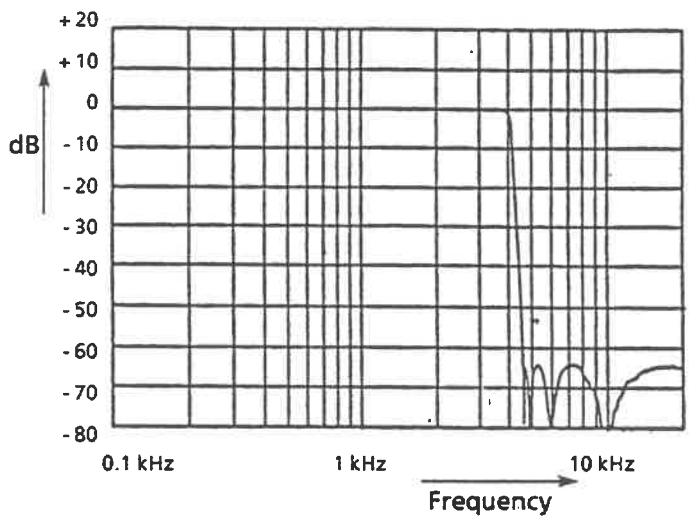


Fig. 3-20 AM LP 4.5 kHz

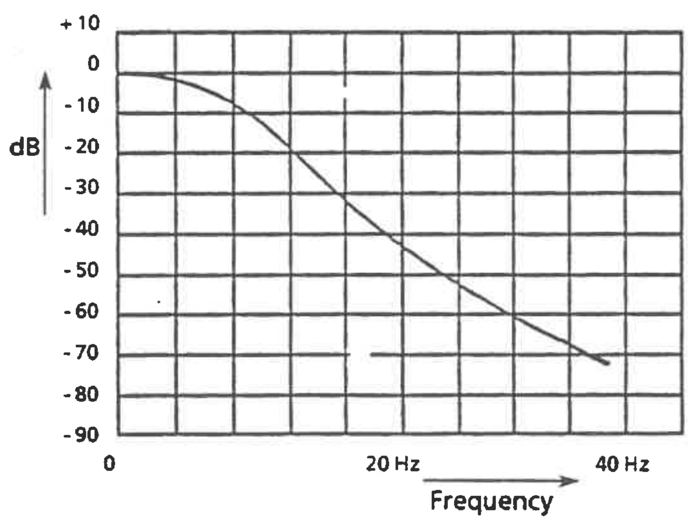


Fig. 3-21 DC voltmeter LP 5 Hz

Special

Up to two special universal and user-specific filters can be inserted into the slots for the filter option.

Coding enables the instrument to recognize the respective optional fitting and effects display of the Special Filter menu.

These special filters 1 or 2 may also be combined with the standard filters or option filters, as well as with an external filter, as desired and suitable.

3.3.5.3.5 External Filter

BNC sockets are provided on the rear of the instrument for connecting an external filter into the AF measuring path.

Previously, any of the internal filters may be selected. If only an external filter is required, the internal filters are to be switched off.

An attenuation of 6.02 dB occurring with an external passive filter can be compensated for the internal display using softkey `Gain 6 dB`.

3.3.5.3.6 Tunable Bandpass Filter (only with optional AF Analyzer/DSP Unit FMA-B8)

The optional AF Analyzer/DSP Unit FMA-B8 also allows highly selective voltage and modulation measurements with the aid of the fast Fourier transform. With the aid of a fast A/D converter the signal of the AF measurement path is sampled and a fast Fourier transform (FFT) performed. A 1024-point FFT using a flat-top window is employed. The FFT point closest to the tuning frequency ***(Tune Freq)*** is read out on the modulation display either as amplitude modulation depth, frequency or phase deviation or as AF voltage, depending on whether AM, FM or PM demodulation or voltmeter mode has been selected as the operating mode. The flat-top window used ensures that the measurement errors are negligible (specified measurement errors see data sheet FMA-B8). The tuning frequency is rounded to 3 digits and read out under BP XXX in the filter field of the modulation display.

Proceed as follows:

Main function key filter
left-hand menu
TUNE BP

The FFT and hence the resulting resolution and selectivity are determined by the tuning frequency of the bandpass filter (to be entered upon pressing softkey Tune Freq?). Fast Fourier transform with the following bandwidth, resolution and spacing between the points will be used (differing from FMA-B8 data sheet):

Tuning frequency	-3-dB bandwidth	Resolution -80 dB	Scaling in Hz/div*	Spacing between points in Hz
10 to < 50 Hz	2,27 Hz	7.3 Hz	49	0.53
≥ 50 to 500 Hz	6,8 Hz	21.9 Hz	148	1.59
≥ 500 to ≤ 5000 Hz	22,7 Hz	73.1 Hz	492	5.3
≥ 5000 Hz to ≤ 25 kHz	204 Hz	658 Hz	4600	47.7
≥ 25 kHz to 150 kHz	816 Hz	2632 Hz	18400	190.7

*) When using the rear outputs DSP1, DSP2 and an oscilloscope in X-Y mode. The start and stop frequency as well as the scaling can be called up with the main function key: **INFO**, softkey: **Spectrum**. The corresponding values are read out on the menu display.

Scaling of the reading:

The scaling of the reading depends on the detector selected (peak, RMS or CCIR quasi-peak detector).

<u>Example:</u>
Voltmeter:
1-kHz sinewave signal of 1 Vrms at voltmeter input:

Reading with RMS detector	1 V
Reading with CCIR quasi-peak detector (only with optional filter FMA-B1)	1 V
Reading with peak detector	1.412 V

This also applies to modulation measurements with AM, PM and FM demodulation.

3.3.6 Detector Menu

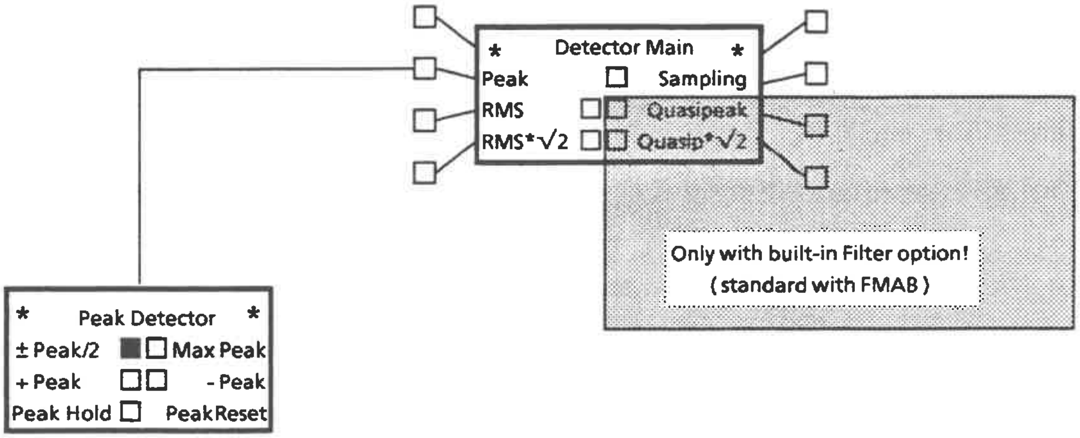


Fig. 3-22 Detector menu tree structure

3.3.6.1 Brief Explanations for the Detector Menu

RMS Indication of rms value in the MODULATION display.

RMS*√2 Indication of rms value for sinewave converted to peak.

Sampling Indication of averaged measured values during the measuring time in the MODULATION display.

Quasi-Peak In combination with the CCIR filters: Detector for weighted noise measurements.

Quasi-Pk*√2 Indication for weighted AF signals for sinewave converted to peak.

Peak

- **± Peak/2** Indication of arithmetic mean of positive and negative peak value in the MODULATION display (default status).
- **+ Peak** Indication of positive peak value in MODULATION display.
- **- Peak** Indication of negative peak value in MODULATION display.
- **Max Peak** Indication of absolute maximum value of + Peak and -Peak.
- **Peak Hold** Peak Hold function of selected peak-responding detector(s).
- **PeakReset** Resetting of peak-responding detector with selected Peak Hold function.

3.3.6.2 Detectors

As standard detectors for the measured modulation value (or the AF voltage in voltmeter operation), rectifiers for the positive and negative peak value (+ Peak, -Peak) as well as a true rms-responding detector are available.

3.3.6.2.1 Peak-responding Detectors

When the ± Pk/2 detector is selected, the arithmetic mean of the measured values of +Pk and -Pk is displayed. For the AM, FM or PM demodulation mode, it is automatically activated in the default status.

The peak-responding detectors are preferably used for precise measurements of wanted modulation. Frequency deviation, phase deviation or modulation depth are defined as peak values.

The peak-responding detectors +Pk, -Pk are also particularly suitable for detecting single modulation peaks (e.g. monitoring of maximum deviation in a current program on FM broadcasting stations).

The function Max Pk is available for display of the maximal value of the +Pk and - Pk detector in the defined period of time.

Single sinewave bursts are detected up to a basic frequency of 15 kHz at an additional error of typically < 1% (in comparison to a continuously applied sinusoidal oscillation of identical frequency). See Fig. 3-23.

3.3.6.2.2 RMS-responding Detector: RMS, RMS*SQR (2)

The true rms-responding detector is provided for unwanted modulation measurements as well as for AC voltage measurements.

The RMS*SQR (2) detector is particularly advantageous for S/N measurements referred to a wanted modulation (e.g. for FM at 40-kHz deviation), when the sinusoidal modulation is converted to peak.

3.3.6.2.3 Sampling Mode

Sampling mode of the FMA permits to measure DC voltages with and without superposed AC voltage. Im this mode automatically the lowpass filter with the lowest cutoff frequency is switched on (3 kHz, with built-in filter option 5 Hz). No other filter setting is then possible. The value displayed is the arithmetic mean of the minimal and maximal values during the respective measuring time.

3.3.6.2.4 Quasi-peak Responding Detector (with Filter Option)

The quasi-peak responding detector strictly complies with the standard CCIR 468-4 and can be combined with the filters CCIR Weighted and CCIR Unweighted to perform weighted measurements of unwanted modulation.

The QuPk*SQR (2) detector designed for rms response of sinewave voltages converts the respective measured value for sinewave to peak. When the quasi-peak responding detector is on, ranging is carried out based on the value measured by this detector. If sinusoidal signals are applied, the signal level is reduced to $^1/_{10}$ of the normal level, as well as the level at the AF output.

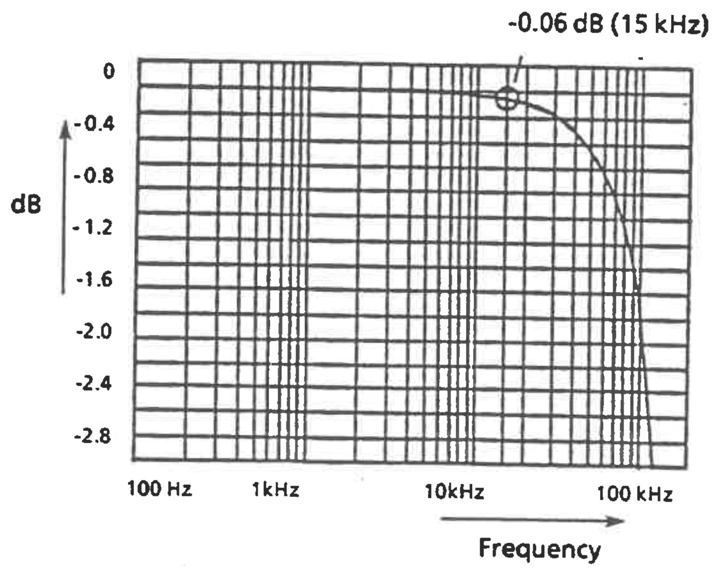
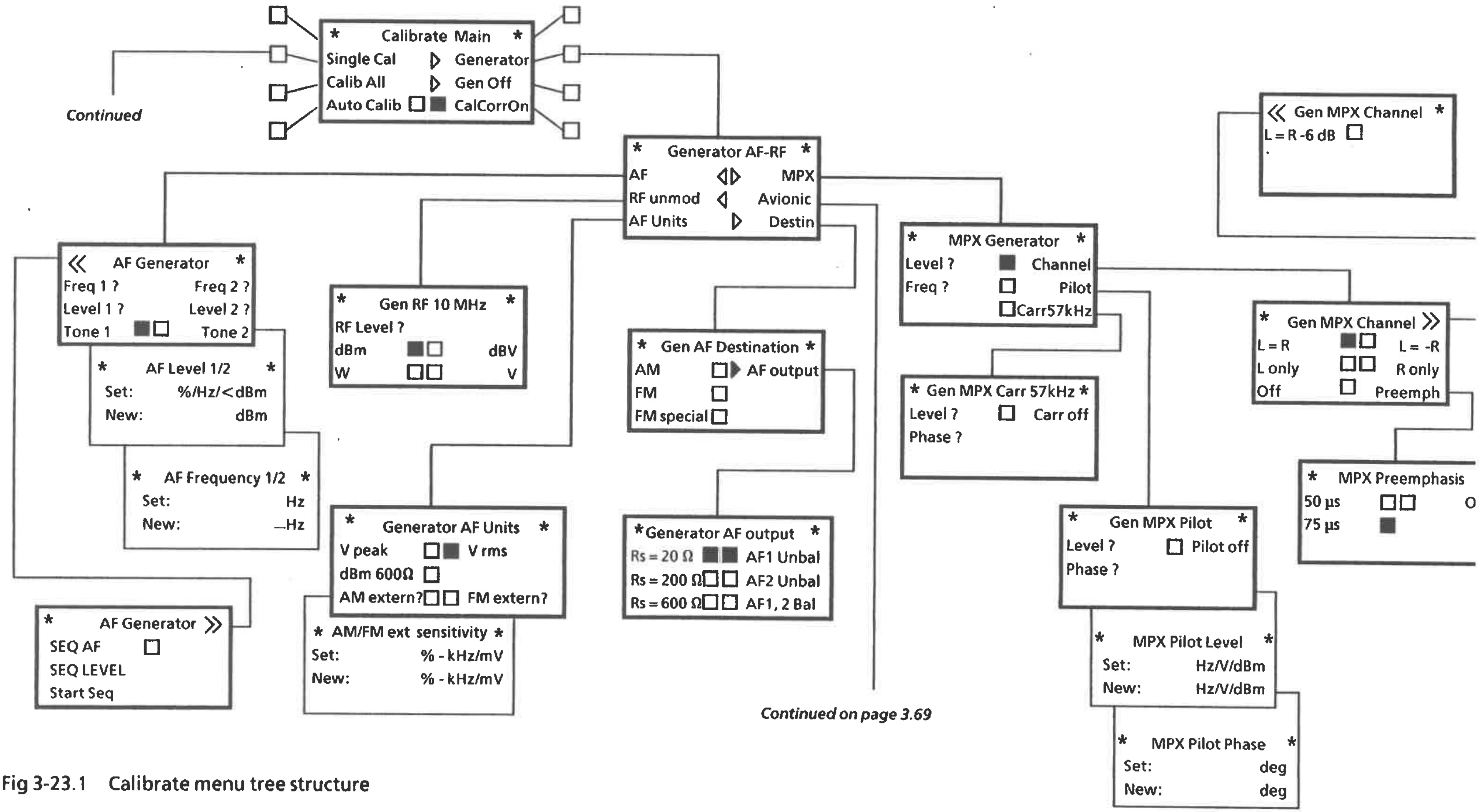


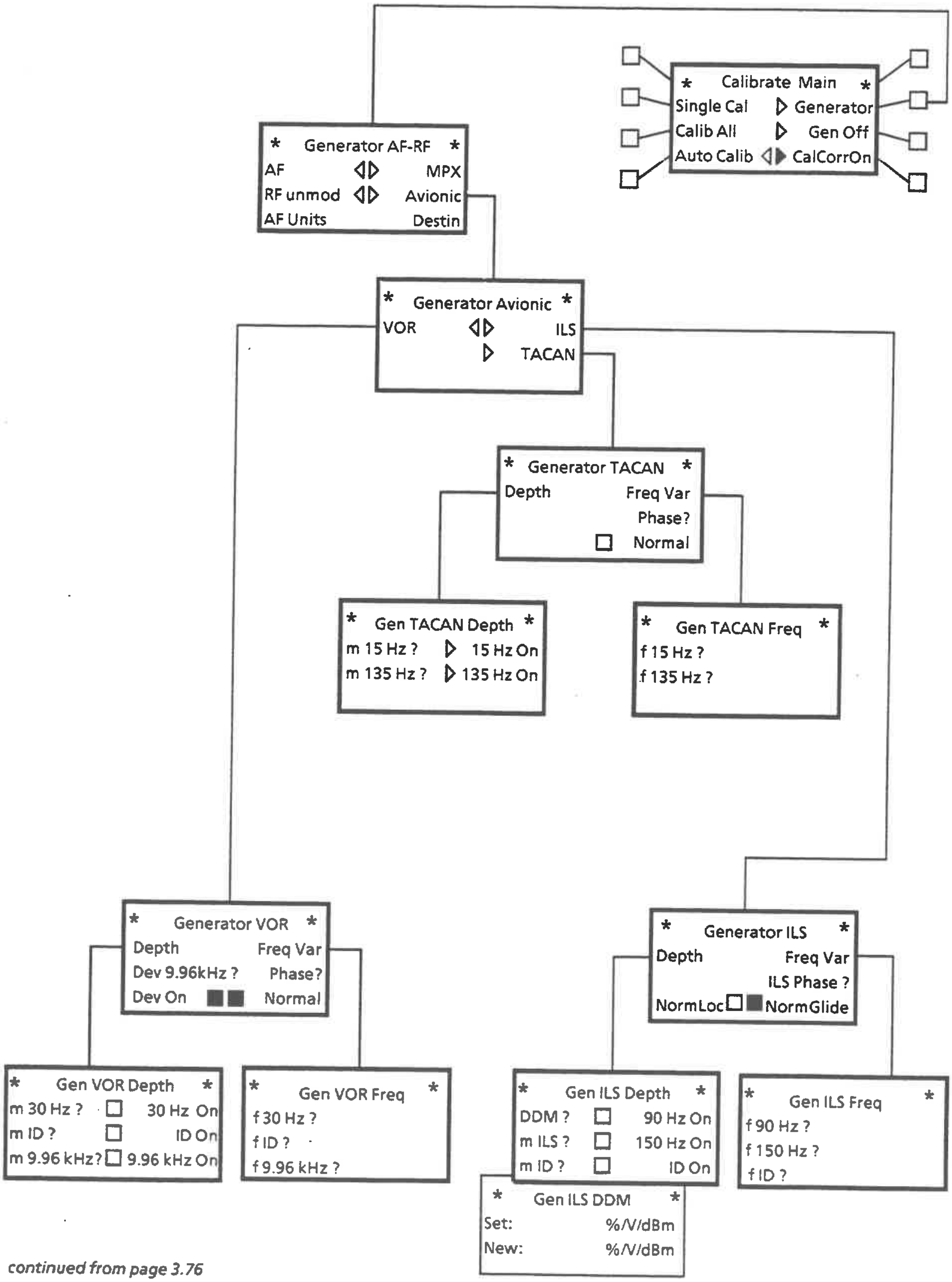
Fig. 3-23: Frequency response of peak detectors with sinewave burst (one sinusoidal oscillation).

3.3.7 Calibrate menu

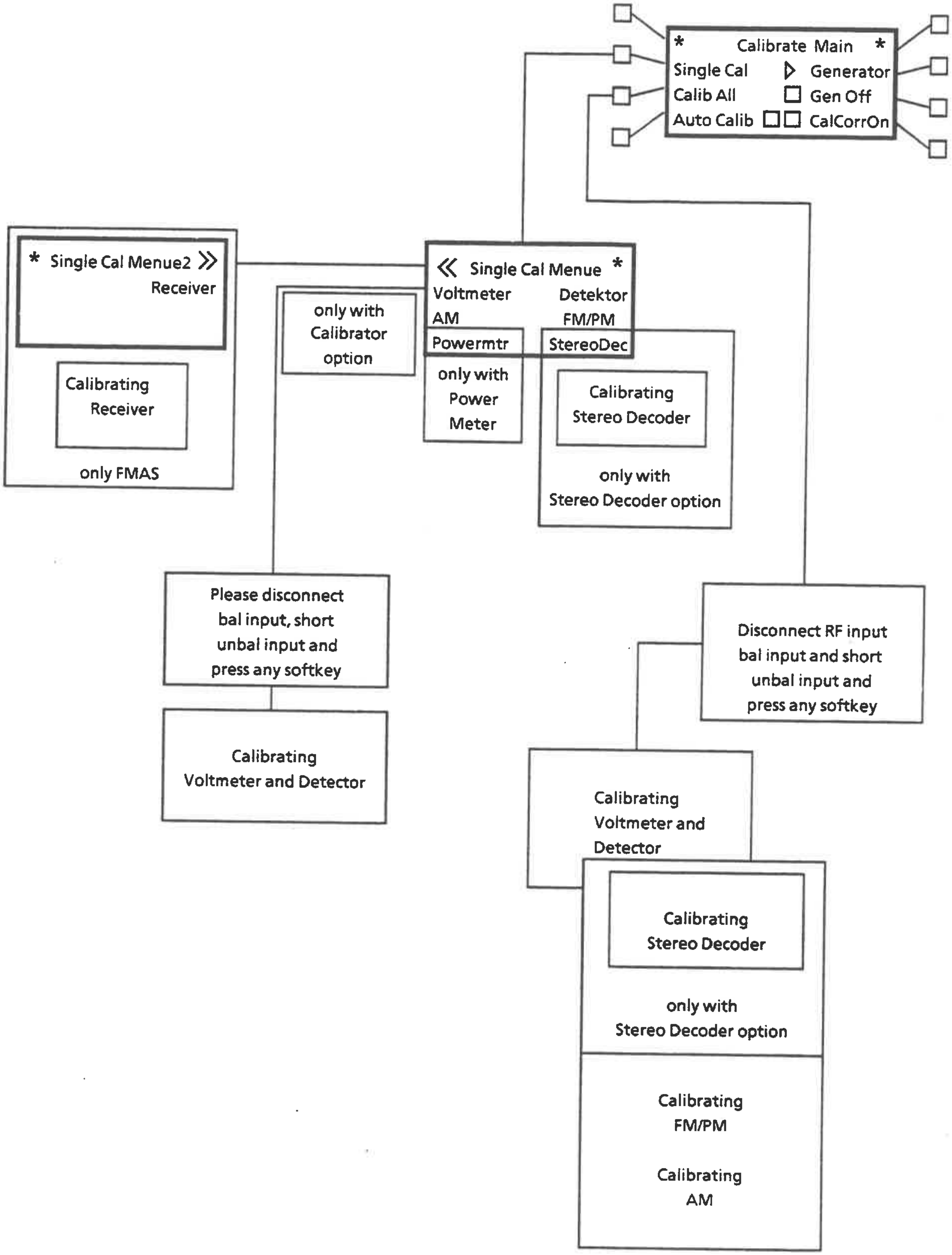


Continued on page 3.69

Fig 3-23.1 Calibrate menu tree structure



continued from page 3.76


* Calibrate Main *
Single Cal
Generator
Calib All
Gen Off
Auto Calib
CalCorrOn
* Single Cal Menue2
Receiver
Calibrating Receiver
only FMAS
Single Cal Menue *
Voltmeter
Detektor
AM
FM/PM
Powermtr
StereoDec
only with Calibrator option
only with Power Meter
Calibrating Stereo Decoder
only with Stereo Decoder option
Please disconnect bal input, short unbal input and press any softkey
Calibrating Voltmeter and Detector
Disconnect RF input bal input and short unbal input and press any softkey
Calibrating Voltmeter and Detector
Calibrating Stereo Decoder
only with Stereo Decoder option
Calibrating FM/PM
Calibrating AM

3.3.7.1 Brief Explanations for the Calibrator Menu

Important note:
The internal temperature checkpoints of the instrument are continuously monitored during operation. When calibration is triggered (Cal All), the current temperature will also be stored together with the correction values. If the deviation from the stored value is greater than 5 °C, a CAL TEMP message is automatically output on the status display. The instrument remains however fully operative and still complies with the data sheet specifications. After recalibration, an enhanced measurement accuracy can be achieved, in particular when using the optional Calibrator FMA-B4. This enhanced measurement accuracy cannot be ensured as soon as the CAL TEMP message is displayed. It can be restored however by triggering a new calibration. If the AUTO CALIB function is switched on, the instrument automatically performs a new calibration on reaching the 5°C tolerance limit. This may however cause an unwanted interruption of the measurement (particularly disturbing in remote-control mode, for instance). The AUTO CALIB function is therefore switched off in the default state of the instrument.

Without calibrator option, offset calibration of the complete AF measurement path (incl. voltmeter inputs) can be made. With stereo decoder option, it is also possible to calibrate this option internally in order to obtain optimum channel crosstalk attenuation.
In the case of FMB or FMA with FMA-B12, offset of the powermeter function can also be calibrated.
With AM/FM calibrator/AF generator option, it is also possible to perform an internal calibration of

- various amplification stages of the AF measuring distance incl. detectors
- gradient of AM demodulator
- gradient of FM/PM demodulator

For external use, a 10-MHz signal which can be AM or FM modulated with high precision is available at the Cal connecter on the instrument front panel.
The signal generated by the AF generator (1-tone, 2-tone, stereo multiplex signal, VOR/ILS/TACAN baseband signal) is applied to two BNC connectors on the instrument rear panel (2 unbalanced outputs or 1 balanced output).
The outputs can be switched off separately, output resistance is selectable.
All baseband signals can be modulated internally onto the 10-MHz carrier signal using the AM and FM modulator (if useful).

Single Cal

Voltmeter — Pressing this softkey allows, in addition to detector calibration, to determine the offset voltages of the voltmeter inputs (bal - unbal), which are subsequently taken into account. To this end, disconnect the bal input, short the unbal input and press any softkey after a request. Voltmeter calibration is only appropriate when DC measurements are to be carried out.
Furthermore the calibrator option allows to calibrate all amplification stages in the AF measuring path.

StereoDec — Calling this calibration routine ensures that channel crosstalk L → R, R → L and M → S becomes minimal (only with stereo decoder option).

Powermtr — Pressing this softkey causes the request to disconnect a cable from the RF input socket, (if any), to be output. When activating another softkey the offset voltages of all powermeter amplifier ranges are determined and taken into account in all further power measurements.

Detector — This softkey serves to determine the offset voltages of all detectors and of the connected amplifiers in one calibration cycle. The offset voltages are taken into account in the following measurements.
The calibrator option also allows to calibrate all amplification stages in the AF measuring path.

AM — A calibration of the AM demodulator gradient is initiated by pressing the AM softkey. In addition detector calibration is automatically performed.

FM/PM — FM/PM When this softkey is actuated, the skirt selectivity of the FM/PM demodulator is calibrated, the detector is automatically calibrated, in addition. Prior to this calibration, the FM modulator is calibrated with regard to centre frequency and skirt selectivity. The FM modulation data given in the data sheet of the calibrator are valid, if an FM/PM calibration is initiated upon a warm-up time > 1 min. (with Destination FM switched on).
(only FMAS with FMA-B4 option, calibrator)

Receiver — Pressing this softkey causes the total gain at 10 MHz, the deviating IF gain for all switchable amplifiers and IF filters as well as the offset voltage of the IF level test point to be determined and considered in the following measurements.

This calibration increases the accuracy in selective RF level measurements. The absolute accuracy is calibrated at 10 MHz. The level linearity from <1 dB to typ. -97 dBm (3 µV) is calibrated for the entire frequency range.
RF frequency response (preselection) relative to 10 MHz is factory-calibrated and can neither be changed nor switched off.

The first calibration is carried out at 23°C in the factory. The calibration values determined are saved in the EPROM. Calling the Receiver calibration described above causes the recently determined IF calibration values to be used instead of the values in the EPROM provided that CalCorrON is switched on. With CalCorrOn being inactive or after a cold start (see 4.2.4), the factory-calibrated values saved in the EPROM are again made use of.

Calib All Calling a universal calibration (St pilot and detector; however not the voltmeter as the inputs must be connected for this purpose).

Auto Calib With the AutoCal function switched on and the permissible temperature window exceeded (last calibration temperature ± 5 °C), the instrument automatically performs a Calib All calibration. In default status, ie AutoCal function is switched off, only the warning "CalTemp" is output in the Status display.

CalCorrOn With the function switched on the correction values determined in the last calibration are considered in the measured value display.

Gen Off Switching off AF generator and 10-MHz Cal signal

Generator Access to AF/RF generator menu

AF Access to AF menu for frequency and level setting of AF generator (AF1, AF2 outputs on rear panel or AM/FM modulation capability of 10-MHz carrier on front-panel CAL).

Freq 1? Calling the menu for entering the frequency for tone 1

Level 1? Calling the menu for entering the level for tone 1 using the unit depending on the Gen AF Units menu and Gen AF Destination menu:

Gen AF Destination	Gen AF Units	Level Units
AM	any unit	%
FM	any unit	Hz
AF Output	V	Volt
AF Output	dBm	dBm/600 OHM

(Level settings with "Destination AF output " refer to generator emf!)

Tone 1 Switching on/off tone 1; default status is on.

Freq 2 ? Calling the menu for entering the frequency for tone 2.

Level 2 ? Calling the menu for entering the level for tone 2.(For the unit cf. above, Level 1)

Tone 2 Switching on/off tone 2; default status is off.

RF unmod Access to menu for level setting of the unmodulated 10-MHz carrier and for selection of the level unit dBm, dBV, W, Volt (CAL output).

RF Level? Calling the submenu for level setting of the 10-MHz carrier signal in the unit selected in * **Gen RF 10 MHz** * .

dBm
dBV
V
W

Selecting the level unit for the unmodulated 10-MHz carrier

Destination: AF output

V peak   Selecting the level unit of AF generator;
V rms Default: Vrms

dBm 600 Ω

AMextern? Calls the entry menu for entering sensitivity %/m of an external AM modulator;
Sensitivity in the instrument default status: 0.02%/mV;
permitted range: 0.001 kHz/m to 100 kHz/m.

FMextern? Calls the entry menu for entering the sensitivity: kHz/mV of an external Fm modulator; sensitivity in the instrument default status: 0.625 kHz/mV [in the future: 0.0259 kHz/mV corresponding to 40 kHz/1.545V (40 kHz/6 dBm)];
permitted range: 0,001kHz/mV bis 100kHz/mV.

Avionics Access to the Avionics signal-generation capabilities (with Destination AM, Amextern and AF Output)

MPX Access to Stereo Multiplex Signal Generator menu (If destination AM was set before, selecting the MPX signal causes automatic switch-over to destination FM (MPX not feasible with AM).

Level? Calling the menu for entering the level for the stereo multiplex generator in the units dBm or Volt for destination AF output or Hz [frequency deviation] for destination FM (default status +6 dBm or 1.545 V (L=R) with destination AF output or deviation: 40 kHz with destination FM). Level settings with destination AF output refer to generator emf! With destination AF output the rms value associated with the channel configuration L=R is always set, however without pilot tone portion. Also with destination FM peak deviation is set without pilot tone portion.

Freq? Calling the menu for entering the frequency for the stereo MPX generator

Channel Access to the menu for selection of the stereo MPX channel; at the same time the channel last selected is activated. (If the Carr 57-kHz signal is switched on, it is switched off since parallel generation is not possible).

L=R
L=-R
L only   Selecting the stereo MPX channel
R only
L = R -6 dB

Off   Switching off the stereo MPX channel (L = R = OFF)

Preemph   Calling the * **MPX Preemphasis*** submenu for selection of preemphasis of audio signal.

50 µs   Preemphasis with time constant 50 µs
75 µs   Preemphasis with time constant 75 µs
Off   Switching off preemphasis

Note:
On switching on the preemphasis, the MPX level is identical to the level without preemphasis with AF = 15 kHz. For a lower AF, the level is reduced according to the time constant 50 or 75 µs). This ensures that the MPX level with preemphasis cannot cause an overload of the test object with frequency response measurement.

Pilot — Access to * **Gen MPX Pilot** * submenu for setting of the phase and level for the stereo MPX pilot tone

Level? — Calling the menu for entering the pilot tone level of the stereo multiplex generator in the units dBm or Volt for destination AF output or Hz [frequency deviation] for destination FM (default status -9.5 dBm or 259 mV with destination AF output or deviation 6.72 kHz with destination FM).

Phase? — Setting the pilot tone phase; default status 0 °

Pilot off — Switching off the pilot tone

Carr 57 kHz — Calling the submenu for activation of the 57-kHz traffic channel signal/ARI carrier; also an activated stereo channel is switched off.

Level? — Setting the level of the 57-kHz carrier

Phase? — Setting the phase of the 57-kHz carrier ref. to the pilot

Carr off — Allows for switching off the 57-kHz carrier

Destin — Access to * **AF Destination menu** *

In this menu destination of the AF (MPX, Avionics) signal is selected. The signals can be switched either to AM or FM modulator of the 10-MHz calibration signal (Cal connector on rear panel) or, they are directly switched as baseband signals to the AF1, AF2 outputs on the rear panel.

AM — Baseband signal is switched to AM modulator; AM-modulated 10-MHz carrier signal is available at the Cal connector with a level of -10 dBm. The AF1, AF2 outputs on the rear panel are not active.

FM — Baseband signal is switched to FM modulator; FM-modulated 10-MHz signal is available at the Cal connector with a level of -10 dBm. The AF1, AF2 outputs on the rear panel are not active.

FM special — Baseband signal is switched to FM modulator; modulated 10-MHz-carrier signal (deviation = 100 kHz, modulation signal = 1 kHz quasi-square with aperiodic settling characteristic) is available at Cal connector with a level of -10 dBm. The AF1, AF2 outputs on the rear panel are not active.

AF output — Access to * **Gen AF Output** * menu for selection of the AF generator output resistance and for switching the AF generator outputs AF1, AF2 on the rear panel. The Cal connector on the front panel is not active.

Rs = 20 Ω — AF generator output resistance = 20 Ω, default setting
Rs = 200 Ω — AF generator output resistance = 200 Ω
Rs = 600 Ω — AF generator output resistance = 600 Ω

AFUnbal1 AF1 generator output (rear panel) unbalanced active/not active; toggle function

AFUnbal2 AF2 generator output (rear panel) unbalanced active/not active; toggle function

AF1;2 Bal AF1, AF2 generator outputs balanced active/ not active; the AF generator baseband signal is balanced and applied to the internal conductors of AF1, AF2 BNC outputs; toggle function

Avionics Access to the Avionics signal-generation capabilities (with Destination AM, Amextern and AF Output)

Generator Avionics Menu for selection of the Avionics signal generation

≫ VOR Switching on the VOR signal generation (instrument default status) and access to the corresponding submenu; (VOR = VHF Omnidirectional Radiorange)

Depth Access to the submenu for setting the modulation depth of the VOR signal components

m 30Hz? Calling the menu for entry of the modulation depth of the 30-Hz component

m ID? Calling the menu for entry of the modulation depth of the identifier signal

m 9,96kHz? Calling the menu for entry of the modulation depth of the 9.96-kHz subcarrier

30Hz On Switching on/off the 30-Hz component; instrument default status: switched on; toggle function

ID On Switching on/off the identifier signal; instrument default status; switched on; toggle function

9,96kHzOn Switching on/off the 9.96-kHz signal component; instrument default status: switched on; toggle function

Dev 9,96kHz? Calling the menu for entry of the frequency deviation of the 9.96-kHz subcarrier signal; specified range: 0 Hz to 1 kHz

Dev On Switching on/off the frequency modulation of the 9.96-kHz subcarrier; instrument default status: switched on; toggle function

Freq Var Calling the submen for frequency variation of the VOR signal components;

f 30Hz? Calling the menu for entry of the frequency of the 30-Hz component; influences the 30-Hz AM component and the 30-Hz FM component, simultaneously; variation range: 30 Hz ± 10%

f ID? Calling the menu for entry of the identifier-signal frequency; instrument default setting, i.e. standard frequency 1.02 kHz; variation range: 10 Hz to 10 kHz

f 9,96kHz? Calling the menu for entry of the frequency of the 9.96-kHz component; variation range: 9.96 kHz ± 10%

Phase? Calling the menu for entry of the phase of the 30-Hz AM component as against the phase of the 30-Hz FM component;
instrument default status: 0 degree phase

Normal Switching on/off the VOR standard signal;
standard signal:
modulation depth of 30-Hz signal: 30%
modulation depth of ID signal: 10%, frequency of ID signal: 1.02 kHz,
modulation depth of 9.96-kHz signal: 30%
frequency deviation to 9.96-kHz signal: 480 Hz with modulation frequency 30 Hz, phase 0 degrees

≫ ILS Switching on the ILS signal generation and access to the corresponding submenu

Depth Access to submenu for setting the modulation depth of the ILS signal components

DDM? Calling the menu for entry of the DDM value (DDM = Difference in Depth of Modulation = (m90 Hz - m150 HZ)/100%)

m ILS? Calling the menu for entry of the average ILS modulation depth (m90 Hz + m150 Hz)/2

m ID? Calling the menu for entry of the modulation depth of the identifier signal

≫ 90Hz On Switching on/off the 90-Hz component of the ILS signal; instrument default status: switched on, toggle function

≫ 150Hz On Switching on/off the 150-Hz component of the ILS signal; instrument default status: switched on;
toggle function

≫ ID On Switching on/off the identifier signal; instrument default status: switched on; toggle function

≫ NormLocal NormLoc Switching on/off the standard Localizer signal:
standard Localizer signal:
m ILS = 20%, DDM = 0, phase 0 degrees
m ID = 10%, fID = 1.02 kHz
instrument default status: switched on

Freq Var Calling the submenu for frequency variation of the ILS signal components; variation of one component causes the two other components to be varied frequency-proportionally;

f 90Hz? Calling the menu for entry of the frequency of the 90-Hz component of the ILS signal; the 150-Hz component is changed frequency-proportionally;

f 150Hz? Calling the menu for entry of the frequency of the 150-Hz component of the ILS signal; the 90-Hz component is changed frequency-proportionally.

f ID? Calling the menu for entry of the frequency of the identifier signal;

Phase? — Calling the menu for entry of the phase of the 150-Hz component referred to the 90-Hz component of the ILS signal;
instrument default status: 0-degree phase

NormGlide — Switching on the standard Glide Path signal:

m90 Hz = m150 Hz = ≫ 40% (DDM = 0);
mID = 10%; fID = 1.02 kHz
instrument default status: switched on

≫ TACAN — Switching on the TACAN signal generation capabilities and access to the corresponding submenu;

Generator TACAN

Depth — Access to submenu for setting the modulation depth of the TACAN signal components.

m 15Hz? — Calling the menu for entry of the modulation depth of the 15-Hz signal

m 135Hz? — Calling the menu for entry of the modulation depth of the 135-Hz signal.

≫ 15Hz On — Switching on/off the 15-Hz component of the TACAN signal;
instrument default status: switched on;
toggle function

≫ 135Hz On — Switching on/off the 135-Hz component of the TACAN signal;
instrument default status: switched on;
toggle function

Freq Var — Calling the submenu for frequency variation of the TACAN signal components

f 15Hz? — Calling the menu for entry of the frequency variation of the 15-Hz component (the 135-Hz component is varied frequency-proportionally).

f 135Hz? — Calling the menu for entry of the frequency variation of the 135-Hz component (the 15-Hz component is varied frequency-proportionally).

Phase? — Calling the menu for entry of the phase of the 135-Hz component referred to the 15-Hz component;
instrument default status: 0-degree phase.

Normal — Menu for entry of the standard TACAN signal:
m 15 Hz = 40%
m 135 Hz = 10%
Instrument default status.

3.4 Remote Control of Instrument

3.4.1 IEC Bus

The modulation analyzer is fitted with an IEC bus interface as standard. The interface corresponds to the IEC 625-1 and IEC 625-2 or IEEE 488.1 and IEEE 488.2 standard. The IEC 625-2/IEEE 488.2 standard describes data transfer formats and common commands etc.

The bus connector *28* is fitted to the rear of the instrument. The modulation analyzer is equipped with the 24-contact female connector as required by standard IEEE 488. The interface comprises 16 bus lines grouped into three clusters according to their functions:

1. **Data bus with 8 lines DIO 1 to DIO 8**

   The 8 signal lines carry data in bit-parallel, byte-serial format across the interface. The characters are transmitted in the ISO-7-bit format (ASCII code).

   Line DIO 1 represents the least significant bit and DIO8 the most significant bit.

2. **Control bus with 5 lines**

   The five control bus lines are used to transmit control functions:

   ATN (Attention)
   becomes active Low when addresses, universal commands or addressed commands are transmitted to the connected participating devices.

   REN (Remote Enable)
   enables the device to be switched to the remote status.

   SRQ (Service Request)
   enables a participating device to send a Service Request to the controller by activating this line.

   IFC (Interface Clear)
   is activated by the controller in order to set the IEC interfaces of the connected participating devices to a defined status.

   EOI (End or Identify)
   can be used to identify the end of data transfer and is used with a parallel poll.

3. **Handshake bus with 3 lines**

   The handshake bus is used to control the data transfer timing.

   NRFD (Not Ready For Data)
   Active Low on this line signals to the talker / controller that one of the participating devices is not ready for data tansfer.

   DAV (Data Valid)
   is sent by the talker / controller shortly after a new data byte has been applied to the data bus for processing.

   NDAC (Not Data Accepted)
   is held at active Low by the participating device until all data present on the data bus are accepted.

More detailed information as to the data transfer timing can be derived from the IEC 625-1 standard.

In line with the IEC 625-1 standard, devices controlled via IEC bus can be equipped with different interface functions. The following Table 3-3 summarizes the interface functions implemented in the FMA:

Table 3-3 Interface functions

Control characters	Interface function
SH1	Source Handshake function, full capability
AH1	Acceptor Handshake function, full capability
L4	Listener function,full capability, unaddress if MTA
T6	Talker function,full capability, capability to reply to serial poll, unaddress if MLA
SR1	Service Request function, full capability
PP1	Parallel Poll function, full capability
RL1	Remote/local switchover function, full capability
DC1	Device Clear function, full capability
DT0	Device Trigger function, full capability
C0	Controller function, no capability

3.4.1.1 Setting the Device Address

The device address can be set in the SPECIAL FUNCTION menu by softkey `IEC-Adress?`. The address in the range from 0 to 30 is entered via numeric keypad and remains stored when the device is switched off. Upon delivery, the instrument is factory-set to address 29.

The device address corresponds to the decimal equivalent of bits 1 to 5 of the talker or listener address. This form is also used for the IEC bus commands of the controllers.

3.4.1.2 Local / Remote Switchover

At power-up, the analyzer is always set to local mode.

When the modulation analyzer is first addressed by a controller as listener (e.g. by the BASIC commands IECOUT or IECLAD in the case of the R&S Process Controllers), it enters the remote state in line with the standard and also remains in this state after data transfer has been completed. Remote state of the instrument is indicated by display REMOTE in the STATE display as well as in the MENU field. All controls on the front panel except the LOCAL and POWER ON keys are disabled.

There are two methods to return to local state:

- by the controller command GTL (Go to Local).
- by actuating the LOCAL key. Data output from controller to device should be stopped before this key is pressed. Otherwise, the device would immediately return to remote state again. The function of the LOCAL key can be disabled by the controller by sending universal command LLO (Local Lockout).

The other device settings are not changed when switching from remote to local state or vice versa.

No softkey menus are displayed when the FMA is set to remote state, as no normal operation is then possible.

When the FMA is set back to local state, the respective main menu of the current operating mode is indicated.

3.4.1.3 Interface Messages

Interface messages (according to IEC 625-1/IEEE 488 standard) are transmitted to the device on the data lines where the Attention line ATN is active (Low).

3.4.1.3.1 Universal Commands

The universal commands are in the code range between 10 and 1F hexadecimal (cf. Table 3-4) and are effective for all the participating devices in the IEC bus system without previous addressing.

Table 3-4 Universal commands

Command	Basic command with R&S controllers	Function
DCL (Device Clear)	IECDCL	Aborts processing of the currently received commands and resets the command processing software to a defined initial status. The device setting is not changed.
LLO (Local Lockout)	IECLLO	LOCAL key is disabled.
SPE (Serial Poll Enable)	IECSPE *	Ready for serial poll.
SPD (Serial Poll Disable)	IECSPD *	Disabling serial poll.

* The BASIC command "IECSPL adr, status" contains the commands "IECSPE" and "IECSPD" and additionally reads the status of the device with address "adr" and stores this in the integer variable "status".

3.4.1.3.2 Addressed Commands

The addressed commands are in the code range between 00 and 0F hexadecimal (cf. Table 3-5) and act only on those participating devices in the IEC bus system that have been addressed as listeners before (e.g. by BASIC command "IECLAD addr").

Table 3-5 Addressed commands

Command	Basic command with R&S controllers	Function
SDC (Selected Device Clear)	IECSDC	Aborts processing of the currently received commands and resets the command processing software to a defined initial status. The device setting is not changed.
GTL (Go To Local)	IECGTL	Change to local state.
GET (Group Execute Trigger)	IECGET	Start of measurement.

3.4.1.4 Device Messages

Device messages (in line with standard IEC 625-1) are transmitted on the data lines of the IEC bus, in which case the Attention line is High (not active). The ASCII code (ISO 7-bit code) is used (cf. Table 3-6).

Table 3-6 ASCII/ISO and IEC character set

Control characters						Numbers and special characters				Upper-case letters				Lower-case letters			
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	GTL	17	DC1	LLO	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	'	55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	|
13	CR		29	GS		45	-	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	? / UNL	79	O	95	_	111	o	127	DEL
Addressed commands			Universal commands			Listener addresses				Talker addresses				Secondary addresses and commands			

Code for control characters:

e.g.

9	HT	TCT

- TCT — interface message ("Take Control")
- HT — ASCII character ("Horizontal Tab")
- 9 — decimal

The device messages can be grouped according to two different aspects:

- common, device-independent commands (as defined by the IEEE 488.2 standard)
- device-specific commands (dependent on the specific device characteristics).

In the following, device messages received by the FMA are referred to as commands.

Commands characterized by "?" at the end of the sequence, e.g."FREQUENCY:RF?", request the FMA for output of the set value, when the same format is used as in the command table. For the given example, this would be:

"FREQUENCY:RF 123.45678E6"

Always the basic unit applies (Hz in this case).

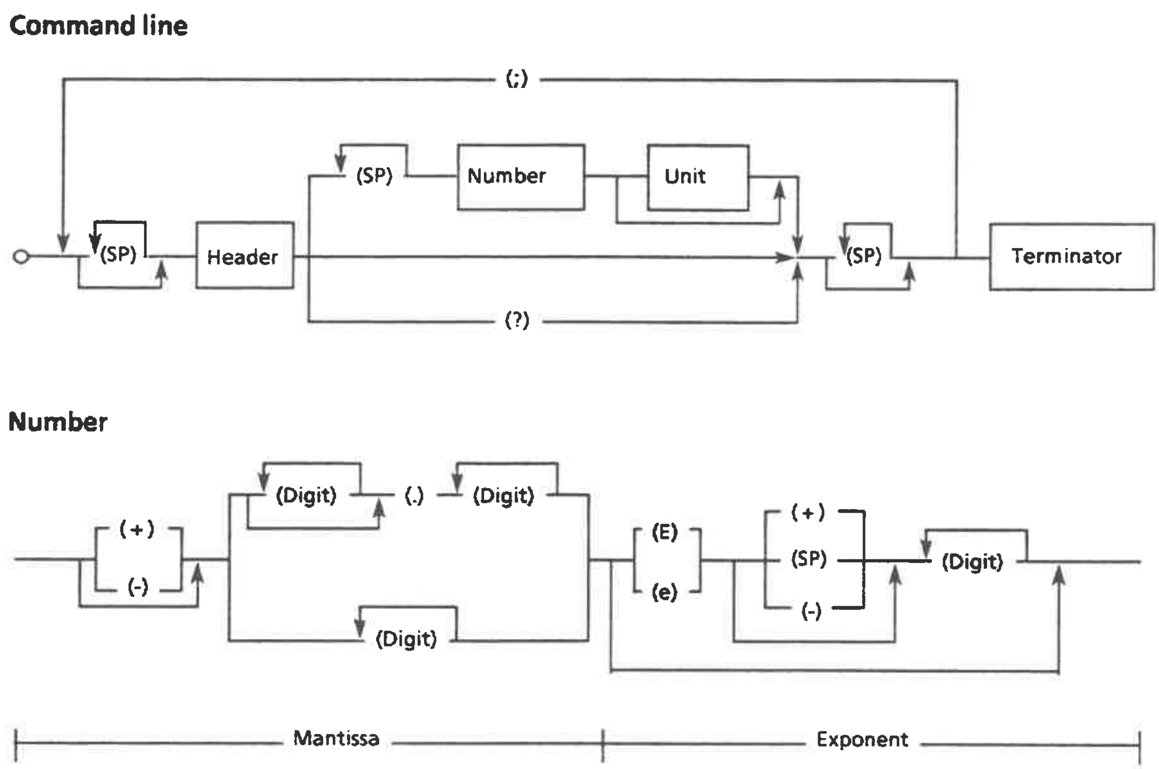
3.4.1.4.1 Commands Received by the FMA in Listener Mode (Controller to Device Messages)

Input buffer

All commands received by the FMA are stored in a buffer of maximally 256 bytes. Also, longer command sequences can be processed, when the part of the command line which was first received is already processed in the device.

Command syntax

Fig. 3-24 shows the syntax of a command line (program message). Each command line must end with a terminator.



SP: Any character with ASCII code 0 to 9 and 11 to 32 decimal, especially space.

Fig. 3-24 Syntax diagram for a command line

Terminators

- New line (ASCII code 10 decimal)
- End (EOI line active) in combination with the last useful character of the command line or the character "New Line".

Since the carriage return character (ASCII code 13 decimal) is permissible as an ineffectual filler before the terminator, also the combination of carriage return + New Line is permissible.

All IEC bus controllers by Rohde & Schwarz send terminators accepted by the device as standard. A command line may require more than one line on the screen of the controller because it is only limited by the terminator. Most IEC bus controllers automatically append the terminator at the end of the command text.

Separators

A command line may consist of several commands (program message units) separated by semicolons (;).

Command structure

A command may consist of the following parts:

- header only,
  e.g.: **RST*

- header and question mark (query message),
  e.g.: *"DEMODULATION?"*

The query message requests the device to provide the desired data in a buffer for output to the IEC bus as soon as it is addressed as a talker.

- header and number,
  e.g.: *"FREQUENCY:RF:TUNE 100 MHZ"*

To remain in accordance with the IEEE 488.2 standard, the header and number(s) have to be separated by at least one space (ASCII code 32 decimal). In the case of the device-specific commands, the number can be supplemented by a subsequent unit.

- header and string,
  e.g.: *"DEMODULATION FM"*

The headers and their meanings are explained in Sections 3 .4.1.4.3 and 3.4.1.4.4.

Lower case/upper case letters

Lower case letters are permissible as equivalents to the corresponding upper case letters. Units can thus be used in the usual form (e.g.: dBm) instead of the upper-case letter notation which is also permissible (e.g. DBM).

Spaces

Additional spaces may be inserted at the following positions:

- before a header;
- between header and number;
- before and after commas (,) and semicolons (;)
- before the terminator.

Numbers

Only decimal numeric data are allowed in the following permissible notations:

- with or without polarity sign,
  e. g. *5, +5, -5*

- with or without exponent to base 10, "E" or "e" are used as the exponent character,
  e. g. *.451, 451E-3, +4.51e-2*

- The exponent is permissible with or without a sign, also a space is permissible instead of the sign,
  e. g. *1.5E+3, 1 .5E-3, 1.5E 3*

- Leading zeros are permissible in mantissa and exponent,
  e. g. *+0001.5, -01.5E-03*

- The length of the number including the exponent must not exceed 20 characters. The number of digits for the mantissa and exponent is only limited by this condition. Digits which exceed the resolution of the device are rounded up or down, but are always considered for the order of magnitude (power of ten),
  e. g. *150000000, 0.00000032*

Note: Specification of the exponent alone (e.g.: E-3) is not permissible, 1E-3 is correct.

3.4.1.4.2 Messages Sent by the FMA in Talker Mode (Device to Controller Messages)

The FMA transmits messages to the IEC bus system for processing if it

- has been requested by one or several query messages (with question mark and within one command line) to provide data in the Output Buffer, and
- indicates by setting bit 4 (MAV = message available) in the status byte that the requested data are now available in the Output Buffer, and
- has been addressed as talker before (BASIC command "IECIN adr, stringvariable").

Note that the command line with the data requests must be transmitted immediately before addressing as talker. The Output Buffer is cleared if another command line is entered in between.

The maximal length of the Output Buffer is 256 bytes.

A query message is formed by appending a question mark "?" to the header of Table 3-9, e.g. "DETECTOR?".

If the FMA is addressed as talker immediately following the query message, the bus handshake is disabled until the requested data are available. This simple procedure of synchronization is certainly meaningful with the modulation analyzer if a query message can be executed independently of the execution and termination of a test run.

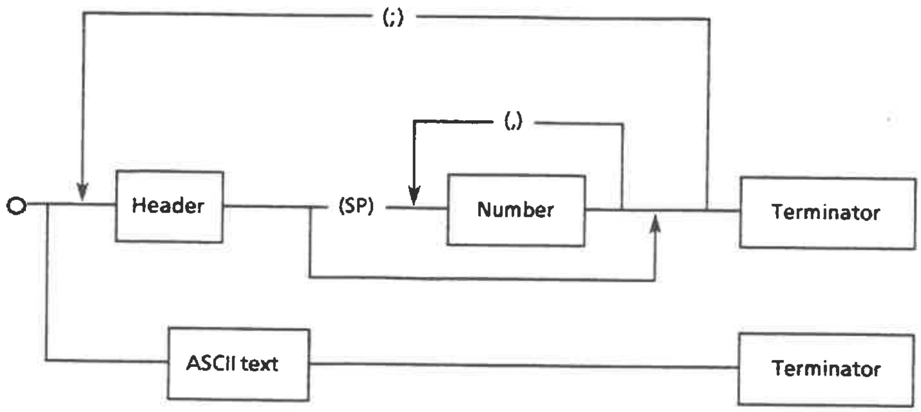
The syntax of the messages sent by the FMA in talker mode is shown in Fig. 3-25. The syntax is similar to that of the messages received by the analyzer in listener mode.

"New Line" (ASCII code 10 decimal) in combination with END (line EOI active) is used as terminator.

The transmission of "header and numbers" makes it possible that the messages sent by the FMA in talker mode can be returned again from the controller to the analyzer in the same form, without any amendments, as setting commands. It is thus possible to read a setting entered via the keyboard, store it in the controller and repeat it later via IEC bus.

- If the FMA receives several query messages, it also returns several messages within one line separated by semicolons (;).
- Several numbers can be transmitted in response to certain query messages, (e.g. "DEMOD:FM:DUAL_PEAK_DEV?"), also to be separated by commas (,).
- Header and numeric data section must always be separated by a space.
- The headers only consist of upper-case letters and the characters ":", "_" and "*".
- The syntax of the numeric data section is described in Fig. 3-25. The exact form of the numbers of each message is described in Tables 3-7, 3-8 and 3-9.
- The messages sent by the FMA in talker mode do not contain units. In the case of physical variables, the numbers are referred to the basic units specified in Table 3-9.

Output message line



Number

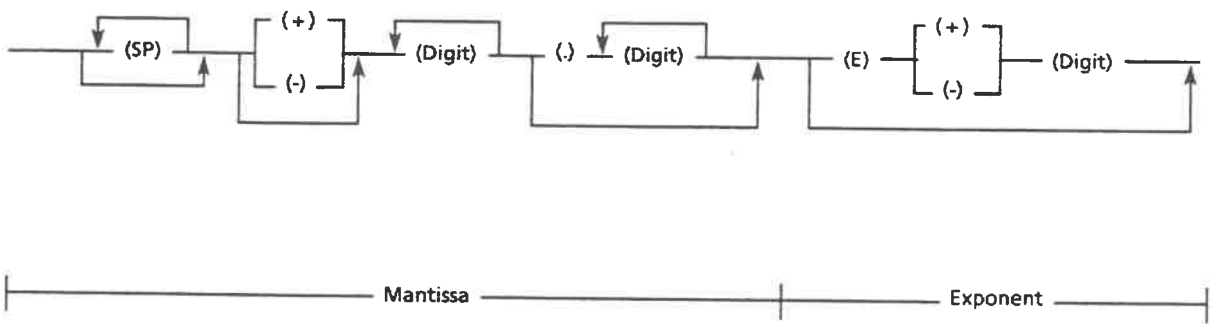


Fig. 3-25 Syntax diagram of a message sent by the FMA in talker mode

3.4.1.4.3 Common, Device-independent Commands (Common Commands)

These commands are listed in Tables 3-7 and 3-8 and can be grouped into the following clusters:

- commands referring to the Service Request function with the associated status and mask registers;
- commands for device identification;
- commands referring to the Parallel Poll function;
- commands for triggering test runs, and
- commands for device-internal sequences (reset, calibrate) and for synchronizing sequences.

They are taken from the IEEE 488.2 standard to make sure that these commands have the same effect on different devices.

The headers of these commands consist of a star (*) followed by three letters.

Table 3-7 Common device-independent commands received by the FMA in listener mode

Command	Number, range	Meaning
*RST	---	**Reset** Acts on the instrument like the PRESET key, but without automatic self-test. This command does not change the status of the IEC bus interface, the set IEC bus address, the mask registers of the Service Request function and the Output Buffer. A current Service Request is only reset if it has not been generated by a message in the Output Buffer (MAV).
*PSC	0 to 65535	**Power On Status Clear** (reset on power-up) If >0: On power-up, the Service Request Enable Mask Register (SRE) and the Standard Event Status Enable Mask Register (ESE) are additionally cleared. If 0: The above-mentioned registers retain their contents also when the device is switched on or off. This enables a Service Request when the device is switched on.
*OPC	---	**Operation Complete** Sets the OPC event bit 0 in the Standard Event Status Register when all selected pending device operations have been completed (cf. Section 3.4.1.7).
*CLS	---	**Clear Status** • Sets the status registers (ESR and STB) to zero. The mask registers of the Service Request function (ESE and SRE) remain unchanged. • Clears the Output Buffer. A present Service Request is cleared (cf. Section 3.4.1.5).
*ESE	0 to 255	**Event Status Enable** Loads the Standard Event Status Enable Mask Register with the specified value which is interpreted as decimal number (cf. Section 3.4.1.5).
*SRE	0 to 255	**Service Request Enable** Loads the Service Request Enable Mask Register with the specified value which is interpreted as decimal number (cf. Section 3.4.1.5).

Command	Number, range	Meaning
*PRE	0 to 65535	**Parallel Poll Enable** Loads the Parallel Poll Enable Mask Register with the specified value which is interpreted as decimal number (cf. Section 3.4.1.5).
*TRG	---	**Trigger** Starts a measurement run. Same function as the GET message.
*RCL	1 to 20	**Recall** Recalls a saved device setting. Same function as the RECALL key.
*SAV	1 to 20	**Save** Saves a current device setting. Same function as the SAVE key.
*WAI	---	**Wait To Continue** Device waits to execute subsequent commands until all pending selected device operations have been completed (cf. Section 3.4.1.7).

Table 3-8 Common device-independent commands sent by the FMA as response messages in talker mode

Command	Output message Data value: No. of digits	Output message Data value: Range	Meaning
*IDN?	23	alpha-numeric	**Identification Query** The following identification text is transmitted via the IEC bus in response to the IDN? message (always without header). Example: Rohde&Schwarz, FMA,0,1.0 Rohde&Schwarz = manufacturer FMA = model 0 = reserved for serial number, (not used with FMA) 1.0 = firmware version (example)
*PSC?	1	0 or 1	**Power On Status Clear Query** For reading the status of the Power-on-clear -flag, see *PSC in Table 3-7.
*OPC?	1	1	**Operation Complete Query** The message "*OPC 1" is entered into the Output Buffer and bit 4 (message available) set in the status byte, when all selected pending device operations have been completed. Also bit 0 (operation complete) is set in the Standard Event Status Register (see Section 3.4.1.7).
*ESR?	1 to 3	0 to 255	**Standard Event Status Query** The contents of the Standard Event Status Register is output in decimal form. The register is destructively read, i.e. cleared following reading.
*ESE?	1 to 3	0 to 255	**Standard Event Status Enable Query** The contents of the Standard Event Status Enable Mask Register is output in decimal form.
*STB?	1 to 3	0 to 255	**Read Status Byte Query** The contents of the status byte is output in decimal form.

Command	Output message Data value		Meaning
	No. of digits	Range	
*SRE?	1 to 3	0 to 255	**Service Request Enable Query** The contents of the Service Request Enable Mask Register is output in decimal form.
*TST?	1 to 3	0 to 255	**Self-Test Query** The self-test routine is performed in the device. The output value "0" indicates that no errors were detected during the self-test.
*IST?	1	0 or 1	For reading the individual status of the device (cf. Section 3.4.1.5).
*PRE?	1 to 5	0 to 65535	The contents of the Parallel Poll Enable Register is output in decimal form.
*OPT	String	alpha-numeric	Query for the model designation and the options fitted.

3.4.1.4.4 Device-specific Commands

All the FMA functions which can be set via the keyboard can also be obtained via the IEC bus. The analyzer performance initiated via IEC bus setting commands fully corresponds to that obtained by local keyboard entries.

According to the output in the displays, the values of all setting parameters can also be read via the IEC bus.

Table 3-9 gives a summary of the setting commands and query messages with the associated messages sent by the FMA.

The headers are mostly identical with or similar to the respective key or softkey designations, which results in easy-to-read (self-documenting) programs.

The headers may be abbreviated at will by omitting any characters at the end (e.g. L or LEV for LEVEL). The shortest possible notations are shown in Table 3-9 in **bold print**.

Many headers consist of several parts separated by colons (:), e.g. "COUNTER:RESOLUTION". Each part of the header may be individually abbreviated in this case (e.g. "CO:RES").

Some headers include the underline character (ASCII code 95 decimal) to improve readability.

All setting commands that can be assigned numeric values are listed in Table 3-9 in column "Data". Certain commands may also have a character string as data, e.g. "DEMODULATION AM" in AM demodulation mode for measuring the modulation depth.

The device-specific setting commands permit to append a unit to the number (e.g. 125.3 MHz, also 125.3E3 kHz is permissible). All permissible units are listed in Table 3-9. They may be abbreviated and written in lower-case or upper-case letters. If no unit is appended, the respective default unit is valid (Hz, dBm, dBV, %, dB, see Table 3-9).

Setting the RF counter

Table 3-9: Device-Specific commands

Setting the RF counter			
Command	**Data**	**Units**	**Remarks**
COUNTER	—	—	
:RF	—	—	
:INDICATION_MODE	ABSOLUTE DIFFERENCE RATIO PERCENT_ERROR	— — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays.
:INDICATION_MODE?	—	—	
:RESOLUTION	0.1 Hz 1 Hz 10 Hz 100 Hz	HZ KHZ MHZ GHZ	Setting the resolution of the RF counter. The measuring time increases with increasing resolution.
:RESOLUTION?	—	—	
:REFERENCE	INTERNAL EXTERNAL	— —	Switching between internal and external source of reference clock.
:REFERENCE?	—	—	
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured frequency value is available, the previous reference value remains unchanged.
	50 kHz to 1.36 GHz (opt. 5.2 GHz)	HZ KHZ MHZ GHZ	
:REF_VALUE?	—	—	Query for reference value.

Tune settings

Tune-settings			
Command	**Data**	**Units**	**Remarks**
FREQUENCY	—	—	
:RF	—	—	
:TUNE	FIXED	—	In Auto Tune mode, the latest measured value is used for setting the tuning range and the instrument is set to manual tuning. If no measured value is available when the command is being processed, the instrument remains in Auto Tune mode. This command has no effect in manual mode.
	50 kHz to 1.36 GHz (opt.5.2 GHz)	HZ KHZ MHZ GHZ	Direct setting of the tuning range.
:TUNE?	—	—	Query for tuning range.
:AUTO	ON OFF	— —	Switching between Auto Tune and Manual Tune. If Manual Tune mode is selected, the stored Tune value is referred to for setting the tuning range. A new determination of the tuning range as with the FIXED function is not made.
:AUTO?	—	—	
:SIDEBAND	NORMAL INVERSE	—	Switching between normal and inverse position.
:SIDEBAND?	—		
:DISPLAY	MEASURED_FREQUENCY TUNE_FREQUENCY	— —	Switching between the frequencies read out in the RF display: either the measured frequency or the tuning freqeuncy can be indicated. The Tune_Frequency is identical with the tuning frequency in Manual Tune mode. In Auto Tune mode the Tune Frequency corresponds to the frequency which is calculated by a special averaging procedure and used for setting the LO.
:DISPLAY?	—	—	

Receiver settings (only with FMAS)			
Command	**Data**	**Units**	**Remarks**
FREQUENCY	—	—	—
:RF	—	—	—
:TUNE	—	—	—
:RECEIVER	ON OFF		Switching the Receiver mode on. Activating the Receiver mode causes the instrument to adopt the frequency value specified under FREQUENCY:RF:TUNE as receiver frequency. Automatic frequency tuning is possible.
:RECEIVER?	—	—	
:MODE	LOW_NOISE LOW_DISTORTION	—	Setting of Receiver mode
:MODE?	—	—	Query for Receiver mode

Receiver settings (only with FMAS)			
Command	**Data**	**Units**	**Remarks**
FREQUENCY	—	—	—
:RF	—	—	—
:FILTER	FM_NARROW FM_WIDE TV_Sound	—	Selecting the IF filters in Receiver mode
:FILTER?	—	—	

Frequency query

Frequency query			
Command	**Data**	**Units**	**Remarks**
FREQUENCY	—	—	
:RF?	—	—	Query for RF

Setting the attenuator			
Command	**Data**	**Units**	**Remarks**
LEVEL		—	
:RF	FIXED	—	In Auto Level mode the currently measured value is used for setting the attenuator and the instrument is switched to Manual Level mode. If no measured value is available when the command is being processed, the instrument remains in Auto Level mode. This command has no effect in Manual Level mode.
	-37,5 dBm to + 30 dBm	DBM V W	Direct setting of the level range.The unit of the input value corresponds to the unit entered with UNITS and is absolutely necessary.
:RF?			
:AUTO	ON OFF	— —	Switching between Auto Level and Manual Level. If Manual Level mode is selected, the stored Level value is referred to for setting the level range. A new determination of the level range as with the FIXED function is not made.
:AUTO?	—	—	
:UNITS	DBM W V	— — — —	
:UNITS?	—	—	
:POWER?	—	—	This query for measured value does not switch off the LO during measurement of the RF level in order to obtain a higher measuring rate. Thus, with low levels (< 5 dBm) the measurement result can be slightly falsified due to effects of the LO on the test point. For precision measurements the POWER:RF query should be used.

Setting the type of level measurement (only with FMAS)			
Command	**Data**	**Units**	**Remarks**
LEVEL	—	—	—
:RF	—	—	—
:DISP	NORMAL TUNED	—	Switching between selective and non-selective level measurement in the FMAS. In the selective mode too, a level query is made using the command LEVEL:POWER?
:DISP?	—	—	Query for the currently selected level measurement mode.

Powermeter			
Command	**Data**	**Units**	**Remarks**
POWERMETER			
:RF	—	—	Switching to power meter operation, disabling all other measurements. Power meter mode is automatically switched off when another measured value is requested or when settings not pertinent to power meter operation are selected
:INDICATION_MODE	ABSOLUTE DIFFERENCE RATIO PERCENT_ERROR LOGARITHMIC	— — — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays.
:INDICATION_MODE?	—	—	
:RANGE	FIXED		In Auto Range mode, the currently measured value is used for setting the measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	+ 30 dBm + 12 dBm + 3 dBm - 10 dBm	DBM	Direct range setting.
:RANGE?	—	—	Query for range.
:AUTO	ON OFF	— —	Switching between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the range. A new determination of the range as with the FIXED function is not made.
:AUTO?	—	—	
:MEASUREMENT_TIME	1 s 100 ms 33 ms	S MS US NS	
:MEASUREMENT_TIME?	—	—	

Powermeter			
Command	**Data**	**Units**	**Remarks**
POWERMETER	—	—	
:RF			
:REF VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available when the command is being processed, the previous reference value remains unchanged.
	- 120 dBm to + 200 dBm	DBM	Direct definition of a reference value.
:REF VALUE?	—	—	Query for reference value.
:UNITS	DBM DBV W V	— — — —	
:UNITS?	—	—	
:CORRECTION	—		
:ATTENUATION	- 60 dBm to + 100 dBm	DBM	Information for device software as to external amplifiers or attenuators. The entered values are considered in the displayed measurement value
:ATTENUATION?	—	—	
:STATE	ON OFF	— —	Switching attenuation correction on/off.
:STATE?	—	—	
POWERMETER	—	—	
:RF?	—	—	Query for applied RF level. The LO is switched off during this measurement in order to achieve high measurement accuracy. The measuring rate is thus slightly reduced.

Powermeter (only available for FMB or FMA with B12 option (attenuator II and RF unit II)			
Command	**Data**	**Units**	**Remarks**
POWERMETER	—	—	
:RF			
:CORRECTION	—	—	
: FREQUENCY	50 kHz to 1,36 GHz (opt. 5,2 GHz)	HZ KHZ MHZ GHZ DBM	
: FREQUENCY?	—	—	Selection of the frequency point which is referred to for frequency response correction of the level measuring diode.
:STATE	ON OFF	— —	Switching on/off the frequency response correction.
:STATE?	—	—	

DEMODulation Menu

Basic Settings

Selection of demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	AM FM PM OFF	— — —	Switching between the demodulators or switching off demodulation. If demodulation is completely switched off, the measuring rates of the other measurements increase, especially in mere RF counter operation.
DEMODULATION?	—	—	
:MEASUREMENT_TIME	1 s 100 ms 33 ms	S MS US NS	
:MEASUREMENT_TIME?	—	—	

Setting the AM demodulator

Setting the AM demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:AM	—	—	
:RANGE	FIXED	—	In Auto Range mode, the currently measured value is used for setting the measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	0 % to 100 %	PCT	Direct range setting.
:RANGE?	—	—	Query for range.
:AUTO	ON OFF	— —	Switching between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the range. A new determination of the range as with the FIXED function is not made.
:AUTO?	—	—	
:INDICATION_MODE	ABSOLUTE DIFFERENCE RATIO PERCENT_ERROR LOGARITHMIC	— — — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays.
INDICATION_MODE?			

Setting the AM demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:AM	—	—	
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available when the command is being processed, the previous reference value remains unchanged.
	0 % to 100 %	PCT	Direct definition of a reference value.
:REF_VALUE?	—	—	Query for reference value.
:DEPTH?	—	—	Query for modulation depth determined by the selected detector.
:DUAL_PEAK_DEPTH?	—	—	Query for modulation depth. The measurement of the positive peak detector is output as first result, the measurement of the negative peak detector as second.
:DUAL_PEAK_RMS_DEPTH?	—	—	AM modulation depth measured by positive, negative and RMS detectors.
:DEEMPHASIS	50 µs 75 µs 750 µs	S MS US NS	Switching over or off the deemphasis filter.
	OFF	—	
:DEEMPHASIS?	—	—	Query for selected deemphasis filter.
:STATE?	—	—	Is any deemphasis filter switched on?
:PRE_DSP	ON	—	Deemphasis filter is cut out of the signal path for the modulation depth measurement
	OFF	—	The deemphasis filter is cut in the signal path for modulation depth measurements. Always the selected deemphasis filter is used for the AF output irrespective of this command.
:PRE_DSP?	—	—	

Demodulation AM (only with built-in filter option)			
Command	**Data**	**Units**	**Remarks**
DEModulation	—	—	
:AM	—	—	
:DUAL_PEAK_RMS_QUPK _DEPTH?	—	—	Query for the AM modulation depth. The results of the positive and the negative peak detector as well as those of the RMS detector and the quasi-peak detector are read out.

Controlling the outputs			
Command	**Data**	**Units**	**Remarks**
Output			
:AM	AC	—	AM output coupling.
	DC	—	
:AM?	—	—	

Setting the FM demodulator

Setting the FM demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:FM	—	—	
:RANGE	FIXED	—	In Auto Range mode, the currently measured value is used for setting the deviation measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	1 Hz to 1 MHz	HZ KHZ MHZ GHZ	Direct range setting.
:RANGE?	—	—	Query for range.
:AUTO	ON OFF	— —	Switching between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the range. A new determination of the range as with the FIXED function is not made.
:AUTO?	—	—	
:COUPLING	AC DC	— —	Switching between AC/DC coupling of FM demodulator and AF output and of FM demodulator and the other detectors.
:COUPLING?			
:DEEMPHASIS	50 µs 75 µs 750 µs OFF	S MS US NS —	Switching over or off the deemphasis filter.
:DEEMPHASIS?	—	—	Reading out selected deemphasis filter.
:MUTE_MODE	NORMAL	—	Mute circuit of the FM/PM demodulator with delayed enabling (instrument default setting).
	FAST	—	Mute circuit of the FM/PM demodulator with a minimally delayed enabling.
:MUTE_MODE?	—	—	

Setting the FM demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:FM	—	—	
:DEEMPHASIS	—	—	
:STATE?	—	—	Is any deemphasis filter switched on?
:PRE_DSP	ON	—	The deemphasis filter is cut out of the signal path for the frequency deviation measurement.
	OFF		The deemphasis filter is cut in the signal path for the frequency deviation measurement. Always the selected deemphasis filter is used for the AF output irrespective of this command.
:PRE_DSP?	—	—	
:INDICATION_MODE	ABSOLUTE DIFFEREMCE RATIO PERCENT ERROR LOGARITHMIC	— — — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays.
:INDICATION_MODE?	—	—	
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available when the command is being processed, the previous reference value remains unchanged.
	1 Hz to 1 MHz	HZ KHZ MHZ GHZ	Direct definition of a reference value.
:REF_VALUE?	—	—	Query for reference value.
:DEVIATION?	—	—	Query for frequency deviation measured by the selected detector
:DUAL_PEAK_DEVIATION?	—	—	Query for frequency deviation. The measurement of the positive peak detector is output as first result, the measurement of the negative peak detector as second.
:DUAL_PEAK_RMS_DEVIATION?	—	—	FM deviation, measured by positive and negative peak detectors and RMS detector.

Setting the FM demodulator (only with built-in DSP UNIT option)			
Command	**Data**	**Unitts**	**Remarks**
DEMODULATION :FM :QUOTIENT_AM_FM :QUOTIENT_AM_FM? :NORMALIZED_DEPTH?	 ON OFF — —	 — PTC/kHz	 Switching on/off the quotient-measurement AM/FM Query for the AM/FM quotient

Setting the FM demodulator (only with built-in filter option / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
DEMODULATION :FM :DUAL_PEAK_RMS_QUPK_DEVIATION?	— — —	— — —	 FM deviation, measured by positive and negative peak detectors as well as by RMS detector.

Controlling the outputs			
Command	**Data**	**Units**	**Remarks**
OUTPUT :FM :NOISE_FILTER :NOISE_FILTER?	— — ON OFF	— — — —	 Connecting a filter ahead of the FM output.

Setting the PM demodulator

Setting the PM demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:PM	—	—	
:RANGE	FIXED	—	In Auto Range mode, the currently measured value is used for setting the modulation measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	0 RAD to 700 * PI RAD	RAD	Direct range setting.
:RANGE?	—	—	Query for range.
:AUTO	ON OFF	— —	Switching between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the deviation range. A new determination of the range as with the FIXED function is not made.
:AUTO?	—	—	
:INDICATION_MODE	ABSOLUTE DIFFERENCE RATIO PERCENT_ERROR LOGARITHMIC	— — — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays.
:INDICATION_MODE?			
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available when the command is being processed, the previous reference value remains unchanged.
	0 RAD to 700 * PI RAD—	RAD	Direct definition of a reference value.
:REF_VALUE?	—	—	Query for reference value.
:DEVIATION?	—	—	Query for phase deviation, measured by the selected detector.
:DUAL_PEAK_DEVIATION?	—	—	Query for phase deviation. The measurement of the positive peak detector is output as first result, the measurement of the negative peak detector as second.

Setting the PM demodulator			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:PM	—	—	
:DUAL_PEAK_RMS_DEVIATION?	—	—	Phase deviation, measured by positive and negative peak detectors and by the RMS detector.

Setting the PM demodulator (only with built-in filter option)			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:PM	—	—	
:DUAL_PEAK_RMS_QUPK_DEVIATION?	—	—	Phase deviation, measured by positive and negative peak detectors as well as by RMS detector and quasi-peak detector.
:LOW_FREQ	ON OFF	— —	Connecting a PM lowpass filter.
:LOW_FREQ?	—	—	

Demodulation (only with AF Analyzer/DSP Unit FMA-B8)			
Command	**Data**	**Units**	**Remarks**
DEMODULATION	—	—	
:PM	—	—	
:PHASE_NOISE	ON OFF	—	Switching PM noise measurement on/off
:PHASE_NOISE?	—	—	
:CARRIER_OFFSET	10 Hz to 150 kHz	HZ KHZ	Setting the carrier offset
:CARRIER_OFFSET?	—	—	Query of phase noise
:DBC?	—	dBc/1 Hz	Switching AM noise measurement on/off
:AM	—	—	Setting the carrier offset
:NOISE	ON OFF	— —	
:NOISE?	—		
:CARRIER_OFFSET	10 Hz to 150 kHz	HZ KHZ	Query of carrier offset
:CARRIER_OFFSET?	—	—	Query of AM noise
:DBC?	—	dBc/1 Hz	

Setting the stereo decoder

Demodulation (only with built-in stereo decoder option / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
STEREO_DECODER	ON OFF	— —	Switching on/off the internal stereo decoder.
STEREO_DECODER?	—	—	
:INPUT	INTERNAL	—	Switching the internal FM demodulator to the stereo decoder input.
	EXTERNAL	—	Applying an external stereo signal to the input of the stereo decoder.
:INPUT?	—	—	Query for signal source applied to the stereo decoder.
:CHANNEL	LEFT_CHANNEL RIGHT_CHANNEL M MPX S PILOT AM_57KHZ CHARRIER57KHZ_	— — — — — — — —	Command for selecting a component of the stereo signal.
:CHANNEL?	—	—	
:DEEMPHASIS	50 µs 75 µs	S MS US NS	Switching deemphasis filter on/off.
	OFF	—	
:DEEMPHASIS?	—	—	Query for selected deemphasis filter.
:STATE?	—	—	Is any deemphasis filter switched on?

Demodulation (only with built-in stereo decoder / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
STEREO_DECODER	—	—	
:RANGE	FIXED	—	In Auto Range mode, the currently measured value is used for setting the demodulation range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	1 Hz to 100 kHz	HZ V DBM	Direct range setting. The unit of the range value corresponds to the unit entered with UNITS and is absolutely necessary.
:RANGE?	—	—	Query for range.
:AUTO	ON OFF	— —	Switching between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the range. A new determination of the range as with the FIXED function is not made.
:AUTO?			
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available when the command is being processed, the previous reference value remains unchanged.
	1 Hz to 1 MHz	HZ V DBM	Direct definition of a reference value.T he unit of the reference value corresponds to the unit entered with UNITS and is absolutely necessary.
:REF_VALUE?	—	—	Query for reference value.
:INDICATION_MODE	ABSOLUTE DIFFERNECE RATIO PERCENT_ ERROR LOGARITHMIC	— — — — —	Indication mode for measuring result display. The reference value set via REV_VALUE is used for all relative displays.
:INDICATION_MODE?			

Demodulation (only with built-in stereo decoder / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
STEREO_DECODER	—	—	
:SENSITIVITY_EXTERN	FIXED	—	In Auto Range mode, the currently measured value is used for setting the measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	-14 dBm/ 40 kHz to + 14 dBm/ 40 kHz	DBM_KHZ	Indication of the gradient of the demodulation characteristic.
:SENSITIVITY_EXTERN?	—	—	Query for gradient
:AUTO	ON OFF	—	Switching on/off automatic adjustment for achieving the standard level (-9.5 dBm) for the pilot tone.
:AUTO?	—	—	
:RF	—	—	
:STATE	ON OFF	— —	Switching on/off the RF unit, while measurements are performed by the stereo decoder. Switching off the RF unit increases the measuring rates of the other measurements. (Only of interest with use of an external FM demodulator).
:STATE?	—	—	

Demodulation (only with built-in stereo decoder / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
STEREO_DECODER	—	—	
:UNITS	MV DBM HZ	— — —	
:UNITS?	—	—	
:DEVIATION?	—	—	Query for deviation. The value measured by the detector selected by means of the DETECTOR command is read out as measuring result. The channel selected via the CHANNEL command is measured.
:LEFT_CHANNEL?	—	—	The subsequent commands additionally indicate the desired channel.
:RIGHT_CHANNEL?			
:M?			
:MPX?			
:S?			
:PILOT?			
:CARRIER_57KHZ?			
:DUAL_PEAK_DEVIATION?	—	—	Query for deviation. The measuring results of the positve and the negative peak detector are output. The measurement is performed at the channel selected via the CHANNEL command.
:LEFT_CHANNEL?			The subsequent commands additionally indicate the desired channel.
:RIGHT_CHANNEL?			
:M?			
:MPX?			
:S?			
:PILOT?			
:CARRIER_57KHZ?			
:DUAL_PEAK_RMS_DEVIATION?	—	—	Same command as above. The measuring result of the RMS detector is additionally read out.

Demodulation (only with built-in stereo decoder / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
STEREO_DECODER	—	—	
:DUAL_PEAK_RMS_DEVIATION	—	—	
:LEFT_CHANNEL?			The subsequent commands additionally indicate the desired channel.
:RIGHT_CHANNEL?			
:M?			
:MPX?			
:S?			
:PILOT?			
:CARRIER_57KHZ?			
:AM_57KHZ_DEPTH	—	—	Query for AM modulation depth of the ARI signal. The measuring result of the detector selected via the DETECTOR command is read out.
:NOISE_FILTER	ON OFF	— —	
:NOISE_FILTER?	—	—	Switching noise filter on/off.

Demodulation (only with built-in stereo decoder and filter option)			
Command	**Data**	**Units**	**Remarks**
STEREO_DECODER	—	—	
:DUAL_PEAK_RMS_QUPK_DEVIATION?	—	—	Query for deviation. The measuring results of the positive and the negative peak detector as well as those of the RMS detector and the quasi-peak detector are read out. Measurements are performed at the channel selected via the CHANNEL command.
:LEFT_CHANNEL?	—	—	The subsequent commands additionally indicate the desired channel.
:RIGHT_CHANNEL?	—	—	
:M?	—	—	
:MPX?	—	—	
:S?	—	—	
:PILOT?	—	—	
:CARRIER_57KHZ?	—	—	

Demodulation (only with FMAV)			
Command	**Data**	**Units**	**Remarks**
DEModulation	—	—	
:AVionics?			
:BASEband	ON OFF		Switching on and off baseband mode. Attention. This mode can only be selected with ILS and VOR measurements.
:BASEband?	—	—	
:AM_BB_SENSITIVITY?	100µV/100% to 100V/100%	V MV UV	Direct display of sensitivity of AM modulator. = peak voltage of carrier
:AM_BB_SENSITIVITY?	— VOR ILS TACAN	— —	Query for the currently selected measurement mode
:VOR :SIGNAL	—	—	
	M_30 Hz M_ID M_9_96 kHz DEV_9_96 kHz		Setting the current measurement mode in the VOR menu. Measurement is started only after a measured value query (see below)
:SIGNAL?			
:DEPTH?	—	PCT	Query for the modulation depth of the VOR signal component selected via SIGNAL
:AM_MOD_FREQUENCY?	—	HZ	Query for the AM modulation frequency
:FM_MOD_FREQUENCY?	—	HZ	Query for the FM modulation frequency
:DEViation?	—	HZ	Query for FM deviation of the 9.96-kHz component of the VOR signal.
:PHASE_MEASUREMENT	ON OFF	—	Switching on and off VOR phase measurement
:PHASE_MEASUREMENT?			
:PHASE?	—	Degree	Query for the VOR phase value
:ILS :SIGNAL	— M_90 Hz M_150 Hz M_ID M_ILS_SUM DDM	— —	Setting the current measurement mode in the ILS menu. Measurement is started only after a measured value query (see below)
:SIGNAL?			
:DEPTH?	—	PCT	Query for the modulation depth of the ILS signal component selected via SIGNAL
:DDM?	—	—	Query for the difference in modulation depth between the 90-Hz and 150-Hz ILS signal component.
:SDM?	—	PCT	Query for the total modulation depth of the 90-Hz and 150-Hz signal components of the ILS signal

Demodulation (only with FMAV)			
Command	**Data**	**Units**	**Remarks**
DEModulation	—	—	
:AVionics?	—	—	
:ILs	—	—	
:DIstortion_ils	DIST_FI SUMME_DIST_MAX OFF	—	Switching on or off the ILS distortion measurement and selection of the intermodulation products. All the other ILS measurements are switched off during distortion measurement.
:DIstortion_ils?			
:FRequency	10 Hz ... 1.5 kHz	Hz	Setting of a specified intermodulation frequency (FI)
:FRequency?	—	—	
:MAx_frequency	10 Hz ... 1.5 kHz	Hz	Setting of the maximum intermodulation frequency (Fmax)
:MAx_frequency?	—	—	
:DIst_fi?	—	PCT	Query for the measured value of individual ILS distortion measurement
:SUmme_dist_fmax?	—	PCT	Query for the measured value of the total ILS distortion measurement
:TAcan	—	—	
:SIgnal	M_15 Hz M_135 Hz M_TAcan_sum	—	Setting of the current type of measurement in the TACAN menu. Start is only effected through a measured-value poll (see below).
:SIgnal?			
:DEpth?	—	PCT	Poll of the modulation depth of the signal component of the TACAN signal selected via SIGNAL.
:AM_mod_frequency?	—	Hz	Poll of the AM modulation frequency of the TACAN signal component selected via SIGNAL.
:PHASE_Measurement	ON OFf	—	Switching on or off of the TACAN phase measurement.
:PHASE_Measurement?			
:PHASE?	—	Degree	Polling the TACAN phase value.

Setting the AF counter

Setting the AF counter			
Command	**Data**	**Units**	**Remarks**
COUNTER:	—	—	
:AF	ON OFF	— —	
:AF?	—	—	
:INDICATION_MODE	ABSOLUTE DIFFERENCE RATIO PERCENT_ERROR	— — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays.
:INDICATION_MODE?	—	—	
:MEASUREMENT_TIME	1 s 100 ms 33 ms	S MS US	
:MEASUREMENT_TIME?	—	—	
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available when the command is being processed, the previous reference value remains unchanged.
	1 Hz to 300 kHz	HZ KHZ MHZ GHZ	Direct definition of a reference value.
:REF_VALUE?	—	—	Query for reference value.

Frequency query

Frequency query			
Command	**Data**	**Units**	**Remarks**
FREQUENCY	—	—	
:AF?	— —	—	Query for AF applied to the channel selected. In contrast to other query commands for an AF measuring value this command needs the signal source to be enabled via special setting commands. Thus, more universal query routines are possible; however, the instrument must be correctly set by the programmer.
:AM?	—	—	Frequency of the AM-demodulated AF signal.
:FM?	—	—	Frequency of the FM-demodulated AF signal.
:PM?	—	—	Frequency of the PM-demodulated AF signal.
:EXTERNAL?	—	—	Frequency of the signal applied to the voltmeter input.

Frequency query (only with FM stereo decoder option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
FREQUENCY	—	—	
:AF	—	—	
:STEREO_DECODER	—	—	
:LEFT_CHANNEL?	—	—	Query for AF frequency of the left stereo channel.
:RIGHT_CHANNEL?	—	—	Query for AF frequency of the right stereo channel.
:M?	—	—	Query for AF frequency of the M-signal applied to the stereo decoder
:MPX?	—	—	Query for the AF frequency of the MPX-signal applied to the stereo decoder (not suitable with wanted modulation, since MPX is a mix of signals).
:S?	—	—	Query for AF frequency of the S-signal applied to the stereo decoder.
:PILOT?	—	—	Query for frequency of the pilot tone applied to the stereo decoder.
:CARRIER_57KHZ?	—	—	Query for RDS carrier frequency.
:ARI_57KHZ?	—	—	Query for frequency of the AM-demodulated ARI signal.

Setting the distortion meter (only with distortion meter option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
DISTORTION_METER	ON OFF	—	Switching on/off distortion measurement
DISTORTION_METER?	—	—	
:UNITS	DB	—	Activate SINAD measurement; Readout in dB
			Activate distortion measurement;
	DIST_DB	—	Readout in dB
	PCT	—	Readout in %
:UNITS?	—	—	
:RANGE	FIXED	—	In Auto Range mode, the currently measured value is used for setting the measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	0 dB to 80 dB 0 % to 100 %	DB PCT	Direct range setting.
:RANGE?	—	—	Query for range.

Setting the distortion meter (only with distortion meter option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
DISTORTION_METER	—	—	
:RANGE	—	—	
:AUTO	ON OFF	— —	Switching between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the range. A new determination of the range as with the FIXED function is not made.
:AUTO?			
:TUNE	FIXED	—	In Auto Tune mode, the currently measured value is used for setting the tuning range and the instrument is switched to Manual Tune mode. If no measured value is available when the command is being processed, the instrument remains in Auto Tune mode. This command has no effect in Manual Tune mode.
	10 Hz to 100 kHz	HZ KHZ	Direct setting of tuning range.
:TUNE?	—	—	Query for tuning range.
:AUTO	ON OFF	—	Switching between Auto Tune and Manual Tune. If Manual Tune mode is selected, the stored Tune value is referred to for setting the range. A new determination of the tuning range as with the FIXED function is not made.
:AUTO?	—	—	
:DISTORTION?	—	DIST_DB DB PCT	Query for distortion of the AF channel selected. In contrast to other commands for distortion query this command needs the signal source to be enabled via special setting commands. Thus, more universal query routines are possible; however, the correct channel must be selected by the programmer.
:AM?	—	DIST_DB DB PCT	Distortion of the signal generated by AM demodulation.

Setting the distortion meter (only with distortion meter option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
DISTortion_METER	—	—	
:DIStortion	—	—	
:FM?	—	DIST_DB DB PCT	Distortion of the FM-demodulated signal.
:PM?	—	"	Distortion of the PM-demodulated signal.
:EXTernal	—	"	Distortion of the signal applied to the voltmeter input.

Distortion meter (only with distortion meter option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
DISTortion_METER	—	—	
:DIStortion	—	—	
:STEreo_DECODER :LEFt_CHANNEL?	—	DIST_DB DB PCT	Distortion of signal applied to the left channel of the stereo decoder.
:RIGht_CHANNEL?	—	"	Distortion of signal applied to the right channel of the stereo decoder.
:M?	—	"	Distortion of the M-signal applied to the stereo decoder.
:S?	—	"	Distortion of the S-signal applied to the stereo decoder.

Distortion meter (only with DSP UNIT option fitted)			
Command	**Data**	**Units**	**Remarks**
DISTortion_METER	—	—	
:MODe	TOTAL_PLUS_N SELective	— —	Selection between normal (analog) and selective (digital) distortion measurement
:MODe?	—	—	
:SELective	K2 SUMME_K2_KN		Setting the operating mode of selective distortion measurement (K2 or THD)
:SELective?	—		
:HARmonic	> = 2	—	Entry of the harmonic to be analyzed (i)
:HARmonic?	—	—	
:MAX_HARMONIC	> = 2	—	Entry of the maximum harmonic to be analyzed (n)
:MAX_HARMONIC	—	—	

Intermodulation

Setting the distortion meter (only with distortion meter option fitted or with FMAB)			
Command	**Data**	**Units**	**Remarks**
INTERMODULATION	ON OFF	—	Switching on/off intermodulation measurement
INTERMODULATION?	—	—	
:MODE	INTERMOD TWO_TONE_FACT	—	Setting the intermodulation mode
:MODE?	—	—	
:TYPE	D2 D3	—	Selection of the intermodulation products
:TYPE?	—	—	
:UNITS	PTC DB	—	Selection of unit for indication of the intermodulation value
:UNITS?	—	—	
:TUNE	—	—	
:TONE_ONE	1 mHz to 100 kHz	HZ	Setting the tune frequency for tone 1
:TONE_ONE?	—	—	
:TONE_TWO	1 mHz to 100 kHz	HZ	Setting the tune frequency for tone 2
:TONE_TWO?	—	—	
:AM?	—	PTC DB	Intermodulation of the AM-demodulated signal
:FM?	—	PTC DB	Intermodulation of the FM-demodulated signal
:PM?	—	PTC DB	Intermodulation of the PM-demodulated signal
:EXTERNAL?	—	PTC DB	Intermodulation of the signal applied to the voltmeter input.

Intermodulation (only with DSP UNIT and stereo-decoder options fitted)			
Command	**Data**	**Units**	**Remarks**
INTERMODULATION	—	—	
:STEREO_DECODER	—	—	
:LEFT CHANNEL?	—	PCT DB	Intermodulation of the signal applied to the left stereo-decoder channel.
:RIGHT CHANNEL?	—	PCT DB	Intermodulation of the signal applied to the right stereo-decoder channel.
:M?	—	PCT DB	Intermodulation of the M-signal applied to the stereo decoder.
:S?	—	PTC DB	Intermodulation of the S-signal applied to the stereo decoder.

Intermodulation (only with DSP UNIT and calibrator options fitted)			
Command	**Data**	**Units**	**Remarks**
INTERMODULATION	—	—	
:TUNE	EXTERNAL INTERNAL	—	Setting of the tuner mode
:TUNE?	—		With INTERNAL, the AF frequencies entered in the generator menu are referred to as tune frequencies.

Special Function-Menu
Display Parameter

Setting the display parameters			
Command	**Data**	**Units**	**Remarks**
DISPlay	—	—	
:BRIGhtness	1 % to 100 %	PCT	
:BRIGhtness?	—	—	
:CONTrast	2 % to 100 %	PCT	
:CONTrast?	—	—	
:BARgraph	ON	—	
	OFF	—	
:BARgraph?	—	—	
:PEAK_hold	ON	—	
	RESet	—	
	OFF	—	
:PEAK_hold?	—	—	
:FIll	ON	—	
	OFF	—	
:FIll?	—	—	
:MOde	SYMmetric	—	Symmetric scaling of bargraph.
	UNSymmetric	—	Asymmetric scaling of bargraph.
	AUto	—	The type of scaling is switched over by the instrument firmware depending on the polarity sign of the displayed measurement value
:MOde?	—	—	

Voltmeter

Voltmeter			
Command	**Data**	**Units**	**Remarks**
VOLTmeter	ON	—	Switching the voltmeter on/off.
	OFF	—	
VOLTmeter?	—	—	
VOLTmeter	—	—	
:RF	—	—	
:STATe	ON	—	Switching on measurements in the RF unit.
	OFF	—	Switching off measurements in the RF unit, thus increasing the measuring rate of the voltmeter.
:STATe?	—	—	
:COUPling	—	—	Query for state of measurements in the RF unit (switched on/off).
		—	Switchover between AC/DC coupling of the voltmeter input.
:COUPling?	AC		
:INPut	DC		
	BALanced UNBalanced	—	Selection of balanced or unbalanced voltmeter input.
:INPut?	—	—	

Voltmeter			
Command	**Data**	**Units**	**Remarks**
VOLTMETER			
:MEASUREMENT_TIME	1 s 100 ms 33 ms	S MS	
:MEASUREMENT_TIME?	—	—	
:RANGE	FIXED	—	In Auto Range mode, the currently measured value is used for setting the voltage measuring range and the instrument is switched to Manual Range mode. If no measured value is available when the command is being processed, the instrument remains in Auto Range mode. This command has no effect in Manual Range mode.
	100 µV to 100 V	V MV UV	Direct range setting
:RANGE?	—	—	Query for measuring range.
:AUTO	ON OFF	—	Switchover between Auto Range and Manual Range. If Manual Range mode is selected, the stored Range value is referred to for setting the range. A new range determination as with the FIXED function is not made.
:AUTO?			
:INDICATION_MODE	ABSOLUTE DIFFERENCE RATIO PERCENT_ERROR LOGARITHMIC	— — — — —	Indication mode for measuring result display. The reference value set via REF_VALUE is used for all relative displays
:INDICATION_MODE?	—	—	
:REF_VALUE	FIXED	—	The currently measured value is defined as reference value for relative display of the measuring result. If no measured value is available while the command is being processed, the previous reference value remains unchanged.
	1 nV to 100 V	V MV UV	Direct definition of a reference value.
:REF_VALUE?	—		Query for reference value.

Voltmeter			
Command	**Data**	**Units**	**Remarks**
VOLTMETER	—	—	
:**V**OLTAGE**?**	—	—	Query for voltage measured by the selected detector.
:**DUAL_PEAK_V**OLTAGE**?**	—	—	Query for voltage. The measurement of the positive peak detector is read out as first result, the measurement of the negative peak detector as second.
:**DUAL_PEAK_RMS_V**OLTAGE**?**	—	—	Voltage applied to the voltmeter input, measured by the positive and the negative peak detector and by the RMS detector.
:**A**TTENUATION_20DB	**ON** **OF**F	— —	Switching on/off the internal attenuator at the voltmeter input. This command only applies for Manual Range mode. The attenuator is switched off in Auto Range mode.
:**A**TTENUATION_20DB**?**	—	—	Switching over or off the deemphasis filter.
:**DE**EMPHASIS	50us 75us 750us OFF	S MS US NS	
:**DE**EMPHASIS**?**	—	—	Query for selected deemphasis filter.
:**S**TATE**?**	—	—	Is any deemphasis filter switched on?
:**P**RE_DSP	**ON**	—	The deemphasis filter is cut out of the signal path for frequency deviation measurement.
	OFF	—	The deemphasis filter is cut in the signal path for frequency deviation measurement. The selected deemphasis filter is always used for the AF output, independent of this command.
:**P**RE_DSP**?**	—	—	

Voltmeter (only with filter option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
VOLTMETER	—	—	Voltage at the voltmeter input, measured by the positive and the negative peak detector as well as by the RMS detector and the quasi-peak detector.
:**DUAL_PEAK_RMS_QUPK_V**OLTAGE**?**	—	—	

Filter-Menu

Basic Settings

Filter settings			
Command	**Data**	**Units**	**Remarks**
FILTER	---	—	
:LOWPASS	3 kHz 23 kHz 100 kHz	HZ KHZ	Switching lowpass filter over/off.
	OFF	—	
:LOWPASS?	—	—	Reading out the selected lowpass filter.
:STATE?	—	—	Is any lowpass filter switched on?
:HIGHPASS	10 Hz 20 Hz 300 Hz	HZ KHZ	Switching highpass filter over/off.
	OFF	—	
:HIGHPASS?	—	—	Reading out the selected highpass filter.
:STATE?	—	—	Is any highpass filter switched on?

Settings with Filter Card Option Fitted

Filter settings (only with filter option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
FILTER	—	—	
:AM_LOWPASS	ON OFF	— —	Special lowpass filter of high attenuation rate for measurement at AM radio transmitters. Cutoff frequency = 4.5 kHz.
:AM_LOWPASS?	—	—	
:COUPLED FILTER	—	—	Definition of a further filter, used only in conjunction with the AM_LOWPASS.
:HIGHPASS	10 Hz 20 Hz 300 Hz	HZ KHZ	
	OFF	—	
:HIGHPASS?	—	—	Query for selected highpass filter?
	—	—	
:STATE?	—	—	Is any highpass filter switched on?
:CCIR	WEIGHTED UNWEIGHTED OFF	— — —	
:CCIR?	—	—	

Filter settings (only with filter card option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
FILTER	—	—	
:BESSEL_LOWPASS	30 kHz 120 kHz OFF	HZ KHZ —	
:BESSEL_LOWPASS?			Query for selected Bessel lowpass filter.
:STATE?			Is any Bessel lowpass filter switched on?
:LOWPASS	5 Hz OFF	HZ KHZ —	Switching on the 5-Hz lowpass (for DC measurement)
:LOWPASS?			Lowpass filter switched on

Filter settings (only with filter card option fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
FILTER	—	—	
:CCITT	ON OFF	— —	
:CCITT?	—	—	
:CCIR	WEIGHTED UNWEIGHTED OFF	— — —	
:CCIR?	—	—	Query for selected CCIR filter.
:EXTERNAL	ON OFF	— —	
:EXTERNAL?	—	—	
:GAIN	0 dB 6 dB	DB	Additional gain of 6.02 dB is switched in to compensate for the attenuation of an external passive filter.
:GAIN?	—	—	Query for additional gain.

Settings for User-specific Filters

Filter settings (only with filter option and user-specific filters fitted / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
FILTER			
:SPECIAL_1	ON OFF	— —	
:SPECIAL_1?	—	—	
:SPECIAL_2	ON OFF	— —	
:SPECIAL_2?	—	—	

Filter settings (only with optional AF Analyzer/DSP Unit FMA-B8)			
Command	**Data**	**Units**	**Remarks**
FILTER	—	—	—
:TUNABLE_BANDPASS	ON OFF	—	Switching the tunable bandpass on/off
:TUNABLE_BANDPASS?	—	—	
:TUNE_FREQUENCY	10 Hz ... 150 kHz	HZ KHZ	Switching the tunable bandpass on/off
:TUNE_FREQUENCY?	—	—	—

Detector Menu

Standard Detectors

Selecting a detector			
Command	**Data**	**Units**	**Remarks**
DETECTOR	POS_PEAK NEG_PEAK AVERAGE_PEAK MAXIMUM_PEAK RMS SQR_RMS SAMPLING	— — — — — — —	
DETECTOR?	—	—	
:PEAK_HOLD	ON RESET OFF	— — —	Influences the RMS detector and the quasi-peak detector in case of repeated queries. If Peak Hold is switched on, the maximum values since the last reset are output.
:PEAK_HOLD?	—	—	

Detectors with Filter Card Option

Selecting a detector (only with built-in filter option / standard with FMAB)			
Command	**Data**	**Units**	**Remarks**
DETECTOR	QUASI_PEAK	—	
	SQR_QUASI_PEAK	—	
DETECTOR?			

CALIBRATE Menu

Calibrating the instrument			
Command	**Data**	**Units**	**REmarks**
CALIBRATION	ALL	—	All adjustments listed are carried out.
	VOLTMETER	—	For this adjustment, the unbalanced input must be short-circuited and the balanced input open.
	DETECTOR	—	
:AUTO	ON	—	.Switching on the temperature-dependent automatic adjustment.
	OFF	—	.Switching off the temperature-dependent automatic adjustment.
:AUTO?	—	—	
:CORRECTION	ON	—	Switches on the automatic transfer of the values determined during calibration to the measurements under way.
	OFF	—	Prevents the automatic transfer of the correction values to the measurements under way.
:CORRECTION?			

Instrument Calibration (Only with stereo decoder option)			
Command	**Data**	**Units**	**Remarks**
CALIBRATION	STEREO_DECODER	—	

Calibrating the instrument (only with calibrator option fitted)			
Command	**Data**	**Units**	**Remarks**
CALIBRATION	AM	—	
	FM_PM	—	
	VOLTMETER	—	The amplification factors of the signal paths are measured in addition to the offset measurements (see above).
	DETECTOR	—	The amplification factors of the signal paths are measured in addition to the offset measurements (see above).
	ALL	—	The amplification factors of the signal paths are measured in addition to the offset measurements (see above).

Instrument Calibration (Only with attenuator 2 option, ed. FMB)			
Command	**Data**	**Units**	**Remarks**
CALIBRATION	POWERMETER	—	RF input must be open-circuited.

Signal Generator (Only with calibrator option)			
Command	**Data**	**Units**	**Remarks**
GENERATOR	ON OFF	— —	Activate generator operation Switch off generator operation
GENERATOR?	—	—	
:MODE	AF RF_UNMOD MPX AVIONICS	—	Setting of generator operating mode
:MODE?	—	—	
:UNITS_AF	V V_PEAK HZ PCT DBM_600	—	Definition of the AF units. Switchover into operating state FM_ or AM_EXTERN is linked to the selection of units Hz or PCT.
:UNITS_AF?	—	—	
:AM_SENSITIVITY	0.001%/mV to 1%/mV	PCT_MV	Definition of the external AM sensitivity
:AM_SENSITIVITY?	—	—	
:FM_SENSITIVITY	0.001 kHz/mV to 1 kHz/mV	KHZ_MV	Definition of the external FM sensitivity
:FM_SENSITIVITY?	—	—	
:DESTINATION	AM FM_NORMAL FM_SPECIAL AF	—	Setting of destination. The selection of another operating mode may reduce the AF level, since, in this case, the hardware conditions change which must be adhered to.
:DESTINATION?	—	—	
:IMPEDANCE	LOW MIDDLE HIGH	—	Setting of output impedance
:IMPEDANCE?	—	—	
:SYMMETRY	BALANCED UNBAL1 UNBAL2 UNBAL1_2 AF_OFF	—	Setting of output symmetry
:SYMMETRY?	—	—	

Signal Generator (Only with calibrator option)			
Command	**Data**	**Units**	**REmarks**
GENERATOR			
:AF_ONE_TONE	**ON** **OFF**	—	Switching on or off the first tone of the AF generator
:AF_ONE_TONE?	—	—	
:FREQUENCY	0Hz to 100kHz	HZ KHZ	Input of the frequency of tone 1 of the AF generator
:FREQUENCY?	—	—	
:LEVEL	0 to 100%	PCT DBM HZ V	Input of the level of tone 1 of the AF generator. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum level sum of the individual signal components.
:LEVEL?	—	—	
:AF_TWO_TONE	**ON** **OFF**	—	Switching on or off tone 2 of the AF generator
:AF_TWO_TONE?	—	—	
:FREQUENCY	0Hz to 100kHz	HZ KHZ	Input of the frequency of tone 2 of the AF generator
:FREQUENCY?	—	—	
:LEVEL	0 to 100%	PCT DBM HZ V	Input of the level of tone 2 of the AF generatorSelection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum level sum of the individual signal components.
:LEVEL?	—	—	
:RF_UNMOD	—	—	
:LEVEL	-50 to -4dBm	DBM DBV W V	Input of the level of the RF signal (only in the case of unmodulated RF signal)
:LEVEL?	—	—	
:UNITS	**DBM** **DBV** **W** **V**	—	Definition of the level unit for the RF signal
:UNITS?	—	—	

Signal Generator (Only with calibrator option)			
Command	**Data**	**Units**	**Remarks**
GENERATOR			
:MPX	—	—	
:CHANNEL	ON OFF	—	Switching on or off the sidebands
:CHANNEL?	—	—	
:CONFIGURATION	L_ONLY R_ONLY L_EQU_R L_INV_R	—	Define configuration of the two stereo channels
:CONFIGURATION?	—	—	
:FREQUENCY	10 Hz to 15 kHz	HZ KHZ	Input of the frequency for the channel configuration indicated above
:FREQUENCY?	—	—	Input of the level for the channel configuration defined above. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum level sum of the individual signal components.
:LEVEL	0 to5 V	V DBM HZ	
:LEVEL?	—	—	
:PREEMPHASIS	50 µs 75 µs OFF	US	Setting of the channel preemphasis
:PREEMPHASIS?	—	—	
:STATE?	ON OFF		Poll whether the preemphasis is activated.
:PILOT	ON OFF	—	Input of the phase of the pilot tone
:PILOT?	—	—	
:PHASE	-10 to +10 deg	DEG	Switching on or off the 57-kHz carrier
:PHASE?	—	—	
:LEVEL	0 to 5 V	V DBM HZ	Entry of the pilot-tone level. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum level sum of the individual signal components.
:LEVEL?	—	—	

Signal Generator (Only with calibrator option)			
Command	**Data**	**Units**	**Remarks**
GENERATOR			
:MPX	—	—	
:CARRIER	ON OFF	—	Switching on or off the 57-kHz-carrier (only possible without MPX components möglich)
:CARRIER?	—	—	
:PHASE	-30 to +30 deg	DEG	Input of the phase of the57-kHz carrier
:PHASE?	—	—	
:LEVEL	0 to 5 V	V DBM HZ	Input of the 57-kHz-carrier. Selection of the unit correponds to the unit entered with DESTINATION or UNITS__AF and is absolutely necessary. The system monitors adherence to the maximum level sum of the individual signal components.
:LEVEL?	—	—	

Signal Generator (only with Calibrator option and FMAV)			
Command	**Data**	**Units**	**Remarks**
GENERATOR			
:AVIONICS	VOR ILS TACAN	—	Input of the operating mode of the Avionics generator
:AVIONICS?	—	—	
:VOR	—	—	
:CONFIGURATION	NORMAL	—	Setting of the VOR standard configuration
:CONFIGURATION?	NORMAL USER	—	Poll of the current configuration state
:SUBCARRIER	ON OFF	—	Switching on or off the 9.96-kHz carrier
:SUBCARRIER?	—	—	
:DEVIATION	0 to 700 Hz OFF	HZ KHZ	Switching on or off the 9.96-kHz carrier
:DEVIATION?	—	—	
:STATE?	ON OFF	—	Query for switch-on state of modulation of 9.96-kHz carrier.
:DEPTH	0 to 100%	PCT V DBM	Setting of the deviation of the 9.96-kHz carrier. Selection of the unit correponds to the unit entered with DESTINATION or UNITS__AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	
:FREQUENCY	9.5 to 10.5 kHz	HZ KHZ	Setting of the frequency of the 9.96-kHz carrier
:FREQUENCY?	—	—	
:VAR30	ON OFF		Switching on or off the phase-variable 30-Hz tone
:VAR30?	—	—	
:DEPTH	0 to 100%	PCT V DBM	Definition of the modulation depth of the 30-Hz tone. Unit depending on DESTINATION Selection of the unit correponds to the unit entered with DESTINATION or UNITS__AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	

Signal Generator (Only with calibrator and FMAV option)			
Commands	**Data**	**Units**	**Remarks**
GENERATOR			
:AVIONICS			
:VOR			
:FREQUENCY	25 to 35 Hz	HZ KHZ	Setting of the frequency of the 30-Hz tone
:FREQUENCY?	—	—	
:ID	ON OFF		Switching on or off the ID
:ID?	—	—	
:DEPTH	0 to 100%	PCT V DBM	Definition of the modulation depth of the ID. Unit depending on DESTINATION. Selection of the unit correponds to the unit entered with DESTINATION or UNITS__AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	
:FREQUENCY	300 Hz to 4 kHz	HZ KHZ	Setting of the frequency of the ID
:FREQUENCY?	—	—	
:PHASE	0 to 360 deg	DEG	Setting the VOR phase
:PHASE?	—	—	

Signal Generator (Only with calibrator and FMAV option)			
Command	**Data**	**Units**	**Remarks**
GENERATOR :AVIONICS			
:ILS	—	—	
:CONFIGURATION	GLIDE_NORM LOCALIZER_NORM	—	Setting the ILS standard configuration
:CONFIGURATION?	GLIDE_NORM LOCALIZER_NORM USER	—	Poll of the current configuration state
:DEPTH	0 to 100%	PCT V DBM	Setting the ILS modulation depth. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	
:DDM	-1 to + 1	—	Setting the DDM value
:DDM?	—	—	
:VAR90	ON OFF		Switching on or off the frequency variability of the 90-Hz tone
:VAR90?	—	—	
:FREQUENCY	80 to 100 Hz	HZ KHZ	Setting the frequency of the 90-Hz tone. Fixed frequency relation to the 150-Hz tone!
:FREQUENCY?	—	—	
:VAR150	ON OFF		Switching on or off the frequency variability of the 150-Hz tone
:VAR150?	—	—	
:FREQUENCY	132.8 to 166 Hz	HZ KHZ	Setting the frequency of the 150-Hz tone. Fixed frequency relation to the 90-Hz tone!
:FREQUENCY?	—	—	
:ID	ON OFF		Switching on or off the ID
:ID?	—	—	
:DEPTH	0 to 100%	PCT V DBM	Specification of the modulation depth of the ID. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	

Signal Generator (Only with calibrator and FMAV option)			
Command	**Data**	**Units**	**Remarks**
GENERATOR			
:AVIONICS			
:ILS			
:ID			
:FREQUENCY	900 Hz to 1.15 kHz	HZ KHZ	Setting of the frequency of the ID
:FREQUENCY?	—	—	
:PHASE	-60 to +60 deg	DEG	Definition of the phase of the 150-Hz component
:PHASE?	—	—	

Signalgenerator (Nur mit Option Calibrator und FMAV)			
Command	**Data**	**Units**	**Remarks**
GENERATOR :AVIONICS			
:TACAN :CONFIGURATION	— NORM	— —	Setting the TACAN standard configuration
:CONFIGURATION?	NORM USER	—	Poll of the current configuration state
:VAR15	ON OFF		Switching on or off the frequency variability of the 15-Hz tone
:VAR15?	—	—	
:FREQUENCY	13.3 to 16.6 Hz —	HZ KHZ	Setting the frequency of the 15-Hz tone. Fixed frequency relation to the 135-Hz tone!
:FREQUENCY?	—	—	
:DEPTH	0 to 100%	PCT V DBM	Definition of the modulation depth of the 15-Hz tone. Unit depending on DESTINATION. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	
:VAR135	ON OFF		Switching on or off the frequency variability of the 135-Hz tone
:VAR135?	—	—	
:FREQUENCY	120 to 150 Hz	HZ KHZ	Setting the frequency of the 135-Hz tone. Fixed frequency relation to the 15-Hz tone!
:FREQUENCY?	—	—	
:DEPTH	0 to 100%	PCT V DBM	Definition of the modulation depth of the 135-Hz tone. Unit depending on DESTINATION. Selection of the unit correponds to the unit entered with DESTINATION or UNITS_AF and is absolutely necessary. The system monitors adherence to the maximum total modulation depth of the individual signal components.
:DEPTH?	—	—	
:PHASE	-180 to +180 deg	DEG	Defining the phase of the 135-Hz tone
:PHASE?	—	—	

Further settings (attainable via IEC bus only)

Mode switchover			
Command	**Data**	**Units**	**Remarks**
MODE	SINGLE	---	Operating mode for triggered measurements via IEC bus. By common command *TRG, one measuring cycle at a time is started with the currently valid device settings. As soon as the cycle is successfully completed, the measuring run is halted.
	CONTINUOUS	—	Continuous measuring run is resumed.
MODE?	—	---	
ERROR?	—	—	Reading out the internal error queue. With repeated call, the individual error messages contained in the error queue are output one after the other. The return string contains the respective error number and an error message marked by quotation marks, which is separated by a comma. The error message consists of a short description and, optionally, FMA-specific further details which are separated from the description by a semicolon. Subsequent to readout of an error message, the latter is deleted in the queue. If event bits have been set, they are not deleted. If the error queue is empty, the message 0, "No error" is output.

3.4.1.5 Service Request and Status Registers

Fig. 3-26 shows the status registers and the links effective between them. To remain in accordance with the IEEE 488.2 standard, the status byte (STB) and its associated mask register (SRE), which are also implemented in devices of earlier production dates, have been supplemented by the Event Status Register (ESR) and its Event Status Enable Mask Register (ESE).

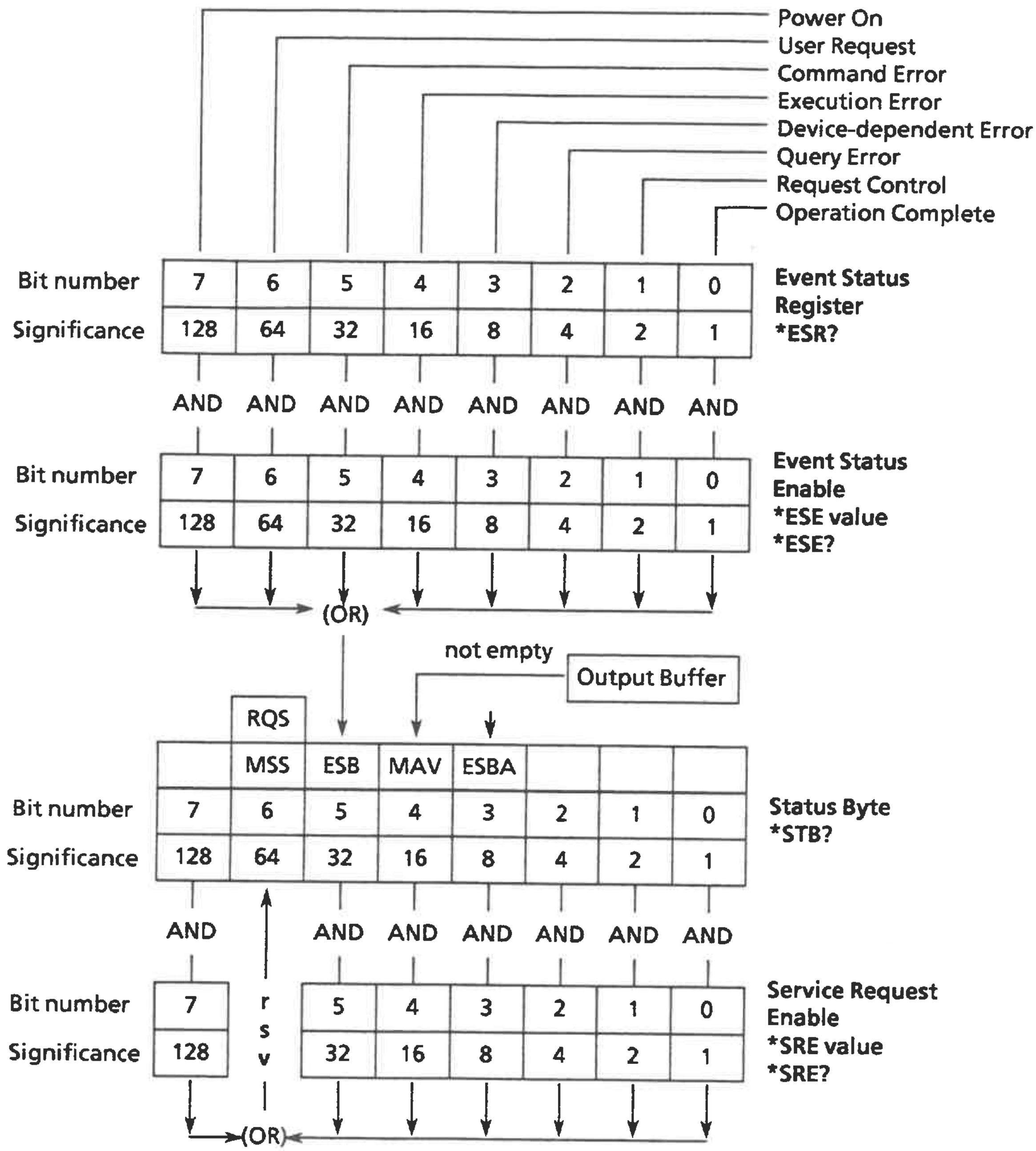


Fig. 3-26 Status registers

A bit is set to 1 in the Event Status Register (ESR) in the case of certain events (e.g. error, ready signal). Confer Table 3-11.

These bits remain set until cleared by reading the Event Status Register (with query *ESR?) or by one of the following conditions:

- by commands *RST or *CLS
- by switching on the ac supply (the power-on bit is set in this case).

The Event Status Enable Mask Register (ESE) allows the user to select the bits in the Event Status Register (ESR) which also set the summary-message bit ESB (bit 5 in the status byte) for service request generation.

The summary-message bit is therefore only set if at least one bit in the ESR and its corresponding bit in the ESE are set to "1". The summary bit is automatically cleared again if the above condition is no longer fulfilled, e.g. if the bits in the ESR have been cleared by reading the ESR or if the ESE has been modified.

The Event Status Enable Mask Register is written with command

"*ESE xy"

when "xy" represents the contents in decimal form, and can be read with query "*ESE?".

It is set to "0" upon switch-on of the ac supply if the power-on-status-clear flag is "1" ("*PSC 1"). The ESE Mask Register is not changed by other commands or interface messages (e.g. "DCL" or "SDC").

The bits listed in the following table are used in the status byte (STB):

Table 3-10 Bit allocation of status byte

Bit No.	Bus line	Designation	Meaning
3	DIO 4	ESBA	Summary-message bit of Event Status Register A.
4	DIO 5	MAV	Message Available Indicates that a message is present in the Output Buffer which can be read. The bit is "0" if the Output Buffer is empty.
5	DIO 6	ESB	Summary-message bit of Event Status Register.
6	DIO 7	RQS	Request Service.

Note that the bits of the status registers are numbered from 0 to 7 in compliance with the IEEE 488.2 standard, but that the data bus lines are designated as DIO 1 to DIO 8.

Event Status Register A

In analogy to the registers ESR and ESE required by standard IEEE 488.2, an additional "Event Status Register A "ERA" and its associated Enable Register "ERAE" have been implemented in the FMA as expansion to control the bit 3 "ESBA" in the status byte.

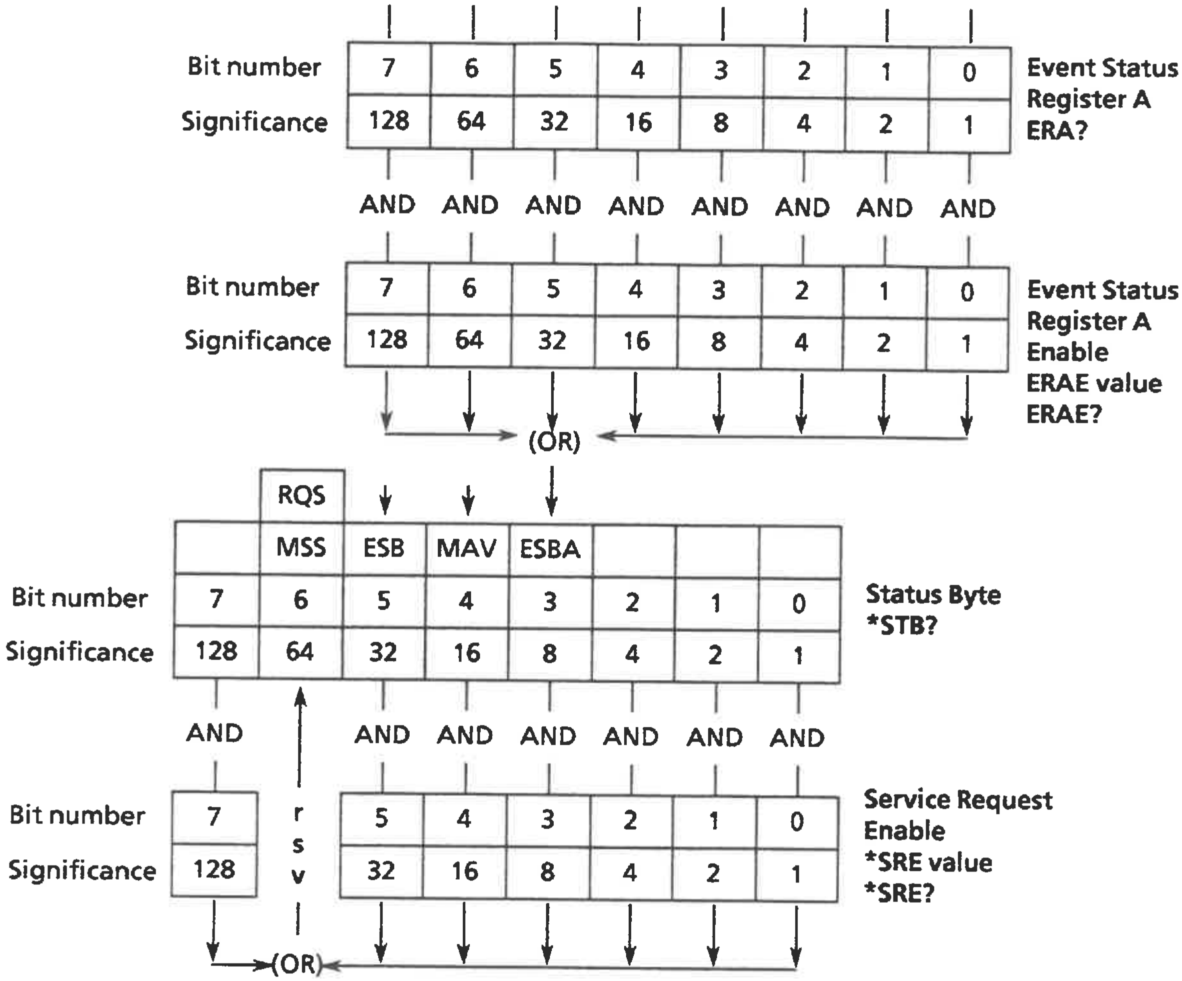


Fig. 3-27 Event Status Register A

Note: Event Status Register A is planned for future developments and not implemented in Version 1.0.

Table 3-11 Bit allocation of the Event Status Register

Bit No.	Meaning
7	**Power On** This bit is set when the device is switched on or when the power returns following a power failure.
6	**User Request** By actuating the LOCAL key, the user can set this bit regardless of the current state (whether remote or local) and thus issue a service request if the mask registers are set accordingly. This function is useful for test runs requiring both manual and IEC bus operation.
5	**Command Error** This bit is set if one of the following errors was detected during execution of the received commands: • syntax error • illegal unit • illegal header • a number was combined with a header that allows no numeric data.
4	**Execution Error** This bit is set if one of the following errors was detected during execution of the received commands: • A number is outside the legal input range of the respective parameter. • A selected device function could not be properly executed due to the current device condition.
3	**Device-dependent Error** This bit is set if an error has occurred during operation.
2	**Query Error** Bit 2 is set if • an attempt is being made by the controller to read data from the analyzer when no query has been issued before, or • if the data prepared by the device in the Output Buffer are not read and instead a new setting command has been sent to the device. The Output Buffer is cleared in this case.
1	**Request Control** Not implemented in the device.
0	**Operation Complete** This bit is set in response to commands *OPC and *OPC? when all the selected pending device operations have been completed.

The Service Request Enable Mask Register (SRE) allows the user to determine whether the RQS bit of the status byte is also set when the ESB, ESBA and/or MAV bit of the status byte changes from "0" to "1", and whether a Service Request is sent to the controller by activating the SRQ line. Since each bit in the Service Request Enable Mask Register is assigned to the corresponding bit in the status byte, the following possibilities and combinations thereof exist (cf. Table 3-12):

Table 3-12 Bit allocation of the Service Request Enable Register (SRE).

Contents of SRE (decimal)	Set bit No. in SRE	Effect
0	–	no Service Request
8	3	Service Request if ESBA bit is set (at least one bit in the Event Status Register A set and not masked)
16	4	Service Request if MAV bit is set (message in Output Buffer)
32	5	Service Request if ESB bit is set (at least one bit in the Event Status Register set and not masked)

The SRE Mask Register is written with the setting command "*SRE value" (value as the contents in decimal form) and can be read with query *SRE?. It is set to "0" when the ac power is switched on, if the power-on-clear-flag is "1"; the Service Request function of the device is thus disabled. The SRE Mask Register is not changed by other commands or interface messages (DCL, SDC).

Several participating devices may simultaneously trigger a Service Request; the open collector drivers generate an OR function on the SRQ line. The controller must read the status bytes of the devices in order to identify the device that has triggered the Service Request. A set RQS bit (bit 6/DIO7) indicates that the device sends a Service Request.

The status byte of the analyzer may be read:

- with query *STB?

  The contents is output in decimal form. The status byte is not changed by reading and the Service Request not cleared.

- by means of a Serial Poll

  (with R&S controllers: IECSPL adr, status; cf. Table 3-4). The contents is transferred in binary form as one byte. The RQS bit is then set to "0" and the Service Request becomes inactive; the other bits of the status byte are not changed.

The status byte is cleared:

- with command *CLS

  This command clears the ESR and the Output Buffer; the ESB and MAV bits in the status byte are also set to "0". This in turn clears the RQS bit and the Service Request message.

- by reading the Event Status Register (query *ESR?) or setting the Event Status Enable Mask Register to "0" (command *ESE) and by reading the contents of the Output Buffer.

Parallel Poll Enable Register

The Parallel Poll Enable Register is a sixteen bit wide register. Each bit in this register corresponds to a bit in the status byte or a device-specific register (not implemented in the FMA). If the bitwise combination of the Parallel Poll Enable Register with the two others does not equal 0, the IST (individual state) bit is set to "1". The IST bit is sent in response to a parallel poll from the controller, which allows to identify the participating device requesting service. (The IST bit can also be read with "*IST?").
The following Fig. 3-28 is given for better illustration.

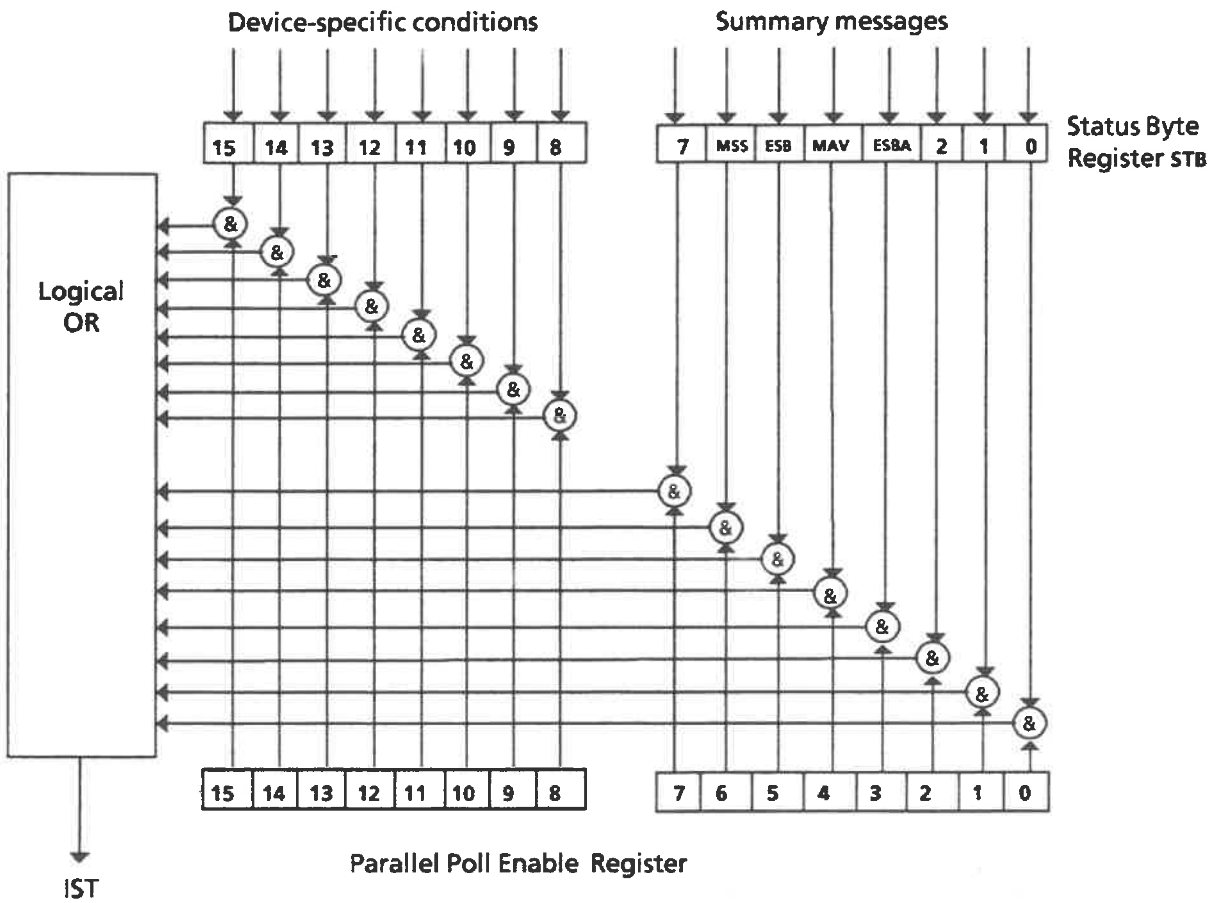


Fig. 3-28 Parallel Poll Enable Register PPE

3.4.1.6 Resetting of Device Functions

The following table summarizes various events and commands which cause a partial resetting of individual device functions.

Table 3-13 Resetting of various device functions

Event	Power-on		DCL, SDC (Device Clear, Selected Device Clear)	Commands	
	Power-On-Clear-Flag			*RST	*CLS
	0	1			
Default device status	--	--	--	yes	--
Set Event Status Register ESR, ERA to zero	yes	yes	--	---	yes
Set Mask Registers ESE, ERAE and SRE to zero	--	yes	--	--	--
Clear Output Buffer	yes	yes	yes	--	yes
Clear Service Request	yes	1)	2)	3)	yes
Reset command processing and Input Buffer	yes	yes	yes	--	--

1) yes, but Service Request possible on power-on
2) yes, if only caused by message in the Output Buffer
3) yes, if not caused by message in the Output Buffer

3.4.1.7 Command Processing Sequence and Synchronization

All messages received by the device are first stored in an Input Buffer, which can accomodate a maximum of 256 characters. Once the terminator has been received, the device starts processing the received commands in the sequence in which they were transmitted. During this time, the IEC bus can be used for communication with other participating devices in the IEC bus system. Command lines which exceed the capacity of the Input Buffer are processed in several parts. The bus is occupied during this time.

OPERATION COMPLETE

The "Operation Complete" messages *OPC and *OPC? are used as response messages to indicate when a received command has been fully processed or a started test sequence completely executed.

Common command *OPC sets bit 0 in the Event Status Register and is thus capable of triggering a Service Request once all selected pending device operations have been completely executed.

Common query *OPC? provides an additional message in the Output Buffer and sets bit 4 (MAV) in the status byte.

The "Operation Complete" function operates with all commands that restart a complete test cycle and thus ensures synchronization at the end of the test measurement run.

WAIT

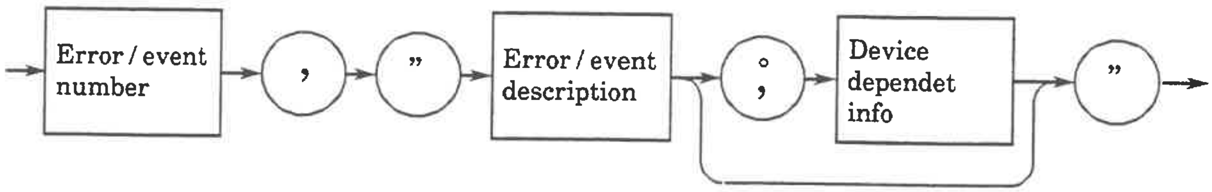
The "*WAI" command can be used to establish the synchronization within a command line, which means that the device does not process any new commands until all pending selected device operations have been completed.

3.4.1.8 Error Handling

All the errors detected by the device during IEC bus operation are indicated by setting a respective bit (bit 2, 4 or 5) in the Event Status Register (cf. Table 3-11). Functional errors are signalled by setting bit 3. These bits remain set until the Event Status Register is read or cleared with the commands *RST or *CLS. This fully complies with the IEEE 488.2 standard and enables triggering of a Service Request and program-controlled evaluation of the type of error.

Appendix A List of Error Messages

Principally, remedy of errors via the IEC bus corresponds as far as possible to the standard SCPI 91.0. The "ERROR?" query is used to read out an internal error queue, where all instrument errors which are currently valid or relevant, are stored. An integer error number [-32767 to 32767] which is assigned to the respective error and which informs about the error is returned (see tables). Negative error numbers are assigned standard messages specified with SCPI, positive numbers are assigned instrument-specific error messages. The number is followed by an error description in the form of an ASCII string in inverted commas (see tables), which is separated by a comma; a further instrument-specific, additional message may follow, separated by a semicolon. The maximum length of the SCPI standard message including the instrument-specific addition is 100 characters per queue entry. The return string consists of the following components:



The error messages contained in the error queue are read out successively by repeating the "ERROR?" command several times. The first error message describes the error which first occurred. The error messages read out by the user are deleted, thus creating space for new error messages at the end of the queue. If no message is contained in the error queue or the end of the error queue is reached after output of several error messages, the message 0, "No error" is output.
Switching on the FMA deletes the error queue. The command *CLS in REMOTE mode as well as pressing the PRESET key in LOCAL mode also cause deletion of the error queue.
The length of the error queue is limited to 10 entries. If the error queue is already full when an error occurs, the standard message -350, "Queue overflow" is entered instead of the error message.
Apart from operating the error queue, the system also sets the IEC-bus event bits. A service request is released as soon as a command error, execution error, device-dependent error or query error occurs and the user has set the associate mask bit. It must be taken into account that the corresponding error message is deleted with subsequent reading out of the error queue, however, a bit which may have been set in the ESR register, is not deleted. To do this, the user must additionally call *ESR? or *CLS.
The IEC-bus error messages implemented in the FMA are divided in the subsequent tables as the error groups of the device status reporting with reference to the SCPI standard.

A.1 NO ERROR

The message "NO ERROR" is returned, if the error queue is empty or when the last error contained has been read out.

Error No.:	Description	Device dependent Info	Remarks
0	No error	---	The error queue is empty.

A.2 Command ERROR

Command errors are output when the IEC bus parser receives an incorrect command string. The command-error bit (bit 5) is then set in the ESR.

Error No.:	Description	Device dependent Info	Remarks
-100	Command Error	illegal command	The preceding command was illegal.
-101	Invalid character	incorrect character in command	One or more characters within the command string are invalid.
-102	Syntax error	unrecognized command or data	The command syntax according to IEEE 488.2 was not adhered to.
-103	Invalid seperator	incorrect or missing seperator	The separator of the command string is illegal or missing.
-104	Data type error	illegal data type detected	The type of the data transferred is illegal.
-105	GET not allowed	---	According to IEEE 488.2, a Group Execution Trigger is not allowed at this position.
-110	Command header error	ambiguous or illegal header	A header of the command string is ambiguous, unknown or illegal.
-112	Programm mnemonic too long	---	A header of the command string is too long.
-113	Undefined header	header not defined in this device	The header syntax is correct, however, it is not defined in this hardware configuration.

Error No.:	Description	Device dependent Info	Remarks
-120	Numeric data error	numeric data out of range	The numeric data given is invalid.
-123	Exponent too large	---	The value of the exponent given exceeds 32000.
-124	Too many digits	mantissa out of range	The mantissa given contains more than 255 digits.
-128	Numeric data not allowed	---	The syntax of the data received is correct, however, it is not allowed at this position in the command string.
-130	Suffix error	ambiguous or illegal suffix	The suffix of the preceding command string is ambiguous, unknown or illegal.
-131	Invalid suffix	---	The syntax of the suffix does not correspond to IEEE 488.2.
-134	Suffix too long	---	The suffix contains more than 12 characters.
-138	Suffix not allowed	---	A suffix is not allowed following this data.
-140	Character data error	ambiguous or illegal character data	The character argument of the preceding command string is ambiguous, unknown or illegal.
-141	Invalid character data	---	The character data contains an invalid character.
-144	Character data too long	---	The character data contains an invalid character.
-148	Character data not allowed	---	The character data is not allowed at this position.

A.3 Execution Error

Execution errors are output, if the system control of the FMA cannot execute an IEC-bus command correctly. The execution-error bit (bit 4) is set in the ESR.

Error No.:	Description	Device dependent Info	Remarks
-200	Execution error	fatal error in execution control block	The preceding command could not be executed correctly.
-220	Parameter error	parameter wrong	A parameter transferred causes an execution error.
-222	Data out of range	data legal but not executable	The given data is correct, however, it is not within the specified range.
-240	Hardware error	no execution because of a fatal hardware problem	The preceding command cannot be executed because of a hardware problem.
-241	Hardware missing	hardware option missing	The preceding command cannot be executed, since the respective boards (options) are not fitted.
-260	Expression error	error while formatting or computing data	Errors occured with formatting or computing of data.

A.4 Device-Specific Error

Device-specific errors occur, when system-specific problems arise in the FMA, which are not treated by the other error groups. The device-dependent error bit (bit 3) is set in the ESR.

Error No.:	Description	Device dependent Info	Remarks
-300	Device-specific error	---	A system-specific problem occured, which cannot be specified in detail.
-315	Configuration memory lost	battery low	The voltage supply of the CMOS battery-backup is no longer sufficient. The stored system configuration got lost. Default values are used.
-330	Self-test failed	---	The selftest of the FMA could not be performed correctly.
-350	Queue overflow	error occurred but was not recorded	The error queue is full. An error occured, but was not recorded in the error queue.

A.5 Query Error

Query errors are output, if the empty output buffer of the device was tried to be read out or if the read-procedure was interrupted. The query-error bit (bit 2) is set in the ESR.

Error No.:	Description	Device dependent Info	Remarks
-400	Query error	---	The preceding query could not be executed correctly.
-410	Query INTERRUPTED	---	A query was interrupted before the reply had been returned completely (see also IEEE 488.2).
-430	Query DEADLOCKED	---	Both, the input and output queues of the FMA are full, however, further processing is not possible (see also IEEE 488.2).

A.6 FMA-specific Errors

Subsequently, all error messages are listed which occur exclusively in the FMA and which are not included in the messages listed above. Event bits are not set.

Error No.:	Description	Device dependent Info	Remarks
100	Fatal error	---	A fatal error occurred in the FMA which cannot be specified in detail. All processes are stopped.
101	Power down	power supply dropped	At least one of the operating voltages has failed (temporarily). Measuring is aborted.
102	Overload	reduce RF-power and restart system	The maximum permitted RF input level of the FMA was exceeded.
103	Synthi1 VCXO	VCXO out of range	The tuning voltage of the VCXO on the synthesizer board 1 is out of tolerance.
104	Synthi1 oventemp	VCXO-oventemp out of range	The oven-temperature of the VCXO is out of the permitted tolerance. Compensation is not possible.
105	Synthi1 M-Loop	M-Loop lockout	The tuning voltage of the M-loop on the synthesizer board 1 is out of tolerance.
106	Extern reference	missing external reference	The external reference is not connected.
107	Synthi2 main-loop	main-loop lockout	The tuning voltage of the main-loop on the synthesizer board 2 is out of tolerance.
108	Synthi2 interpolation	interpolation-loop lockout	The tuning voltage on the interpolation-loop on the synthesizer board 2 is out of tolerance.
109	PFC error	Frequency counter failed	The frequency counter could not work correctly.

Error No.:	Description	Device dependent Info	Remarks
110	Generator error	- - -	The AF generator does not work correctly.
111	AF tone1	level of tone1: value out of range	Switching over the operating mode of the AF generator causes the valid level of the AF1 component to be out of the permitted range.
112	AF tone2	level of tone2: value out of range	Switching over the operating mode of the AF generator causes the valid level of the AF2 component to be out of the permitted range.
113	MPX Pilot	level of MPX pilot: value out of range	Switching over the operating mode of the AF generator causes the valid level of the MPX pilot tone to be out of the permitted range.
120	Basic drivers failed	internal hardware communication failed	The internal communication layer to the instrument hardware does not work correctly.
121	Calibrator DSP	communication to calibrator DSP devices failed	The communication with the calibrator DSP devices is faulty.
122	DSP unit	communication to DSP unit failed	The communication with the DSP component on the DSP unit is faulty.

Error No.:	Description	Device dependent Info	Remarks
130	Calibration error	---	An error occurred during calibration. Calibration could not be completed.
131	Calibration value	calibration values out of tolerance	A (few) calibration value(s) is (are) out of tolerance.
		FM/PM Demodulation not calibrated	The calibration values for FM/PM modulation are out of tolerance.
		AM Demodulation not calibrated	The calibration values for AM modulation are out of tolerance.
		Stereo Decoder not calibrated	The calibration values for the stereo decoder are out of tolerance.
		Voltmeter not calibrated	The calibration values for the voltmeter are out of tolerance.
132	Calibration tempera-ture	present temperature exceeds tolerance:	The present temperature exceeds the permitted tolerance limits:
		Calibrate FM/PM	an FM/PM calibration had to be performed;
		Calibrate AM	an AM calibration had to be performed;
		Calibrate Detector	a detector calibration had to be performed;
		Calibrate Voltmeter	a voltmeter calibration had to be performed.

Error No.:	Description	Device dependent Info	Remarks
140	AF Ranging	AF Overflow	Overflow with AF Manrange.
		AF Underflow	Underflow with AF Manrange.
		Overload with quasi peak range	The peak value exceeds the required 20-dB overload immunity with quasi-peak measurement.
141	Stereo Pilot	Pilot level too low	The level of the stereo pilot tone is too low.
		Pilot level too high	The level of the stereo pilot tone is too high.
142	Dist_Sinad	Dist/Sinad overflow	Overflow with current Dist/Sinad measurement.
		Dist/Sinad underflow	Underflow with current Dist/Sinad measurement.
		Dist/Sinad new Frequency	The given signal frequency is not stable.
		Dist/Sinad Frequency out of Range	The level of the given signal frequency is out of the specified measuring range
		Dist/Sinad Frequency out of Tune	The signal frequency is out of the specified measuring range.
143	Distortion selective	harmonic frequency out of range	The harmonic frequency to be checked is out of range.
		intermodulation: tune frequencies not correct	The tune frequency for intermodulation measurement is out of the permitted range.

APPENDIX B

B.1 IEC-bus Programming

The members of the FMA family are equipped with an IEC-bus interface that is electrically compatible with IEEE-488.1. The following sections explain by way of examples the programming of the devices via this interface.

B.1.1 Setting the Device Address

Menu item IEC Adr in the SPECial FUNCtion main menu allows you to set the IEC-bus address of devices appertaining to the FMA family. Valid addresses are values from 1 to 31.
The device is factory-set to the default address 29.

B.1.2 Syntax

The syntax used for the IEC-bus commands of the FMA family meets the requirements of IEEE488.2 and complies, to a large extent, with the SCPI standard.
The IEC-bus command syntax reflects the modular design of the device hardware.

The following sections give some examples which illustrate the opportunities provided by the implemented command set.

B.1.2.1 Syntax of Device-specific Command Strings

To give an example, the `FILTER` command of the FMA family is subjected to closer examination. Here, it is used to activate the 10-Hz highpass filter.

All IEC-bus commands required for setting the filters in the FMA begin with the keyword `Filter`.
In order to address the group of highpass filters, the keyword HIGHPASS is added to the first keyword, separated by ":".
The highpass filter to be activated is subsequently selected by the data appended, in this example "10 Hz". The data are separated from the command string by a space.

Specification of the unit appertaining to a parameter is optional and may be omitted. A default unit is then selected. The default unit is always the first specified in the command tables as possible units, here: Hz.

The setting command is thus: `FILTER:HIGHPASS 10 Hz.`

To query the setting of the highpass filter, just add "?" instead of data to the header.
The query then reads:

`FILTER:HIGHPASS?`

As a response, the current setting of the highpass filter is provided. With no highpass filter being active, the query is answered by the error value "99E99".

Status information can be read out using the query `FILTER:HIGHPASS:STATE?`. The response will be ON when any highpass is active or, OFF when no highpass is switched on. The rules and techniques described above (including the query for status information) also apply to other command groups.

B.1.2.2 Abbreviating Device-specific Commands

To facilitate the writing of IEC-bus programs, the commands may be abbreviated as long as they are unambiguous. The shortest possible notation is marked in the tables. There is no difference between upper-case and lower-case letters.

The setting command dealt with in the previous section can thus also be written in this manner (of course, there are also other ways to represent this command!):

```
FI:H 10
FIL:HigHpa 0.01kHz
```

Caution: *Due to syntax extensions, new firmware versions may require the shortest abbreviations used for the IEC-bus commands to be lengthened.*

In order to facilitate firmware updates, the abbreviations used for writing IEC-bus control programs should exceed the shortest possible abbreviation by two characters.

B.1.2.3 "Compound Header Rules" and "Enhanced Tree Walking"

Writing of IEC-bus programs can be further facilitated by using the implemented Compound Header Rules (see IEEE488.2) and Enhanced Tree Walking efficiently (see Annex A to IEEE488.2).

Both methods can be applied for device messages consisting of several parts.

They allow those parts of a command specifying only the way through the syntax tree to be used again in subsequent commands not introduced by ":" without having to repeat the parts.

In commands introduced by ":", however, the device firmware begins its command analysis at the roots of the the syntax tree without using the tree walking algorithm.

The following sequence is given as an example:

```
"FILTER:HIGHPASS 0.3 KHZ;FILTER:LOWPASS 23000 HZ;VOLTMETER ON;VOLTMETER:INPUT
BALANCED;VOLTMETER:VOLTAGE?;VOLTMETER:INPUT UNBALANCED;VOLTMETER
OFF;DISTORTION_METER ON;DISTORTION_METER:UNITS DB"
```

This sequence can be shortened with the help of the methods described above:

```
"FILTER:HIGHPASS 0.3 KHZ;LOWPASS 23000 HZ;VOLTMETER ON;INPUT
BALANCED;VOLTAGE?; INPUT UNBALANCED;VOLTMETER OFF;DISTORTION_METER ON;UNITS
DB"
```

The sequence can be further shortened by using the abbreviations and default units:

```
"FI:H 0.3KHZ;L 23000;VOL ON;INP B;V?;INP UNBALA;VOLTM OF;DIST ON;U DB"
```

Besides, the example illustrates a problem arising with enhanced tree walking.
The shortest possible abbreviation to switch off the voltmeter is now **VOLTM OF** instead of **VOL OF**.

The reason can be easily detected.
The path valid just before **VOLTM OF** was defined by the command string to be **VOLTMETER:INPUT**.

The tree walking algorithm would interprete **VOL OF** as the illegal command **VOLTMETER:VOLTAGE OFF**, thus not executing the command.
Only **VOLTM OF** allows the algorithm to make out that the analysis has to start at the roots of the syntax tree and the command must be **VOLTMETER OFF**.

This problem can be eluded by entering ":" at the beginning of the command, resulting in a sequence allowing the use of the shortest possible abbreviation **VOL OF**:

```
"FI:H 0.3KHZ;L 23000;VOL ON;INP B;V?;INP UNBALA;:VOL OF;DIST ON;U D"
```

B.1.3 Single and Continuous Measurements

For the IEC-bus mode, two entirely different methods for control of the measuring cycles have been implemented in the instruments.

B.1.3.1 Continuous Measurements

As default setting or after an instrument preset, continuous measurement mode is started. It is appropriate for most applications and identical with the operation via the front panel.
In the continuous measurement mode, the instrument determines cyclically all required measured values in keeping with the selected settings and makes them available to the user via the front panel or via an IEC-bus output.
After a measured value has been determined, a new measurement cycle is started automatically to determine the next measured value.

Common command `*TRG` allows you to invalidate all measurement results currently available in the instrument and to restart the measurement. As against in single measurements, the measurement run is not aborted when the first valid measurement result is obtained after `*TRG`.

The continuous measurement mode can be used for measurements on devices under test and test signals which are not in transient condition.

B.1.3.2 Single Measurements

For measurements on non-steady signals or, for example, switchable devices under test, the use of triggered single measurements may be required.
Using the IEC-bus command `MODE SINGLE`, the measuring instrument is made to enter the single measurement mode.

In this mode, the measurement run for determining the required measured values is started exactly once any time the common command `*TRG` is issued. The measurement is aborted when the measured values are determined.
The single measurement mode is used to attain two ends:

- a measurement cycle is started at a defined time (approx. 7 msec after the instrument has received the `*TRG` command).
- the measured value thus determined is kept in the instrument until it is read out via IEC-bus or until another new measurement cycle is triggered by a new `*TRG` command.

The continuous measurement mode can be entered again using the IEC-bus command `MODE CONTINUOUS`.

B.1.4 Synchronization Techniques

The IEC-bus command set provides several techniques for synchronization of a controller with device-internal operations.
The following sections introduce the various techniques. Programming examples are given in Section 1.6.

B.1.4.1 Default Technique

Any number of setting commands or queries can be sent to the device via IEC-bus. The device firmware processes the commands in the order they were sent. A command always finishes before the next command is executed.
This technique does not require the explicit use of `*WAI` (see 1.4.3) but allows it any time.

B.1.4.2 *TRG

This common command invalidates all measurement results currently present in the device and starts a new measuring cycle with the current settings.

B.1.4.3 *WAI

After the device firmware has decoded the common command `*WAI` in the input string, the device is prevented from executing any further commands sent via IEC-bus before all other pending commands are finished.
This behaviour corresponds to that described in Section 1.4.1, Default Technique

B.1.4.4 *OPC?

This command places the character "1" as string in the IEC-bus output buffer of the device when all pending IEC-bus commands have been finished.
"1" is returned after an instrument query by the controller and signals the execution of all pending IEC-bus commands.

B.1.4.5 *OPC

`*OPC` is used to trigger a service request from the instrument to the controller when all commands have been executed.
This technique is definitely the most elegant and flexible solution to the synchronization of operations, however also the most complex technique.

`*OPC` requires an interrupt routine to be available in the system controller program. Upon a service request, this routine is executed asynchronously to the normal program execution.

B.1.5 Programming Examples

This section presents a series of examples which illustrate the programming of the modulation analyzer. They may also contribute to the solution of more complex measurement spheres. The programming examples are based on each other and provided with explanations.

Rohde & Schwarz-BASIC, version 2.00 or later has been used as programming language. However, the programs can be translated into other languages.

B.1.5.1 Initialization and Default Status

At the beginning of each program, both the IEC-bus and the modulation analyzer settings should be in a defined default status. To this end, it is useful to employ subroutines, here: Prolog and Init_fma.

The controller terminator should be set to "linefeed" (decimal 10) which is, together with EOI, the only permissible terminator according to standard IEEE 488.2. Linefeed is also used in all instruments of the FMA family.

```
10000 '
10010Prolog:
10020 '
10030     IEC TERM 10: '                  Linefeed
10040     IEC TIME 1000: '                Timeout 1s
10050 '
10060     Fma=29: '                       Modulationanalyzer IEC address
10070 '
10080 '                                   other initialization
10090 '
10100 RETURN
10110 '--------------------------------
```

The IEC-bus status registers and modulation analyzer default settings are made to assume their default status by means of another subroutine:

```
11000 '
11010Init_fma:
11020 '
11030 '                                   reset status registers
11040     IEC OUT Fma,"*CLS"
11050 '
11060 '                                   reset Modulationanalyzer settings
11070     IEC OUT Fma,"*RST"
11080 '
11090 '                                   init other devices
11100 '
11110 RETURN
11120 '--------------------------------
```

B.1.5.2 Sending a Device Setting Command

This example illustrates how to send modulation analyzer settings, for example demodulator, detector and RF counter resolution settings.

```
100 '-------------------------------
110 '      Send Modulationanalyzer settings
120 '-------------------------------
130 '
140 GOSUB Prolog
150 GOSUB Init_fma
160 '                                 send new settings
170 IEC OUT Fma,"DEMODULATION AM"
180 IEC OUT Fma,"DETECTOR POS_PEAK;COUNTER:RF:RESOLUTION 0.1"
190 '
200 END
210 '-------------------------------
10000 '
10010Prolog:
10020 '
10030    IEC TERM 10: '               Linefeed
10040    IEC TIME 1000: '             Timeout 1s
10050 '
10060    Fma=29: '                    Modulationanalyzer IEC address
10070 '
10080 '                               other initialization
10090 '
10100 RETURN
10110 '-----------------------------
11000 '
11010Init_fma:
11020 '
11030 '                               reset status registers
11040     IEC OUT Fma,"*CLS"
11050 '
11060 '                               reset Modulationanalyzer settings
11070     IEC OUT Fma,"*RST"
11080 '
11090 '                               init other devices
11100 '
11110 RETURN
11120 '-----------------------------
```

The subroutines Prolog and Init_fma which are still included in the above example are omitted in the examples to follow.

B.1.5.3 Reading Device Settings

The settings made in the previous example are read out. The abbreviated commands are used.

```
100 '--------------------------------
110 '      Read Modulationanalyzer settings
120 '--------------------------------
130 '
140 GOSUB Prolog
160 '                                  read settings
170 IEC OUT Fma,"COUNTER:RF:RESOLUTION?"
180 IEC IN Fma,Resolution$
190 '
200 IEC OUT Fma,"DEMODULATION?
210 IEC IN Fma,Demodulator$
220 '
230 IEC OUT Fma,"DETECTOR?"
240 IEC IN Fma,Detector$
250 '                                  print settings on screen
260 PRINT Resolution$
270 PRINT Demodulator$
280 PRINT Detector$
290 '
300 END
310 '--------------------------------
```

In line with the previous settings, the following is read out:

COUNTER:RF:RESOLUTION 100E-3
DEMODULATION AM
DETECTOR POS_PEAK

B.1.6 Use of Synchronization Techniques

1.6.1 Triggering a Single Measurement and Synchronization using *WAI

This example illustrates a level measurement at a frequency previously set using the common command *TRG. *WAI delays the execution of further commands until all pending commands (here: the level measurement) have been executed. It is not until then that the result of the last measurement is read in and indicated on the screen. Please note that with *WAI, the set timeout has to be longer than the processing time of the commands, otherwise an error message would be generated. In this example, the timeout of 1 s set in Prolog is sufficient for the default measuring time of 100 ms.

```
100 '-------------------------------
110 '    Trigger and read result
120 '-------------------------------
130 '
140 GOSUB Prolog
150 GOSUB Init_fma
160 '                                         select powermeter operation
170 IEC OUT Fma,"MODE SINGLE;POWERMETER:RF"
180 '                                         Trigger and Wait
190 IEC OUT Fma,"*TRG;*WAI"
200 '                                         get result
210 IEC OUT Fma,"POWER:RF?"
215 IEC IN Fma,Power$
220 '                                         print result on screen
230 PRINT Power$
240 END
245 '
250 '--------------------------------
```

The screen output might, for example, be :

POWER:RF -17DBM

The synchronization technique described above can be applied with all other commands.

B.1.6.2 Service Request Routine

The service request offers the definitely most elegant and most flexible way of synchronization of operations.

In order to activate the interrupt capability of the controller, insert the command

```
nnn   ON SRQ GOSUB label
```

into the main menu.

Service request routine:

```
12000 '--------------------------------
12010 '    Service Request Routine
12020 '--------------------------------
12030 Srq_routine:
12040 '                                   Serial Poll
12050    IEC SPL Fma,Sb%
12060 '                                   Check SRQ?Bit
12070  IF (Sb% AND 64) THEN
12080 '                                   SRQ?Flag TRUE
12090     Srq%=1
12100 '                                   e.g. check registers
12110  ELSE
12120 '                                   poll other devices
12130  ENDIF
12140 '                         enable SRQ Interrupt and return
12150 '                         in the same line to avoid nesting!
12160 '
12170 ON SRQ GOSUB Srq_routine: RETURN
```

This simple service request routine can be extended for any application. The extension may concern the operation of other devices under IEC-bus control, the evalution of additional IEC-bus registers or error handlings.

By a device poll, the subroutine allows the identification of the device(s) requesting service with the help of their status bytes. The appropriate measures can then be taken.

In addition to this subroutine on the system controller, the event status enable register ESE and service request enable register in the device must be configured appropriately in order to allow the generation of a service request.

Command *OPC sets bit 0 in the event status register. Analogously, bit 0 must be set in the event status enable register. To be finally able to trigger the service request, bit 5 in the service request enable register must also be set.

B.1.6.3 Synchronization with the End of a CALIBRATE? Operation using `*OPC` and `*OPC?`

In this example, **CALBRATE ALL** is triggered, the end of which is waited for with the help of command ***OPC**. Flag Srq% which is set in the service request routine serves to indicate the end. The registers mentioned in the previous example must be configured before.

```
100 '-------------------------------
110 '      Execute Calibration using *OPC
120 '-------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_fma
160 '
170    GOSUB Exec_cal
180 '
190 END
3000 '-------------------------------------------------------
3010 '      Execute Calibration and wait for Operation Complete
3020 '-------------------------------------------------------
3030Exec_cal:
3040 '                            Init SRQ-Flag
3050    Srq%=0
3060 '                            Init SRQ-Routine
3070    ON SRQ1 GOSUB Srq_routine
3080 '                            Config Registers
3090    IEC OUT Fma,"*CLS;*ESE 1;*SRE 32"
3120 '                            Start Calibration
3130    IEC OUT Fma,"CALIBRATION ALL;*OPC"
3140 '
3150 '                            Do something useful
3160 '                            while calbrating
3170 '
3180    REPEAT
3190 '                            ...
3200 '                            or just wait
3210    UNTIL Srq%
3220 '                            Calibration is completed
3230 RETURN
3240 '
3250 '--------------------------------------------------------
```

When using the *OPC command, the operation takes the following course:

```
100 '------------------------------
110 '      Execute Calibration using *OPC?
120 '------------------------------
130 '
140    GOSUB Prolog
150    GOSUB Init_fma
160 '
170    GOSUB Exec_cal
180 '
190 END
3000 '--------------------------------------------------
3010 '      Execute Calibration and wait for Operation Complete
3020 '--------------------------------------------------
3030Exec_cal:
3080 '                               Calibration may take a long time
3090    IEC TIME 40000
3120 '                               Start Calibration
3130    IEC OUT Fma,"CALIBRATION ALL;*OPC?"
3140 '
3145 '                               wait for completion
3150    IEC IN Fma,Result$
3160 '                               Result o.k. ?
3170 IF Result$="1" THEN
3220 '                               done
3221 ELSE
3222 '                               here we need some error handling
3223 ENDIF
3224
3230 RETURN
3240 '
```

B.1.7 FM Deviation Measurement

Deviation of the present FM-modulated signal is determined. As soon as the measured value is available, a service request is triggered. The measured value is read out on the screen.

```
100 '------------------------------
110 '             Measurement of Modulation
120 '------------------------------
130 '
140 GOSUB Prolog
150 GOSUB Init_fma
160 '
170 GOSUB Measure_modulation
180 '
190 END
1000 '-------------------------------------------------------
1010 '   Start Measurement and wait for Message available
1020 '-------------------------------------------------------
1030Measure_modulation:
1040 '                                        Init SRQ-Flag
1050 Srq%=0
1060 '                                        Init SRQ-Routine
1070 ON SRQ1 GOSUB Srq_routine
1080 '                                        Config Registers
1090 IEC OUT Fma,"*CLS;*ESE 1;*SRE 16"
1110 '                                        configure device for measurement
1120 IEC OUT Fma,"DEMODULATION FM"
1160 '
1170 'start measurement
1180 IEC OUT Fma,"DEMODULATION:FM:DEVIATION?"
1190 '
1200 REPEAT
1210 '
1220 '                                        wait for message available
1230UNTIL Srq%
1240 '                                        FMA is ready
1250 '
1270 '                                        read results from FMA
1280 IEC IN Fma,Result$
1290 '
1300 PRINT Result$
1310 '
1320 RETURN
1330 '------------------------------
```

B.1.8 AM Modulation Depth Measurement

The AM modulation depth is measured at the set frequency.

```
100 '-------------------------------
110 '        Measurement of Modulation
120 '-------------------------------
130 '
140 GOSUB Prolog
150 GOSUB Init_fma
160 '
170 GOSUB Measure_modulation
180 '
190 END
1000 '----------------------------------------------------
1010 '   Start Measurement and wait for Message available
1020 '----------------------------------------------------
1030Measure_modulation:
1040 '                                      Init SRQ-Flag
1050 Srq%=0
1060 '                                      Init SRQ-Routine
1070 ON SRQ1 GOSUB Srq_routine
1080 '                                      Config Registers
1090 IEC OUT Fma,"*CLS;*ESE 1;*SRE 16"
1110 '                                      configure device for measurement
1120 IEC OUT Fma,"DEMODULATION AM"
1190 '                                      start measurement
1200 IEC OUT Fma,"DEMODULATION:AM:DEPTH?"
1210 '
1220 REPEAT
1240 '                                      wait for message available
1250 UNTIL Srq%
1260 '                                      FMA is ready
1280 '
1290 '                                      read results from FMA
1300 IEC IN Fma,Result$
1310 '
1320 PRINT Result$
1330 '
1340 RETURN
1350 '-----------------------------------
```

B.1.9 Maximum Measuring Speed

An outstanding characteristic of the FMA family is the combination of high measuring speed with high measuring accuracy.

The instrument firmware guarantees that the measured values supplied are not affected by transients occurring in the devices.
Transients of the test signal which are caused by the signal source or the device under test can, of course, not be suppressed by the arrangements made in the firmware.

This section provides a programming example and describes the marginal conditions which affect the maximum attainable measuring speed in IEC-bus mode.

1.9.1 Influence of Overall Test Setup

In IEC-bus mode, the maximum attainable measurement repetition rate is of decisive importance for the user.
The measurement repetition rate attainable in IEC-bus mode is not only affected by the mere measurement time of the instrument, but also by a number of other influencing factors determined by the total setup, which includes the modulation analyzer, process controller and other IEC-bus controlled devices:

- Process controller characteristics
- Programming language used
- Instrument settings
- Properties of test signal
- Behavior of instruments which are also under IEC-bus control (if any)
- IEC-bus interface of process controller

In particular the used programming language, the IEC-bus interface of the process controller and the process controller itself (eg clock rate) may influence the measurement repetition rate considerably.
Therefore, measures taken to enhance the measurement repetition rate usually must comprise the items stated above.

1.9.2 Influence of Modulation Analyzer

To enhance the measurement repetition rate, the following points concerning the instrument itself must be observed:

- Switch off all measurements which are currently not required (eg the AF path when only RF parameters are of interest)
- Remove filters currently not required from the signal path
- Set the measuring times as low as possible.

Autotune-, autorange- and autolevel-functions do not affect the measuring speed. However, there are the following exceptions:

The commands

`FREQUENCY:RF:TUNE:AUTO ON`	automatic frequency tuning of RF section
`DISTORTION_METER:TUNE:AUTO ON`	automatic frequency tuning of distortion meter
`DISTORTION_METER:RANGE:AUTO ON`	automatic level adjustment of distortion meter

may adversely affect the measuring speed because of complex control mechanisms involved.
In case of known signal characteristics which remain constant during the measurement, the instrument can be fixedly set to this value and the respective automatic mode can be switched off. For example, the command `FREQUENCY:RF:TUNE 525.3MHz` sets the input frequency to 525.3 MHz and simultaneously switches off frequency tuning.
In addition, observe that the measuring times are interdependent.

B.1.9.3 Programming Example

This example illustrates the determination of the maximum measuring speed by way of the following program. It also demonstrates the maximum attainable measuring speeds for a series of standard measurements.

```
10  '-------------------------------------------------------------
20 ' Test program AM measurement vs. the frequency using FMA and SMHU
30 ' 28.11.92 1ES1
40 ' ROHDE & SCHWARZ
50 ' MUEHLDORFSTRASSE 15
60 ' 8000 MUENCHEN 80
70 '-------------------------------------------------------------
80 '
90     GOSUB Prolog
100      GOSUB Init_fma
110    GOSUB Init_smgu
120    GOSUB Measure
130 '
140 END
150 '
160Measure:
170 Sum=0: K=0
180 DIM Dep(1001): DIM Dev(1001): DIM Dist(1001)
190 '
200 '
210 '
220 '--------------- Measurement of FM deviation   ---------
230 '--------------- vs. modulation frequency starts  ---------
240 '
250 '
260 '
270 '--------------- Default setting SMGU ---------
280 IEC OUT Smgu,"preset;fm50khz;lev0dbm;rf100MHz"
290 '
300 '--------------- FM setting FMA ---------
310 '--------------- for max. measuring speed   --------
320 '
330 I$="fre:rf:tune:auto off;fre:rf:tune 100MHz;counter:rf:res 100Hz;"
340 I0$="lev:rf:auto off;lev:rf 1dBm;"
350 I1$="dem:meas 33ms;dem fm;dem:fm:ra:a of;dem:fm:range 100khz;
360 I2$="dem:fm:deemp off;filter:Hi 300Hz;filter:Lo 100kHz;det a;"
370 I3$="counter:af of;mode sing; "
380 I$=I$+I0$+I1$+I2$+I3$
390 IEC OUT Fma,I$
400 HOLD 2000
410 '
420 '--------------- Start of control loop FM deviation vs. ---------
430 '--------------- modulation frequency ---------
440 '
450 PRINT
460 PRINT "FM deviation vs. modulation frequency:"
470 FOR F9=1000 TO 10000 STEP 500
480 K=K+1
490 J$=STR$(F9)
500 IEC OUT Smgu,"AF"+J$+"Hz"
510 A=TIME: ' Start of time measurement
520 HOLD 10: '---- Waiting time for generator SMHU + FMA ---------
530 IEC OUT Fma,"*TRG"
540 IEC OUT Fma,"Demod:FM:dev?"
```

```
550 IEC IN Fma,Dev$
560 B=TIME: Cs=B-A: Sum=Sum+Cs: ' End of time measurement + summation
570 Dev(K)=VAL(Dev$)
580 'PRINT Cs
590 NEXT
600 '--------------- End of measurement loop ---------
620 FOR Kk=1 TO K STEP 1
630 PRINT Dev(Kk)
640 NEXT
650 PRINT "time/measurement";10*Sum/K;"ms"
660 '
670 '
680 '
690 '--------------- Measurement of AM modulation depth  ---------
700 '--------------- vs. RF starts  ---------
710 '
720 '
730 '
740    GOSUB Init_fma
750    GOSUB Init_smgu
760 K=0: Sum=0
770 '--------------- Default setting SMGU ---------
780 IEC OUT Smgu,"preset;AM50pct;fm50khz;lev0dbm;rf100MHz"
790 HOLD 100
800 '
810 '--------------- AM setting of FMA ---------
820 '--------------- for max. measuring speed   --------
830 '
840 I$="*rst;fre:rf:tune:auto off;fre:rf:tune 100MHz;counter:rf:res 100Hz;"
850 I0$="lev:rf:auto off;lev:rf 1dBm;"
860 I1$="dem:meas 33ms;dem am;dem:am:ra:a of;dem:am:range 50pct;
870 I2$="dem:am:deemp off;filter:Hi 300Hz;filter:Lo 100kHz;det a;"
880 I3$="counter:af of;mode sing; "
890 I$=I$+I0$+I1$+I2$+I3$
900 IEC OUT Fma,I$
910 '
920 '--------------- Start of measurement loop  ---------
930 '--------------- AM modulation depth vs. RF ---------
940 '
950 PRINT
960 PRINT "AM modulation depth vs. RF"
970 FOR F9=100 TO 1000 STEP 50
980 K=K+1
990 J$=STR$(F9)
1000 IEC OUT Smgu,"RF"+J$+"MHz"
1010 IEC OUT Fma,"FRE:RF:tune "+J$+"MHz"
1020 A=TIME: '------- Start of time measurement ---------
1030 HOLD 100: ' Waiting time for generator SMHU + FMA
1040 IEC OUT Fma,"*TRG"
1050 IEC OUT Fma,"Demod:am:depth?"
1060 IEC IN Fma,Dep$
1070 B=TIME: Cs=B-A: Sum=Sum+Cs: '-- End of time measurement   ---------
1080 Dep(K)=VAL(Dep$)
1090 'PRINT Cs
1100 NEXT
1110 '--------------- End of measurement loop   ---------
1130 FOR Kk=1 TO K STEP 1
1140 PRINT Dep(Kk)
1150 NEXT
1160 PRINT "time/measurement";10*Sum/K;"ms"
```

```
1170 '
1180 '
1190 '
1200 '--------------- Measurement of FM deviation and ---------
1210 '--------------- distortion vs. AF starts  ---------
1220 '
1230 '
1240 '
1250    GOSUB Init_fma
1260    GOSUB Init_smgu
1270 '
1280 Sum=0: K=0
1290 '--------------- Default setting SMGU   ---------
1300 IEC OUT Smgu,"preset;AM off;fm50khz;lev0dbm;rf100MHz"
1310 '
1320 '--------------- FMA setting FM deviation and --------
1330 '--------------- distortion measurement --------
1340 '--------------- for max. measuring speed  --------
1350 '
1360 I$="*rst;fre:rf:tune:auto off;fre:rf:tune 100MHz;counter:rf:res 100Hz;"
1370 I0$="lev:rf:auto off;lev:rf 1dBm;"
1380 I1$="dem:meas 33ms;dem fm;dem:fm:ra:a of;dem:fm:range 100kHz;"
1390 I2$="dem:fm:dee off;filter:Hi 20Hz;filter:L 100kHz;det average_peak;"
1400 I3$="dist:tune:auto of;dist:tune 1kHz;mode sing;"
1410 I4$="dist on;"
1420 I$=I$+I0$+I1$+I2$+I4$
1430 IEC OUT Fma,I$
1440 HOLD 4000
1470 IEC OUT Fma,I3$
1480 '
1490 '
1500 '
1510 '--------------- Start of measurement loop FM deviation --------
1520 '--------------- and distortion   --------
1530 '
1540 '
1550 '
1560 PRINT
1570 PRINT "FM modulation depth and distortion vs. AF"
1580 FOR F9=1000 TO 10000 STEP 500
1590 K=K+1
1600 J$=STR$(F9)
1610 IEC OUT Smgu,"AF"+J$+"Hz"
1620 IEC OUT Fma,"dist:tune"+J$+"Hz"
1630 A=TIME: ' Start of time measurement
1640 HOLD 20: ' ----Waiting time for generator SMHU + FMA----
1650 IEC OUT Fma,"*TRG"
1660 IEC OUT Fma,"Demod:FM:dev?"
1670 IEC IN Fma,Dev$
1680 IEC OUT Fma,"dist:dist?"
1690 IEC IN Fma,Dist$
1700 B=TIME: Cs=B-A: Sum=Sum+Cs: ' End of time measurement + summation
1710 Dev(K)=VAL(Dev$): Dist(K)=VAL(Dist$)
1720 'PRINT Cs
1730 NEXT
1740 '--------------- End of measurement loop   --------
1760 FOR Kk=1 TO K STEP 1
1770 PRINT Dev(Kk);Dist(Kk)
1780 NEXT
1790 PRINT "           time/measurement";10*Sum/K;"ms"
```

```
1800 '
1810 '
1820 RETURN
1830 '------------------------------
1840Prolog:
1850 '
1860 IEC TERM 10: '  Linefeed
1870 IEC TIME 2000: '   Timeout 2s
1880 '
1890 Fma=29: ' Modulation analyzer IEC address
1900 Smgu=28: '   Signal generator IEC Address
1910 '
1920 '   other initialization
1930 '
1940 RETURN
1950 '------------------------------
1960 '
1970Init_fma:
1980 '
1990 '      reset status registers
2000  IEC OUT Fma,"*CLS"
2010 '
2020 '      reset modulation analyzer settings
2030  IEC OUT Fma,"*RST"
2040 '
2050 RETURN
2060 '------------------------------
2070 '
2080Init_smgu:
2090 '
2100 '      reset status registers
2110  IEC OUT Smgu,"*CLS"
2120 '
2130 '      reset source settings
2140  IEC OUT Smgu,"*RST"
2150 '
2160 RETURN
2170 '------------------------------
```

B.2 Firmware Update

The entire instrument firmware and any required characteristic data are stored in FLASH EPROMs on the PROCESSOR board.
They allow you to execute a firmware update without opening the instrument in order to replace the programmable memories.

Transfer of a new firmware to the instrument only requires a serial interface (X31 on the instrument rear panel) to be connected to the serial interface (COM1 or COM2) of an IBM-compatible process controller via the update cable supplied.
The firmware update provided on MS-DOS-compatible disks is transferred to the connected instrument using the R&S software FLASHUP supplied with the instrument.

Programming and subsequent checking of the transferred software is performed automatically.

4 Maintenance

4.1 Maintenance

Regular maintenance is not required under normal operating conditions.
However, we recommend to check the lithium battery on the microprocessor board 854.4701 at intervals of 1 to 2 years and to clean the front panel and the display field, if necessary.
Likewise, it may be necessary at these intervals to remove dirt inside the instrument which may be due to internal ventilation (compressed air).

4.1.1 Checking and Replacing the Lithium Battery

For data protection of the stored calibration values and of complete setups with the instrument switched off, a CMOS RAM with battery backup is used.
The stored calibration values can be easily restored without additional aids by calling up the appropriate calibration routines (see 3.3.7 in the operating manual).
The service life of the backup battery is typically 8 to 10 years. The current consumption of the CMOS RAMs and the self-discharge of the battery, however, are subject to manufacturing tolerances which may cause the battery to discharge faster in particular at higher operating temperatures.

Checking the battery:

- Remove the two feet on the rear panel (loosen 4 Phillips screws).
- Push the top and the bottom cover towards the rear panel and remove.
- Remove the microprocessor board after loosening cables W25, W30, W31, remove the upper cover of the board after loosening the cover screws.
- Connect a digital voltmeter to soldering terminals 7 (+) and 8 (-) and measure the battery voltage.
  Rated voltage of a new battery: 3.67 V
  Permissible minimum voltage: ≥3.2 V
- If the voltage has fallen below the permissible minimum voltage, replace the battery as described subsequently.
- Complete the instrument.

Replacing the battery:

In case the stored data are to be preserved at any rate:

- Plug the module onto the Service Adapter 856.4050 (included in Service Kit FMA-Z1 856.4009.52).
- Switch on the instrument (RAMs are supplied via AC supply).
- Cut the fastening strap of the battery.
  Unsolder the terminals by means of an ungrounded soldering iron, making sure not to short-circuit the battery.
- Solder new battery G1 in place and fasten using a new strap.

  Caution: Ensure that the polarity is correct.
- Switch off the instrument and complete again.
- The instrument is immediately ready for use.

If stored data (in particular the stored complete setups) may be lost:

- With the microprocessor board 854.4701 removed, cut the fastening strap of battery G1 and unsolder the terminals.
- Solder new battery G1 in place and fasten using a new strap.

  Caution: Ensure that the polarity is correct.
- Complete the instrument again.
- Switch on the instrument and allow for a warm-up time of approx. 0.5 h.
- Recalibrate the instrument:
  For this purpose, call up the function "CalAll" (Calibrate All) according to section 3.3.7 of the operating manual.
- The instrument is then ready for use.

4.1.2 Cleaning the Front Panel and the Display Field

The front panel and the display field can be cleaned using a soft cloth and a commercially-available non-alcoholic detergent diluted with water.
The identification plate can be easily taken off after unscrewing the 4 Phillips screws.

4.1.3 Internal Cleaning of the Instrument Using Compressed Air

With the instrument switched off, remove the panelling, all boards and the cover of the power supply.
Remove the complete power supply unit towards the rear after loosening the marked screws on the rear of the instrument (4 screws) and in the upper and lower rear instrument frame (3 each) and after removing cable WXY.
Clean the interior of the instrument as well as the power supply and the blower using compressed air.
Clean all boards using compressed air; in the case of boards with perforated side panels, remove the covers if necessary.
Then complete the instrument again.

The frequency accuracy of the synthesizer is simultaneously monitored by an IF measurement. All amplifier stages in the demodulator as well as the linearity and error of all detectors are tested.

4.2 Function Test (Self-test)

4.2.1 Automatic Self-test of the Fundamental Processor Functions

Each time the instrument is switched on, the following basic functions of the microprocessor board are checked:

Microprocessor board:

- Functioning of the RAM
- RAM contents
- Internal parallel and serial interfaces
- Interrupt controllers I and II
- Functioning of the A/D converter
- IEC-bus interface

Keyboard/display module:

- Partial function of the menu display
- Partial function of the three measurement displays

If serious faults are found during these tests, the program run is aborted and an error status is output using the front panel LEDs.

CMOSRAM:
AUDIO, CALIBRATE, STATUS

External serial interface:
DEMOD, CALIBRATE, STATUS

Interrupt controller I:
RF, DEMOD, CALIBRATE, STATUS

Interrupt controller II:
RF, DEMOD, AUDIO, CALIBRATE, STATUS

Internal parallel interface I:
RF, CALIBRATE, STATUS

Internal parallel interface II:
RF, AUDIO, CALIBRATE, STATUS

(See also Microprocessor description 7.3 of the Service Manual)

4.2.2 Module Identification

The processor then performs a module identification:

If modules of the basic instrument are missing, an appropriate brief error message is output in the status display. When pressing the main function key "INFO", an additional plain text message is output in the menu display.
In the following, a check is made to determine all optional boards included in the instrument, and the operating menues are configured accordingly (e.g. filter and detector menu if the filter option is fitted).

4.2.3 Permanent Fault Monitoring during Operation

During operation, important instrument functions are permanently monitored, e.g.:

- Temperature of power supply heat sink
- Temperature inside the instrument and, as a function of this, validity of calibration values (temperature sensor on attenuator module).
- Using Reference Oscillator option FMA-B10: Temperature of 10-MHz reference oscillator
- Permissible tuning voltage range of 100-MHz reference oscillator
- Permissible tuning voltage range of the different synthesizer loops
- Function of frequency counter
- Control range of AF measuring path
- Using DIST/SINAD Meter option FMA-B2 and with distortion or SINAD measurement activated:
  Correct tuning of notch filter and ranging of notch amplifier

Short error messages are output in the status display, and the status LED additionally flashes. When pressing the status key, error messages are additionally output in plain text in the menu display.

4.2.4 Cold Start

The instrument automatically performs a cold start if particular control bits in the CMOS RAM are found to be faulty or if the instrument configuration has been changed after the last switch-on, e.g. when retrofitting an option or following a firmware update.
In this case, the CMOS RAM is deleted, stored instrument setups and calibration values stored in the CMOS RAM being lost.
However, the calibration values can be restored at any time by calling up the appropriate calibration routines without external aids (see section 3.3.7 in the operating manual).

A cold start can also be produced intentionally:
For this purpose, press the PRESET key when switching on.

5 Testing the Rated Specifications

Sections 5.1 to 5.3 describe a complete performance test for models FMA, FMAB and FMB. This test requires an extensive range of measuring equipment. With the help of the FMA-B4 option (Calibrator), 80 % of the performance test can be executed without having to use additional measuring equipment. See also Section 5.4.

When the FMA-B4 option is supplemented by a signal generator (recommended:SMHU) the measurements can be carried out at various carrier frequencies and all measurements of spuriae (with FMA-B1 option, Filter) are possible (see Sections 5.2 to 5.3). This means that more than 95 % of the performance test can be made. The Calibrator option together with a signal generator allow the fast and easy verification of substantial specifications.

5.1 Measuring Equipment and Accessories

Item	Type of instrument	Required characteristics	Appropriate R&S instrument	Order No.	Use
1	Signal generator	4.3 to 5.2 GHz: 80 % AM 50 kHz to 4.3 GHz: Level max. +17 dBm AM/FM 10 Hz to 100 kHz AM depth up to 95 % Frequency deviation up to 700 kHz synchronous AM at 1 kHz Deviation 40 kHz <0.05 % Residual FM unwt RMS up to 340 MHz: <1 Hz up to 2.6 GHz: <5 Hz	SWM SMHU 58	814.7016.05 835.8011.58	5.2.1 5.2.4 5.2.5.1 5.2.5.2 5.2.5.3 5.2.5.4 5.2.6.1 5.2.6.2 5.2.6.3 5.2.6.5 5.2.6.6 5.2.6.7 5.2.7.1 5.2.7.2 5.2.7.3 5.2.13
2	Frequency counter	10 MHz, error $<10^{-9}$			5.2.2
3	Air conditioning cabinet	Temperature 0 to +55° C			5.2.2
4	Spectrum & Network Analyzer	50 kHz to 5200 MHz	FSBS	851.2008.52	5.2.3 5.2.4 5.2.5.1 5.2.6.1 5.2.6.5 5.2.13
5	VSWR bridge	50 kHz to 5200 MHz	<2.7 GHz: ZRB 2	373.9017.53	5.2.3
6	RF power amplifier	50 kHz to 5200 MHz Gain >16 dB; P> +26 dBm			5.2.4
7	Power splitter	DC to 5200 MHz 50 Ω; attenuation 2 x 6 dB	<2.7 GHz: RVZ	800.6612.52	5.2.4 5.2.12 5.2.13
8	RF powert meter	50 kHz to 5200 MHz Error <1.4 GHz <0.15 dB <5.2 GHz <0.25 dB	NRV +NRV-Z5	828.2511.02 828.3818.02	5.2.4 5.2.13
9	AM test source	12.5 MHz Linearity <0.1 % m<95 % FM <5 Hz @ 50% AM/1 kHz			5.2.5.1 5.2.5.4 5.2.6.6

Item	Type of instrument	Required characteristics	Appropriate R&S instrument	Order No..	Use
10	AC calibrator	10 Hz to 200 kHz 1 mV to 10 V Error 30 Hz to 20 kHz: <0.1 % 10 Hz to 100 kHz: <0.2 % 10 Hz to 200 kHz: <0.4 % Noise: <10 µV in 100 kHz bandw.			5.2.5.1 5.2.5.4 5.2.6.1 5.2.6.5 5.2.6.6 5.2.7.3 5.2.8.1 5.2.8.2 5.2.10.3
11	Mixer	RF/LO: 10 to 2000 MHz ZF: 0.05 to 2000 MHz LO: +17 dBm; RF≤ +14 dBm			5.2.5.1 5.2.5.4 5.2.6.1 5.2.6.5 5.2.6.6 5.2.7.3
12	Attenuator 1	6 dB; 50 Ω			5.2.5.1 5.2.5.4 5.2.6.1 5.2.6.5 5.2.6.6 5.2.7.3
13	Filter for AM	Lowpass: $f_{-3\,dB}$ ≈ 5 MHz 2.1 MHz ± 20 kHz: ± 0,2 % 12.5 MHz: <-30 dB Bandpasses: 800 MHz/2 GHz ± 100 kHz: ± 0.2 %; ± 200 kHz: ± 1 % ± 12.5 MHz: <-30 dB			5.2.5.1 5.2.5.4 5.2.6.6
14	RF amplifier	50 kHz to 2 GHz Noise figure <10 dB Gain var. 20 to 30 dB Harmonics <-60 dBc			5.2.5.1 5.2.5.4 5.2.6.1 5.2.6.5 5.2.6.6 5.2.7.3
15	Thermal power meter	12.5 MHz;: with +2 dBm Resolution 0.001 dBm			5.2.5.1
16	Audio Analyzer	Weighting: CCITT, CCIR wght./unwght. RMS and Quasipeak Distortion meter: 10 Hz to100 kHz Measurement range <0,01 % Measuring error <5 %	UPA3	372.6014.03	5.2.5.2 5.2.5.4 5.2.6.2 5.2.6.3 5.2.6.5 5.2.7.2 5.2.7.3
17	FM test source	100/400 MHz; Deviation 700 kHz Frequency response up to 20 kHz: <0.1 % 100 kHz: <0.2 % 200 kHz: <0.4 % Linearity: 0.02 %			5.2.6.1 5.2.6.4 5.2.6.5 5.2.7.3
18	Filter for FM	Lowpass: $f_{-3\,dB}$ ≈ 50 MHz 400 MHz: <-30 dB linear phase up to13 MHz Bandpasses: 800 MHz/2 GHz ± 400 MHz: <-30 dB linear phase ± 500 kHz about centre frequency			5.2.6.1 5.2.6.5 5.2.7.3

Item	Type of instrument	Required characteristics	Appropriate R&S instrument	Order No.	Use
19	Stereo decoder	Crosstalk attenuation 30 Hz to15 kHz: >56 dB 1 kHz: >60 dB Noise voltage >78 dB	MSDC2	281.0514.04	5.2.6.3 5.2.6.4
20	Stereo coder	Crosstalk attenuation 30 Hz to 15 kHz: >56 dB 1 kHz: >60 dB	MSC2	230.9314.04	5.2.6.4
21	Function generator	Sine, square, pulse, single sine burst with manual tiggering and burst sequence 1 Hz to 400 kHz	AFGU	377.5000.02	5.2.6.4 5.2.9 5.2.10.1 5.2.10.2 5.2.10.3 5.2.11 5.2.12 5.2.13
22	DC Voltmeter & Ohmmeter	0 to 10 V, Error <0.1 % 0.6 to 100 kΩ: <0.5 %	UDS5	349.1510.02	5.2.8.1 5.2.8.2
23	DC calibrator	1 mV to 20 V Error <0.1 % ± 10 µV			5.2.8.1 5.2.8.2
24	AC voltmeter	10 mV to 10 V 40 Hz to. 100 kHz: <1 % 100 to 300 kHz: <2 %	URE3	350.5315.03	5.2.12 5.2.13
25	AF generator	Harmonics suppression 10 Hz to 20 kHz: >90 dB >20 to100 kHz: >80 dB			5.2.12 5.2.13
26	Attenuator 1	50 Ω; 10 to 60 dB Error<300 kHz: <0.2 dB	DPSP	334.6010.02	5.2.12 5.2.13

5.2 Test Sequence

The limit values specified in the test report correspond to those in the data sheet; they do not include the errors of the measuring instruments acc. to section 5.1.
In any case the error that may be caused by the measuring instruments used must be considered **with correct sign**. The tolerance is exceeded only when the measurement result exceeds the maximum value according to the test report after having subtracted *) the maximum error of the measuring instruments or when the measurement result is below the minimum value according to the test report after having added *) the maximum error of the measuring instruments.

*) Take into account how the errors add up, e.g. quadratically with deviation (noise) and linearly with useful deviation.

Examples:

Measurement of 100 kHz frequency deviation:

Nominal display of FMA acc. to test report:	99.5 ... 100.5 kHz
Guaranteed deviation of test source used	99.9 ... 100.2 kHz
Permissible display of FMA:	99.4 ... 100.7 kHz
	= (99.5 - 0.1) ...(100.5 + 0.2)

Measurement of residual FM:

Nominal display of FMA acc. to test report:		0 ... 2 Hz
Guaranteed residual FM of signal generator used:		≤ 1 Hz
Permissible display of FMA:	0 ... $\sqrt{(2^2 + 1^2)}$ =	0 ... 2.24 Hz

5.2.1 RF Counter Accuracy and Sensitivity

Test setup: Connect signal generator to RF input of FMA. Connect 10-MHz output of signal generator to external reference input of FMA.

FMA: RF frequency display, Auto Tune, counter resolution 0.1 Hz; external reference

Measurement: Check RF frequency display of FMA according to test report at various frequencies and levels with and without AM.

5.2.2 Reference Oscillator Accuracy

Test setup: Place FMA into air conditioning cabinet. Connect frequency counter to 10-MHz reference output of FMA.

FMA: Internal reference

Measurement: Measure deviation of reference frequency at 23 °C, taking into account the operating time since the last calibration (aging) as well as the additional error within the temperature range 0 to 55 °C (temperature drift) according to the test report.

5.2.3 Reflection at RF Input

Test setup: Connect network analyzer with VSWR bridge to RF input of FMA.

FMA: RF level measurement, Manual Level -10 dBm (corresponds to 10-dB RF attenuation)

Measurement: Measure return loss re over the entire frequency range of the FMA. The VSWR can be calculated as follows:

$$VSWR = (1 + r) / (1 - r); \quad r = 10^{-(a_r/20\,dB)}$$

5.2.4 RF Power Measurement

Test setup: Connect signal generator (+ power amplifier) via power splitter (6 dB) to the terminating measuring head of an RF level measuring set and to the RF input of the FMA. Before, check the harmonics suppression using a spectrum analyzer, since a 40-dB harmonics suppression causes an error in measurement of 0.1 dB. If required, a switched lowpass filter must be connected between signal generator (amplifier) and power splitter.

The VSWR of the source shall be ≤0.1. With a more significant misadjustment, multiple reflections between FMA and Generator cause additional uncertainty in measurement, which is approximately given by the equation:

$\delta_p = 200 \cdot r_F \cdot r_G$

δ_P = uncertainty in power in %
r_F = reflecion faktor FMB/FMAB/FMAV or FMB
r_G = reflecion faktor generator

FMA: RF level measurement, Auto Level

Measurement: Apply various levels at various frequencies according to test report and check the power display of the FMA.

5.2.5 Amplitude Modulation

5.2.5.1 AM Measuring Accuracy

Test setup: The modulation is generated using an AM test source and an AC calibrator. The various carrier frequencies are obtained by up or down-conversion with a signal generator and a low-intermodulation mixer. The mixer must have a broadband termination (6-dB Attenuator 1 pad). This must be followed by a lowpass filter in the case of down-conversion and a bandpass filter for the IF in the case of up-conversion in order to suppress the frequencies of the test source and the signal generator as well as unwanted mixture products. The filters must feature a flat frequency response about the IF within the modulation bandwidth (± 100 kHz 0.2 %, ± 200 kHz). The filter must be followed by a low-distortion and low-noise amplifier to increase the level for the measurement to -17.5 dBm/-11.5 dBm. Use a spectrum analyzer to check whether spurious signals up to ± 300 kHz from the carrier are >80 dbc and, outside this range, decreasing with 30 dB/octave.

Calibration: The test source is calibrated at 12.5 MHz, 80 % AM at various modulation frequencies using a high-resolution thermal power meter (raise level to + 2 dBm using amplifier).

The modulation depth is calculated as follows: $m = 100\,\% \cdot \sqrt{[2 \cdot (P/P_o - 1)]}$
where: P = power with AM, Po = power without AM

The other modulation depths are obtained by modifying the output voltage of the AC calibrator correspondingly.

FMA: Auto Level; Demodulation AM, Auto Range; Detector ± peak/2;
Filter: LP 100 kHz to 20 kHz, >20 kHz no LP

Measurement: Check AM display of the FMA with various carrier frequencies, modulation depths
and modulation frequencies according to test report.

Important note: *Subtract the influence of the spurious modulation from the readout. The residual AM display without modulation must not directly be subtracted. With a reference measurement at the appropriate carrier frequency and for each modulation depth with 400-Hz modulation frequency, the modulation is determined virtually free from spurious modulation (negligible for m = 20 % due to the filters) using a 20-Hz highpass and a 2-kHz lowpass. In subsequent measurements with LP 100 kHz and without lowpass, the readout will increase according to the spurious*

5.2.5.2 Residual AM

Test setup: Connect signal generator to RF input of FMA. If the filter option FMA-B1 is not provided, connect a psophometer to the AF output of the FMA.

FMA: Manual Level -17.5 dBm; demodulation AM, Manual Range 1 %; LP 100 kHz
With filter option: Auto Level, AM-Autorange, filter and detector according to test report.

Measurement: Measure residual AM of FMA using psophometer at various carrier frequencies with the weighting filters according to the test report. For this purpose, a reference measurement must be performed at each carrier frequency and each time the RF level is varied. To this end, the signal generator is modulated with 1 kHz and m = 1 %. The voltage readout of the psophometer at 20 Hz -22 kHz RMS then serves as a reference (= 1 % AM).

If the filter option is provided, the calibration is omitted. After switching on the desired weighting filters, the residual AM is directly read out in % on the FMA.

5.2.5.3 Synchronous AM

Test setup: Connect signal generator to RF input of FMA.

FMA: Auto Level; Demodulation AM, Auto Range; detector ±peak/2; HP 20 Hz, LP 3 kHz

Measurement: Modulate signal generator at different carrier frequencies according to FM test report and check AM display of FMA.

5.2.5.4 AF Distortion with AM

Test setup: Test setup with AM test source as in 5.2.5.1
If the Distortion Meter Option FMA-B2 is not provided, connect distortion meter to AF output of FMA.

FMA: Auto Level; Demodulation AM, Auto Range; LP 100 kHz
With distortion meter: Audio Dist. (%)

Measurement: Check AF distortion with various carrier frequencies, modulation depths and modulation frequencies according to test report.

5.2.6 Frequency Modulation

5.2.6.1 FM Measuring Accuracy

Test setup: The modulation is generated using an FM test source and an AC calibrator. The various carrier frequencies are obtained by up or down-conversion with a signal generator. The mixer must have a broadband termination (6-dB Attenuator 1). This must be followed by a lowpass filter in the case of down-conversion and a bandpass filter for the IF in the case of up-conversion in order to suppress the frequencies of the test source and the signal generator as well as unwanted mixture products. The filters must feature a linear phase response about the IF within the frequency deviation. The filter must be followed by an amplifier, increasing the level for the measurement to -17.5 dBm/-11.5 dBm. Use a spectrum analyzer to check whether spurious signals up to ±300 kHz from the carrier are >90 dBc and, outside this range, decreasing with 30 dB/otave.

Calibration: The deviation is calibrated according to the Bessel zero method using a spectrum analyzer. The modulation frequency response is then measured from the reference points.

Reference deviation	Modulation frequency	η	Zero carrier
5 kHz	2.0792 kHz	2.4048	1
20 kHz	3.6232 kHz	5.5200	2
100 kHz	18.116 kHz	5.5200	2
150 kHz	17.334 kHz	8.6537	3
700 kHz	80.890 kHz	8.6537	3

FMA: Auto Level; Demodulation FM, Auto Range; detector ± peak/2;
Filter: LP 100 kHz to 20 kHz, >20 kHz no LP

Measurement: Check FM readout of the FMA with various carrier frequencies, deviations and modulation frequencies according to the test report.

Important note: Subtract the error caused by the residual FM from the readout. The residual FM display without modulation must not directly be subtracted. With a reference frequency for each carrier frequency and deviation (except 700 kHz) with 400-kHz modulation frequency, the deviation is determined virtually free from residual FM (negligeable for deviations ≥ 5 kHz due to the filters) using a 20-Hz highpass and a 3-kHz lowpass. In subsequent measurements with LP 100 kHz and without lowpass, the readout will increase according to the residual FM. The variation is equal to the residual FM, which is to be subtracted for all measurements with LP 100 kHz/without LP.

5.2.6.2 Residual FM

Test setup: Connect signal generator to RF input of FMA. If the filter option FMA-B1 is not provided, connect a psophometer to the AF output of the FMA.

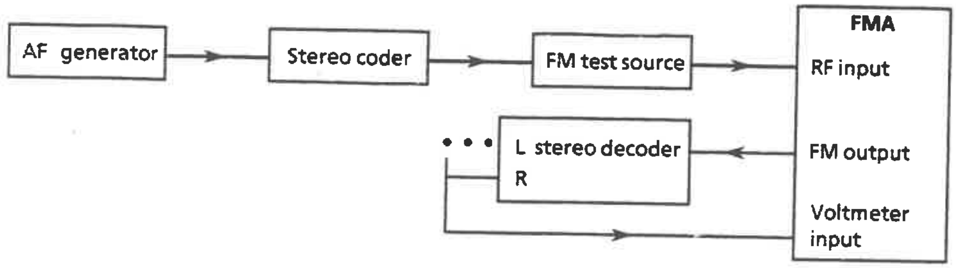
FMA: Auto Level; demodulation FM, Manual Range 100 Hz; deemphasis according to the test report; LP 100 kHz
With filter option: FM-Autorange, filter and detector according to test report

Measurement: Use a psophometer to measure residual FM of FMA at various carrier frequencies with the weighing filters according to the test report. For this purpose, a reference measurement without deemphasis must be performed at any carrier frequency. To this end, modulate the signal generator with 100-kHz deviation and fmod = 1 kHz. The voltage readout of the psophometer at 20 Hz-22 kHz RMS then serves as a reference (= 100-Hz deviation).

If the filter option is provided, the calibration is omitted. After switching on the desired weighting filter, the residual FM of the FMA is directly displayed in Hz.

5.2.6.3 Stereo S/N Ratio

Test setup: Connect signal generator to RF input, stereo decoder to FM output of FMA. Connect L or R output of the decoder to psophometer or, if the filter option FMA-B1 is provided, to the voltmeter input.



FMA: Auto Level; Demodulation FM, Noise LP On
With filter option: Voltmeter AC unbal., autorange, RF on, filter and detector like psophometer under measurement

Measurement: Set stereo coder so that the useful deviation (without pilot) on one channel (L or R) = 40 kHz at f mod = 1khz and the pilot-tone deviation = 6.72 kHz. Drive decoder optimally, switch off deemphasis and connect psophometer to the modulated channel (L or R). Set psophometer weighting to 20 Hz to 22 kHz RMS.The voltage readout of the psophometer is the reference (= 0 dB). Switch off modulation, switch on deemphasis 50 µs and set psophometer to CCIR Wght. quasipeak. Read off the S/N ratio on the psophometer in dB for various carrier frequencies according to the test report.

Using the filter option, the decoder signal can be measured via the voltmeter input and weighted with a psophometer. The reference value is stored and switched to relative dB. The S/N ratio is directly read out in dB.

5.2.6.4 Stereo Crosstalk

Test setup: see 5.2.6.3

FMA: Auto Level; demodulation FM, Noise LP off; detector ± peak/2
After deviation setting: Voltmeter AC unbal., autorange, RF on; LP 100 kHz

Measurement: Set stereo coder such that the useful deviation (without pilot) on one channel = 40 kHz at f_{mod} = 1 kHz, pilot-tone deviation = 6.72 kHz. Use voltmeter to measure output voltage of the same channel on the stereo decoder, store as reference value and switch to relative dB. Change to the non-modulated channel on the stereo decoder. The crosstalk can directly be read in dB on the FMA. Perform measurements for various AF frequencies and both channels according to test report.

5.2.6.5 AF Distortion with FM

Test setup: Test setup with FM test source as in 5.2.6.1
If the Distortion Meter option FMA-B2 is not provided, connect distortion meter to AF output of FMA.

FMA: Auto Level; demodulation FM, autorange; filter: LP 100 kHz to 20 kHz, >20 kHz no lowpass
With distortion meter: Audio Dist.(%)

Measurement: Use distortion meter to check AF distortion with various carrier frequencies, deviations and modulation frequencies according to test report.

5.2.6.6 Synchronous FM

Test setup: Test setup with AM test source as in 5.2.5.1

FMA: Auto Level; demodulation FM, Auto Range; detector ± peak/2; HP 20 Hz, LP 3 kHz

Measurement: AM-modulate test source at various carrier frequencies according to test report and check FM display of FMA.

The residual FM is not negligible; it is to be measured without modulation and subtracted from the display value.

Note: The error in measurement due to the synchronous FM of the test source can be eliminated by performing one measurement with normal sideband and one with inverse sideband (RF special menu) and taking the average of the measured values. The synchronous FM of the test source should be maximally equal to that of the FMA.

5.2.6.7 Deemphases

Test setup: Connect signal generator to RF input of FMA.

FMA: Auto Level; demodulation FM, Auto Range; detector ± peak/2; LP 23 kHz
Deemphasis according to test report

Measurement: Set deviation and f_{mod} on the signal generator according to test report. Measure deviation without deemphasis, store measured value as reference and switch to relative dB. Switch on deemphasis according to test report and read off the attenuation.

5.2.7 Phase Modulation

5.2.7.1 PM Measuring Accuracy

Test setup: Connect signal generator to RF input of FMA.

FMA: Auto Level; demodulation FM bzw. PM, Auto Range; detector ± peak/2;
additionally with filter option: Demod. FM or Low Freq. PM; LP 100 kHz

Measurement: The demodulation is performed via the FM demodulator which is followed by a weighting filter with 1/f frequency response. It is sufficient to prove the accuracy of this filter over the modulation frequency so that:

[Error of PM filter] < [perm. PM measuring error] - [perm. FM measuring error]

Read off the FM and PM display of the FMA with deviation and f_{mod} according to test report. The additional measuring error with PM as against FM is calculated as follows:

Error of PM filter = (f_{mod} x PM/FM-1) x 100 %

5.2.7.2 Residual PM

Test setup: Connect signal generator to RF input of FMA. If the filter option FMA-B1 is not provided, connect a psophometer to the AF output of the FMA.

FMA: Auto Level; demodulation PM, Manual Range 0,1 rad; LP 100 kHz
With filter option: PM-Autorange, filter and detector according to test report.

Measurement: Measurement: Use a psophometer to measure residual PM of the FMA at various carrier frequencies with the weighting filters according to the test report. For reference measurement, the signal generator is modulated with 100-Hz deviation and f_{mod} = 1 kHz at any carrier frequency. The voltage readout of the psophometer at 300 Hz - 22 kHz RMS then serves as a reference (= 0.1 rad).

If the filter option is provided, the calibration is omitted. After switching on the desired weighting filter, the residual PM of the FMA is directly displayed in rad.

5.2.7.3 AF Distortion with PM

Test setup: Test setup with FM test source as in 5.2.6.1
If the Distortion Meter option FMA-B2 is not provided, connect distortion meter to AF output of the FMA.

FMA: Auto Level; demodulation PM, Auto Range; LP 100 kHz
With distortion meter: Audio Dist.(%)

Measurement: Check the AF distortion using the distortion meter with various carrier frequencies, deviations and modulation frequencies according to test report..

5.2.8 Voltmeter

5.2.8.1 Unbalanced Input

Input impedance

Test setup: Connect ohmmeter to unbalanced voltmeter input.

FMA: Any setting

Measurement Measure DC input impedance.

Offset voltage

Test setup: Short-circuit unbalanced voltmeter input.

FMA: Briefly switch the instrument off and on.
Voltmeter DC unbal., Auto Range

Measurement: The FMA reads out the offset voltage. Call up Calibrate Voltmeter and read off the voltage display.

DC measuring accuracy

Test setup: Connect DC calibrater to unbalanced voltmeter input.

FMA: Voltmeter DC unbal., Autorange

Measurement: Call up Calibrate Voltmeter unless this has already been done for the offset measurement. To this end, short-circuit the input first.

Check FMA readout at various voltages according to test report.

RMS measuring accuracy

Test setup: Connect AC calibrator to unbalanced voltmeter input.

FMA: Voltmeter AC unbal., Autorange; filter according to test report.

Measurement: Check FMA display at various voltages and frequencies according to test report.

5.2.8.2 Balanced Input

Input impedance

Test setup: Connect ohmmeter to balanced voltmeter input.

FMA: Any setting

Measurement: Measure DC input impedance.

Offset voltage

FMA: Briefly switch instrument off and on
Voltmeter DC balanced, Autorange

Measurement: FMA displays offset voltage. Call up Calibrate Voltmeter and then read off voltage display.

DC measuring accuracy

Test setup: Connect DC calibrator to balanced voltmeter input. Use short, thick cables because of the 600-Ω input impedance.

FMA: Voltmeter DC balanced, Autorange

Measurement: Call up Calibrate Voltmeter, unless this has already been done in the offset measurement. To this end, leave the input open first.

Check the FMA display with various voltages according to test report.

RMS measuring accuracy

Test setup: Connect AC calibrator to balanced voltmeter input. Use short, thick cables because of 600-Ω input impedance.

FMA: Voltmeter AC balanced, Autorange; filter according to test report.

Measurement: Check FMA display at various voltages and frequencies according to test report.

5.2.9 AF Weighting Filter

Test setup: Connect AF generator to unbalanced voltmeter input.

FMA: Voltmeter AC unbal., Manual Range 2 V, relativ dB; filter according to test report

Measurement: Store the measured voltage as reference value with 2 V RMS at every frequency according to the test report without filter; switch on the filter and measure its attenuation.

5.2.10 Option Filter FMA-B1

5.2.10.1 AF Weighting Filter

Test setup, FMA setting and measurement as in 5.2.9

Exceptions: Measure all attenuation values >30 dB with autorange!
CCIR Wght. Aways use Autorange for measurements on the filter.

5.2.10.2 Phase Linearization of AC Coupling

Test setup: Connect function generator to unbalanced voltmeter input.

FMA: Voltmeter AC unbal., measuring time 100 ms, manual range 2 V;
detector ± peak/2; LP 30 kHz (filter option), no highpass

Measurement: Set generator to symmetrical rectangle 4 Vpp, 5 Hz. Check FMA display.

Note: *The phase linearization is automatically cut in when selecting LP 30 kHz or LP 120 kHz. It reduces falsification of the peak-to-peak value of a squarewave signal due to AC coupling.*

5.2.10.3 Psophometer (CCIR 468-4 Detector)

Meßaufbau: Connect AC calibrator or function generator to unbalanced voltmeter input.

FMA: Voltmeter AC unbal., Meßzeit 1 s, Manual Range 1 V;
Filter CCIR Wght.; Detector quasipeak

Measurement: *Fundamental accuracy*

AC-calibrator 1 kHz, 0,775 V RMS;
check display of FMA according to test report

Single pulse display

Function generator 5 kHz, 0.775 V RMS continuous sinewave signal;

perform reference measurement: store display value (approx. 3 V due to CCIR filter) as reference value and switch to RelativX/Ref.Val.

Switch function generator to burst mode with manual triggering. The single bursts triggered are to contain an even number of sinewave periods (frequency and amplitude as with the reference measurement), the first period having to start in the zero crossing.
Check the relative display of the FMA with different burst duration according to test report.

Pulse sequence display

Reference as with single pulse display;
switch function generator to repeating burst operation. Set the burst duration to 5 ms.
Check the relative display of the FMA with different burst repetition rate according to test report.

Overload immunity

Set frequency = 5 kHz, amplitude = 10 V_{pk} (7 V RMS) on the function generator and switch to burst operation with manual triggering. Set the burst duration to 0.6 ms (= 3 periods).
Reference measurement: (Important: maintain manual range 1 V!)
Trigger single burst, store FMA display as reference value and switch FMA to relative dB.
Reduce amplitude of function generator by 20 dB (1 V_{pk}) and check relative display according to test report.

Polarity reversal error

FMA: Filter CCIR Unwt. (detector remains quasipeak)
Set function generator to squarewave DC pulses of 1 ms duration, frequency 100 Hz, amplitude +0.8 V.
Reference measurement: Store FMA readout as reference and switch to relative dB.
Reverse the polarity of the signal with constant amplitude (0.8 V) and check relative display according to test report.

5.2.11 AF Counter Accuracy

Test setup: Connect AF generator to unbalanced voltmeter input of FMA

FMA: Voltmeter AC unbal, Auto Range; no filter; audio frequency measurement

Measurement: Check AF frequency display of FMA according to test report at 200 mV and various frequencies.

5.2.12 Distortion Meter Option FMA-B2

Inherent distortion display and noise

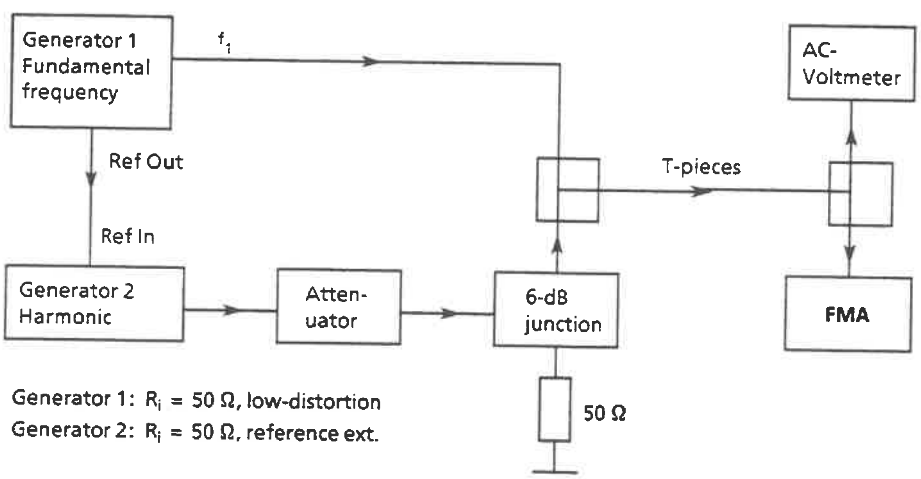
Test setup: Connect low-distortion AF generator to unbalanced voltmeter input of FMA.

FMA: Voltmeter AC unbal, autorange; no highpass, lowpass according to test report; Audio Dist Sinad, Dist. [%], Auto Range, Auto Tune

Measurement: Check inherent distortion display of FMA with various voltages and frequencies according to test report.

Measuring accuracy (SINAD display)

Test setup:



Generator 1: R_i = 50 Ω, low-distortion
Generator 2: R_i = 50 Ω, reference ext.

FMA: Voltmeter AC unbal, Auto Range; kein Filter; Audio DistSinad, Sinad [dB], Auto Range, Man Tune f1

Measurement: For each frequency combination according to the test report, set generator 1 to 2 V, generator 2 to 4 V and the Attenuator 1 to 40 dB. Store the voltage measured using the AC voltmeter as reference value. Set generator 1 to ≤ 1 mV and the AC voltmeter display to -40.0 dB by varying the output voltage of generator 2. For the following measurements, set generator 1 back to its original voltage of 2 V and the Attenuator 1 to the attenuation value according to the test report..

The SINAD value is calculated as follows:

SINAD = 10 dB · log[1 + $10^{(a/10dB)}$]   with a = attenuation

The followig applies for a ≥ 20 dB: SINAD ≈ a

5.2.13 Checking the Outputs

IF output

Test setup: Connect signal generator to RF input and level meter (50 Ω) to IF output of FMA.

FMA: Auto Tune; Auto Level; demodulation AM

Measurement: Set signal generator to 100 MHz. Increase level from -10 dBm to -2 dBm in 0.1-dB steps and check max. IF level according to test report.

AM output

Test setup: Connect signal generator to RF input and AC voltmeter to AM output of FMA.

FMA: Auto Tune; Auto Level; Demodulation AM

Measurement:: Set signal generator to 100 MHz, 95 % AM, f_{mod} = 1 kHz. Increase level from -10 dBm to -2 dBm in 0.1-dB steps and check max. voltage at AM output according to test report.

FM/PM output

Test setup: Connect AF generator to unbalanced voltmeter input and AC voltmeter to AF output of FMA.

FMA: Auto Tune; Auto Level; demodulation FM/PM (see measurement:), Auto Range

Measurement: Set signal generator to 100 MHz, 40-kHz deviation, f_{mod} = 1 kHz. Set the deviation exactly using the Bessel zero method. Check the voltage at the FM/PM output with demodulation FM and PM according to test report.

AF output

Test setup: Connect AF generator to unbalanced voltmeter input and AC voltmeter to AF output of FMA.

FMA: Voltmeter AC unbal, Auto Range;

Measurement: AF generator f = 1 kHz, continuously increase voltage from 1 to 4 V. Check voltage at AF output according to test report.

Distortion output (only FMA-B2)

Test setup: As with distortion meter 5.2.12 measuring accuracy, however connect AC voltmeter to distortion output of FMA.

FMA: Voltmeter AC unbal, Auto Range; no filter; Audio DistSinad, Sinad [dB], Auto Range, Man Tune f_1

Measurement: Generator 1: 2 V, 1 kHz; Generator 2: 4 V, 2 kHz; Attenuator 1 40 dB. Reduce attenuation in 0.1-dB steps down to 30 dB. Check voltage at distortion output according to test report.

Stereo decoder outputs (only FMA-B3)

Connect the MPX output of the stereo decoder to the balanced stereo-decoder input (DEC IN) to perform any measurement. When using the calibrator FMA-B4, use both AF outputs AF1 and AF2 as one balanced output.

Indications of level in dBm refer to 600 Ω. Since the stereo-decoder input is highly resistive, the generator must supply a corresponding voltage at no load (+ 6 dBm = 1.545 V).

Stereocoder: onlyL / only R / L = R / L = -R, level + 6 dBm, freq. 1 kHz, pilot -9.5 dBm;

FMA: Demodulation FM-Stereo Extern, Auto Range

Measurement: Check the level at the decoder outputs L/R/M/S.

5.2.14 Stereo decoder option FMA-B3

Connect the MPX output of the stereo decoder to the balanced stereo-decoder input (DEC IN) to perform any measurement. When using the calibrator FMA-B4, use both AF outputs AF1 and AF2 as one balanced output.

Note: *Indications of level in dBm refer to 600 Ω. Since the stereo-decoder input is highly resistive, the generator must supply a corresponding voltage at no load (+ 6 dBm = 1.545 V).*

Crosstalk attenuation

Stereocoder: Stereo decoder; only L, or L = R, level + 6 dBm, freq. 1 kHz, pilot level -9.5 dBm;

FMA: RMS detector; demodulation FM stereo extern.., Auto Range, Unit dBm, channel: see measurement;

Measurement: Switch to the modulated channel (L or M) in the FM stereo menu, store the value displayed under "Relativ" as reference value and switch to X/Ref dB. Subsequent to switching over to the unmodulated channel (R or S), the crosstalk attenuation is displayed directly in dB. Perform measurement for various AF frequencies according to the test report.

Frequency response

Stereocoder: only L / only R / L = R / L = -R, level + 6 dBm, freq. 1 kHz, pilot -9.5 dBm;

FMA: RMS detector; demodulation FM stereo extern., Auto Range, Unit dBm, channel L / R / M / S;

Measurement: Switch to the modulated channel (L/R/M/S) in the FM stereo menu, store the value displayed under "Relativ" as reference value and switch to X/Ref dB.
Perform measurement for various AF frequencies acc. to the test report. The frequency response is displayed directly in dB.
Perform the reference measurement with 1 kHz in all channels.

Level difference between left channel and right channel

Stereocoder: L = R, level + 6 dBm, freq. 1 kHz, pilot level -9.5 dBm;

FMA: RMS detector, demodulation FM stereo extern., Auto Range, Unit dBm, channel: see measurement;

Measurement: Select left channel in the FM stereo menu, store the value displayed under "Relativ" as reference value and switch to X/Ref dB.
Select right channel and read off difference in dB.

Measurement errors

Stereocoder: only L / only R / L = R, level + 6 dBm, freq. 1 kHz, pilot -9.5 dBm;

FMA: RMS detector; demodulation FM stereo extern., Auto Range, Unit dBm, channel L / R / M / S / pilot;

Measurement: Switch to the modulated channel (L/R/M/S) and pilot tone in the FM-Stereo menu and check level display, respectively.

Note: *If the stereocoder does not supply any calibrated level, its level setting can be checked using a voltmeter with 1 kHz, L = R without pilot tone.*

RDS Carrier

Stereocoder: Switch on RDS carrier level -14 dBm.
(Substitute by function generator 57 kHz, -14 dBm, if necessary)

FMA: Demodulation FM stereo, channel carr 57 kHz

Measurement: Check level display.

Stereocoder: AM-modulate RDS carrier acc. to test report

FMA: Demodulation FM stereo, channel AM 57 kHz

Measurement: Check AM display.

Non-linear distortions

Distortion

Stereocoder: only L / only R/ L = R/ L = -R, level +6 dBm / +12.5 dBm, freq. see measurement, pilot level -9.5 dBm;

FMA: Demodulation FM stereo extern., Auto Range, channel L / R / M / S;
With FMA-B2*): Audio Dist Sinad, dist %, Auto Range, Auto Tune;

Measurement: Switch to the modulated channel (L/R/M/S) in the FM stereo menu and measure distortion with various AF frequencies and levels acc. to test report.

*) If FMA-B2 is not fitted, a distortion meter must be connected successively to the outputs L/R/M/S of the stereo decoder.

Difference frequency distortion

Stereocoder: only L / only R / L = R / L = -R, level +6 dBm / +12.5 dBm, dual-tone signal f_1 = 13 kHz, f_2 = 14 kHz, pilot level -9.5 dBm;

FMA: Demodulation FM stereo extern., Auto Range;

Measurement: Measure difference-frequency distortion factors d2 and d3 according to DIN 45403 at the decoder outputs (L/R/M/S) using a spectrum analyzer with various levels acc. to test report.

Suppression of subcarrier

Stereocoder: L = R, level +6 dBm, freq. 1 kHz, pilot -9.5 dBm;
Switch on RDS carrier level -14 dBm. (Substitute by function generator 57 kHz, -14 dBm, if required)

FMA: Demodulation FM stereo extern., Auto Range

Measurement: Measure the suppression of the 19-kHz pilot tone and the RDS carrier 57 kHz at the decoder outputs L and R using a spectrum analyzer. Reference = level of the 1-kHz signal.

S/N ratio

Stereocoder: only L, level +6 dBm, freq. 500 Hz, pilot level -9.5 dBm;

FMA: FMA: With FMA-B1 *): Quasipeak detector; unweighted CCIR filter;
demodulation FM stereo extern., Auto Range, Unit dBm, deemphasis 50 µs, channel L;

Measurement: Store the value displayed as reference value under "Relativ" and switch to X/Ref dB. Upon switching off the modulation on the stereocoder (channels off, pilot unchanged), the signal-to-noise ratio is directly indicated in dB.
Switch on CCIR-weighted filter. The weighted S/N ratio is indicated (no new reference measurement).

*) If no FMA-B1 is fitted, an audio analyzer must be connected to the L output of the stereo decoder.

5.3 Performance Test report

ROHDE & SCHWARZ
MODULATION ANALYZER FMA/FMAB/FMAV/FMB — Date: ....
Od.No. 852.8500.52 /856.4750.52/856.5005.52
F.-No. .... — Name: ....

Item Nr.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
1	**RF counter accuracy and sensitivity**	5.2.1				
	Frequency MHz / Level dBm / AM/1 kHz m %			Deviation		
	0.05 / -37.5 / 0		-0.1	....	+ 0.1	Hz
	2.1 / -37.5 / 0		-0.1	....	+ 0.1	Hz
	10 / -37.5 / 0		-0.1	....	+ 0.1	Hz
	100 / -37.5 / 0		-0.1	....	+ 0.1	Hz
	1360 / -37.5 / 0		-0.1	....	+ 0.1	Hz
	0.05 / -27.5 / 80		-0.1	....	+ 0.1	Hz
	2.1 / -27.5 / 80		-0.1	....	+ 0.1	Hz
	10 / -27.5 / 80		-0.1	....	+ 0.1	Hz
	100 / -27.5 / 80		-0.1	....	+ 0.1	Hz
	1360 / -27.5 / 80		-0.1	....	+ 0.1	Hz
	only option FMA-B12/FMB:					
	1380 / -31.5 / 0		-0.1	....	+ 0.1	Hz
	2600 / -31.5 / 0		-0.1	....	+ 0.1	Hz
	5200 / -31.5 / 0		-0.1	....	+ 0.1	Hz
	1380 / -21.5 / 80		-0.1	....	+ 0.1	Hz
	2600 / -21.5 / 80		-0.1	....	+ 0.1	Hz
	5200 / -21.5 / 80		-0.1	....	+ 0.1	Hz
2	**Reference oscillator accuracy**	5.2.2				
	Reference 10 MHz (23° C) Error due to aging		-20	....	+ 20	Hz/year
	Temperature drift,reference 23° C 0° C to + 55° C			....		
			-25		+ 25	Hz
	only option FMA-B10:					
	Error due to aging after 30 days of operation			....		
			-1 -0.01		+ 1 + 0.01	Hz/yeara Hz/day
	Temperature drift, reference 23° C 0° C to + 55° C			....		
	only option FMA-B10 VAR.59:		-1		+ 1	Hz
	Error due to aging after 30 days of operation			....		
	Temperature drift, reference 23° C 0° C to + 55° C		-1 -0.005	....	+ 1 + 0.005	Hz/yeara Hz/dayg
			-0.1		+ 0.1	Hz

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
3	**Reflection at RF input**	5.2.3				
	10-dB RF attenuation					
	VSWR: 50 kHz to 1360 MHz		1	....	1.4	1
	only option FMA-B12/FMB:					
	10-dB RF attenuation					
	VSWR: 50 kHz to1360 MHz		1	....	1.4	1
	1360 MHz to 5200 MHz		1	....	2.0	1
	20-dB RF attenuation					
	VSWR: 50 kHz to1360 MHz		1	....	1.2	1
	1360 MHz to 2720 MHz		1	....	1.5	1
	2720 MHz to 5200 MHz		1	....	2.0	1
4	**RF power measurement**	5.2.4				
	FMA without option FMA-B12:					
	Level/dBm Frequency/MHz					
	-37.5 0.05		-41.2	....	-35.2	dBm
	10		-41.2	....	-35.2	dBm
	100		-41.2	....	-35.2	dBm
	1360		-41.2	....	-35.2	dBm
	-10 0.05		-11.0	....	-9.0	dBm
	10		-11.0	....	-9.0	dBm
	100		-11.0	....	-9.0	dBm
	1360		-11.0	....	-9.0	dBm
	+20 0.05		+19.0	....	+21.0	dBm
	10		+19.0	....	+21.0	dBm
	100		+19.0	....	+21.0	dBm
	1360		+19.0	....	+21.0	dBm
	FMA with opt. FMA-B12 /FMB:					
	Level/dBm Frequency/MHz					
	-37.5 0.05		-40.4	....	-35.6	dBm
	10		-40.4	....	-35.6	dBm
	100		-40.4	....	-35.6	dBm
	1360		-40.4	....	-35.6	dBm
	2600		-41.2	....	-35.2	dBm
	5200		-41.2	....	-35.2	dBm
	-10 0.05		-10.3	....	-9.7	dBm
	10		-10.3	....	-9.7	dBm
	100		-10.3	....	-9.7	dBm
	1360		-10.3	....	-9.7	dBm
	2600		-10.5	....	-9.5	dBm
	5200		-10.5	....	-9.5	dBm

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
4		5.2.4				
	Level/dBm frequency/MHz					
	+5 0.05		+4.7	....	+5.3	dBm
	10		+4.7	....	+5.3	dBm
	100		+4.7	....	+5.3	dBm
	1360		+4.7	....	+5.3	dBm
	2600		+4.5	....	+5.5	dBm
	5200		+4.5	....	+5.5	dBm
	+20 0.05		+19.5	....	+20.5	dBm
	10		+19.5	....	+20.5	dBm
	100		+19.5	....	+20.5	dBm
	1360		+19.5	....	+20.5	dBm
	2600		+19.0	....	+21.0	dBm
	5200		+19.0	....	+21.0	dBm
5	**AM measuring accuracy**	5.2.5.1				
	Level = -17.5 dBm					
	Carrier freq. m Mod. freq.					
	50 kHz 20 % 30 Hz		19.84	....	20.16	%
	1 kHz		19.84	....	20.16	%
	3 kHz		19.84	....	20.16	%
	80 % 30 Hz		79.36	....	80.64	%
	1 kHz		79.36	....	80.64	%
	3 kHz		79.36	....	80.64	%
	95 % 10 Hz		93.10	....	96.90	%
	1 kHz		94.05	....	95.95	%
	8 kHz		93.10	....	96.90	%
	100 kHz 20 % 5 kHz		19.84	....	20.16	%
	80 % 5 kHz		79.36	....	80.64	%
	310 kHz 20 % 10 kHz		19.84	....	20.16	%
	80 % 10 kHz		79.36	....	80.64	%
	95 % 20 kHz		94.05	....	95.95	%
	50 kHz		90.25	....	99.75	%
	1.9 MHz 20 % 10 kHz		19.84	....	20.16	%
	80 % 10 kHz		79.36	....	80.64	%
	95 % 20 kHz		94.05	....	95.95	%
	50 kHz		90.25	....	99.75	%
	2.1 MHz 20 % 30 Hz		19.84	....	20.16	%
	1 kHz		19.84	....	20.16	%
	10 kHz		19.84	....	20.16	%
	80 % 30 Hz		79.36	....	80.64	%
	1 kHz		79.36	....	80.64	%
	10 kHz		79.36	....	80.64	%
	95 % 10 Hz		93.10	....	96.90	%
	1 kHz		94.05	....	95.95	%
	20 kHz		94.05	....	95.95	%
	50 kHz		90.25	....	99.75	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
5	Carrier freq. m Mod.freq.	5.2.5.1				
	12.5 MHz 20 % 30 Hz		19.84	....	20.16	%
	1 kHz		19.84	....	20.16	%
	20 kHz		19.84	....	20.16	%
	80 % 30 Hz		79.36	....	80.64	%
	1 kHz		79.36	....	80.64	%
	20 kHz		79.36	....	80.64	%
	95 % 10 Hz		93.10	....	96.90	%
	1 kHz		94.05	....	95.95	%
	100 kHz		94.05	....	95.95	%
	200 kHz		90.25	....	99.75	%
	800 MHz 20 % 1 kHz		19.84	....	20.16	%
	20 kHz		19.84	....	20.16	%
	80 % 1 kHz		79.36	....	80.64	%
	20 kHz		79.36	....	80.64	%
	95 % 1 kHz		94.05	....	95.95	%
	100 kHz		94.05	....	95.95	%
	200 kHz		90.25	....	99.75	%
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	2000 MHz 20 % 1 kHz		19.84	....	20.16	%
	20 kHz		19.84	....	20.16	%
	80 % 1 kHz		79.36	....	80.64	%
	20 kHz		79.36	....	80.64	%
	95 % 1 kHz		94.05	....	95.95	%
	100 kHz		94.05	....	95.95	%
	200 kHz		90.25	....	99.75	%
6	**Residual AM**	5.2.5.2				
	Level = -17.5 dBm					
	Weighting Frequency					
	CCITT, RMS					
	50 kHz		0	....	0.01	%
	1.9 MHz		0	....	0.01	%
	2.1 MHz		0	....	0.01	%
	12.5 MHz		0	....	0.01	%
	100 MHz		0	....	0.01	%
	1360 MHz		0	....	0.01	%
	20 Hz-23 kHz, RMS					
	50 kHz		0	....	0.03	%
	1.9 MHz		0	....	0.03	%
	2.1 MHz		0	....	0.03	%
	12.5 MHz		0	....	0.03	%
	100 MHz		0	....	0.03	%
	1360 MHz		0	....	0.03	%

Item Nr.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
6		5.2.5.2				
	Weighting Frequency					
	CCIR, Quasipeak		0	....	0.05	%
	50 kHz		0	....	0.05	%
	1.9 MHz		0	....	0.05	%
	2.1 MHz		0	....	0.05	%
	12.5 MHz		0	....	0.05	%
	100 MHz		0	....	0.05	%
	1360 MHz		0	....	0.05	%
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	Weighting Frequency					
	CCITT, RMS					
	2000 MHz		0	....	0.02	%
	4300 MHz		0	....	0.02	%
	20 Hz - 23 kHz, RMS					
	2000 MHz		0	....	0.06	%
	4300 MHz		0	....	0.06	%
	CCIR, Quasipeak					
	2000 MHz		0	....	0.10	%
	4300 MHz		0	....	0.10	%
7	**Synchronous AM**	5.2.5.3				
	Level = -17.5 dBm FM modulated with 1 kHz Measurement bandwith 20 Hz to3 kHz					
	FM deviation Frequency					
	5 kHz 50 kHz		0	....	0.2	%
	1.9 MHz		0	....	0.2	%
	2.1 MHz		0	....	0.2	%
	50 kHz 12.5 MHz		0	....	0.1	%
	100 MHz		0	....	0.1	%
	1360 MHz		0	....	0.1	%
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	FM deviation Frequency					
	50 kHz 2000 MHz		0	....	0.1	%
	4000 MHz		0	....	0.1	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
8	**AF distortion with AM**	5.2.5.4				
	Level = -17.5 dBm					
	Carrier freq. m Mod. freq.					
	50 kHz 40 % 10 Hz		0	....	0.2	%
	1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	80 % 10 Hz		0	....	0.4	%
	1 kHz		0	....	0.4	%
	20 kHz		0	....	0.4	%
	1.9 MHz 40 % 10 Hz		0	....	0.2	%
	1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	80 % 10 Hz		0	....	0.4	%
	1 kHz		0	....	0.4	%
	20 kHz		0	....	0.4	%
	2.1 MHz 40 % 10 Hz		0	....	0.2	%
	1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	80 % 10 Hz		0	....	0.4	%
	1 kHz		0	....	0.4	%
	20 kHz		0	....	0.4	%
	12.5 MHz 40 % 10 Hz		0	....	0.2	%
	1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	80 % 10 Hz		0	....	0.4	%
	1 kHz		0	....	0.4	%
	20 kHz		0	....	0.4	%
	800 MHz 40 % 10 Hz		0	....	0.2	%
	1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	80 % 10 Hz		0	....	0.4	%
	1 kHz		0	....	0.4	%
	20 kHz		0	....	0.4	%
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	Carrier freq. m Mod. freq.					
	2000 MHz 40 % 10 Hz		0	....	0.2	%
	1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	80 % 10 Hz		0	....	0.4	%
	1 kHz		0	....	0.4	%
	20 kHz		0	....	0.4	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
9	**FM measuring accuracy**	5.2.6.1				
	Level = -17.5 dBm					
	Carrier freq Deviation Mod. freq.					
	50 kHz 5 kHz 10 Hz		4.9	....	5.1	kHz
	30 Hz		4.975	....	5.025	kHz
	1 kHz		4.975	....	5.025	kHz
	5 kHz		4.975	....	5.025	kHz
	8 kHz		4.9	....	5.1	kHz
	310 kHz 20 kHz 1 kHz		19.9	....	20.1	kHz
	10 kHz		19.9	....	20.1	kHz
	20 kHz		19.8	....	20.2	kHz
	50 kHz		19.6	....	20.4	kHz
	150 kHz 1 kHz		149.25	....	150.75	kHz
	10 kHz		149.25	....	150.75	kHz
	20 kHz		148.5	....	151.5	kHz
	50 kHz		147	....	153	kHz
	1.9 MHz 20 kHz 1 kHz		19.9	....	20.1	kHz
	10 kHz		19.9	....	20.1	kHz
	20 kHz		19.8	....	20.2	kHz
	50 kHz		19.6	....	20.4	kHz
	150 kHz 1 kHz		149.25	....	150.75	kHz
	10 kHz		149.25	....	150.75	kHz
	20 kHz		148.5	....	151.5	kHz
	50 kHz		147	....	153	kHz
	2.1 MHz 20 kHz 10 Hz		19.6	....	20.4	kHz
	30 Hz		19.9	....	20.1	kHz
	1 kHz		19.9	....	20.1	kHz
	10 kHz		19.9	....	20.1	kHz
	20 kHz		19.8	....	20.2	kHz
	50 kHz		19.6	....	20.4	kHz
	150 kHz 1 kHz		149.25	....	150.75	kHz
	10 kHz		149.25	....	150.75	kHz
	20 kHz		148.5	....	151.5	kHz
	50 kHz		147	....	153	kHz
	12.5 MHz 20 kHz 10 Hz		19.6	....	20.4	kHz
	30 Hz		19.9	....	20.1	kHz
	1 kHz		19.9	....	20.1	kHz
	20 kHz		19.9	....	20.1	kHz
	100 kHz		19.8	....	20.2	kHz
	200 kHz		19.6	....	20.4	kHz
	100 kHz 1 kHz		99.5	....	100.5	kHz
	20 kHz		99.5	....	100.5	kHz
	100 kHz		99	....	101	kHz
	200 kHz		98	....	102	kHz
	700 kHz 1 kHz		696.5	....	703.5	kHz
	20 kHz		696.5	....	703.5	kHz
	100 kHz		693	....	707	kHz
	200 kHz		686	....	714	kHz

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
9	Carrier freq. Deviation Mod. freq.	5.2.6.1				
	800 MHz 20 kHz 1 kHz					
	20 kHz		19.9	....	20.1	kHz
	100 kHz		19.9	....	20.1	kHz
	200 kHz		19.8	....	20.2	kHz
	100 kHz 1 kHz		19.6	....	20.4	kHz
	20 kHz		99.5	....	100.5	kHz
	100 kHz		99.5	....	100.5	kHz
	200 kHz		99	....	101	kHz
	700 kHz 1 kHz		98	....	102	kHz
	20 kHz		696.5	....	703.5	kHz
	100 kHz		696.5	....	703.5	kHz
	200 kHz		693	....	707	kHz
			686	....	714	kHz
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	Carrier freq. Deviation Mod. freq.					
	2000 MHz 20 kHz 1 kHz					
	20 kHz		19.9	....	20.1	kHz
	100 kHz		19.9	....	20.1	kHz
	200 kHz		19.8	....	20.2	kHz
	100 kHz 1 kHz		19.6	....	20.4	kHz
	20 kHz		99.5	....	100.5	kHz
	100 kHz		99.5	....	100.5	kHz
	200 kHz		99	....	101	kHz
	700 kHz 1 kHz		98	....	102	kHz
	20 kHz		696.5	....	703.5	kHz
	100 kHz		696.5	....	703.5	kHz
	200 kHz		693	....	707	kHz
			686	....	714	kHz
10	**Residual FM**	5.2.6.2				
	Level = -17.5 dBm					
	Weighting Frequency					
	CCITT, RMS					
	50 kHz		0	....	0.5	Hz
	1.9 MHz		0	....	0.5	Hz
	2.1 MHz		0	....	0.5	Hz
	330 MHz		0	....	0.5	Hz
	670 MHz		0	....	0.7	Hz
	1360 MHz		0	....	1.0	Hz
	20 Hz - 23 kHz, RMS					
	50 kHz		0	....	2.0	Hz
	1.9 MHz		0	....	2.0	Hz
	2.1 MHz		0	....	2.0	Hz
	330 MHz		0	....	2.0	Hz
	670 MHz		0	....	3.0	Hz
	1360 MHz		0	....	5.0	Hz

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
10	Weighting Frequency	5.2.6.2				
	CCIR, Quasipeak Deemphasis 50 µs					
	50 kHz		0	....	3	Hz
	1.9 MHz		0	....	3	Hz
	2.1 MHz		0	....	3	Hz
	330 MHz		0	....	3	Hz
	670 MHz		0	....	4	Hz
	1360 MHz		0	....	6	Hz
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	Weighting Frequency					
	CCITT, RMS					
	2710 MHz		0	....	2	Hz
	4300 MHz		0	....	4	Hz
	20 Hz - 23 kHz, RMS					
	2710 MHz		0	....	10	Hz
	4300 MHz		0	....	20	Hz
	CCIR, Quasipeak Deemphasis 50 µs					
	2710 MHz		0	....	12	Hz
	4300 MHz		0	....	24	Hz
11	**Stereo S/N ratio**	5.2.6.3				
	to CCIR, reference 40-kHz deviation with noise LP					
	Frequency					
	12.5 MHz		76	....	-	dB
	100 MHz		76	....	-	dB
	160 MHz		76	....	-	dB
	330 MHz		73	....	-	dB
	670 MHz		68	....	-	dB
12	**Stereo crosstalk attenuation**	5.2.6.4				
	Level = -17.5 dBm Deviation = 40 kHz without noise filter					
	Carrier freq. Channel AF					
	100 MHz L → R 30 Hz		50	....	-	dB
	1 kHz		56	....	-	dB
	15 kHz		50	....	-	dB
	R → L 30 Hz		50	....	-	dB
	1 kHz		56	....	-	dB
	15 kHz		50	....	-	dB

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
13	**AF distortion with FM**	5.2.6.5				
	Level = -17.5 dBm					
	Carrier freq. Deviation Mod. freq.					
	500 kHz 75 kHz 30 Hz		0	....	0.1	%
	1 kHz		0	....	0.1	%
	20 kHz		0	....	0.1	%
	1.9 MHz 75 kHz 1 kHz		0	....	0.1	%
	20 kHz		0	....	0.1	%
	2.1 MHz 75 kHz 30 Hz		0	....	0.1	%
	1 kHz		0	....	0.1	%
	20 kHz		0	....	0.1	%
	12.5 MHz 75 kHz 30 Hz		0	....	0.05	%
	1 kHz		0	....	0.05	%
	20 kHz		0	....	0.05	%
	100 kHz		0	....	0.15	%
	500 kHz 1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	100 kHz		0	....	0.5	%
	800 MHz 75 kHz 1 kHz		0	....	0.05	%
	20 kHz		0	....	0.05	%
	100 kHz		0	....	0.15	%
	500 kHz 1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	100 kHz		0	....	0.5	%
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	Carrier freq. Deviation Mod. freq.					
	2000 MHz 75 kHz 1 kHz		0	....	0.05	%
	20 kHz		0	....	0.05	%
	100 kHz		0	....	0.15	%
	500 kHz 1 kHz		0	....	0.2	%
	20 kHz		0	....	0.2	%
	100 kHz		0	....	0.5	%
14	**Synchrous FM**	5.2.6.6				
	Level = -30 dBm 50 % AM modulated with1 kHz Test bandwidth 20 Hz to 3 kHz					
	Frequency 50 kHz		0	....	10	Hz
	1.9 MHz		0	....	10	Hz
	2.1 MHz		0	....	10	Hz
	12.5 MHz		0	....	10	Hz
	800 MHz		0	....	10	Hz

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
14	only option FMA-12/FMB:	5.2.6.6				
	Level = -24 dBm					
	Frequency 2000 MHz		0	....	10	Hz
15	**Deemphases**	5.2.6.7				
	RF = 100 MHz Deviation = 40 kHz					
	Deemphasis / Attenuation at f_{mod}					
	50 µs 3.183 kHz		2.9	....	3.1	dB
	75 µs 2.122 kHz		2.9	....	3.1	dB
	750 µs 212.2 Hz		2.9	....	3.1	dB
16	**PM measuring accuracy**	5.2.7.1				
	800 MHz / -17.5 dBm					
	Additional error caused by PM filter as against FM:					
	Freq. Deviation = 700 kHz					
	$\left(\frac{PM}{FM}\cdot f_{mod}-1\right)\cdot 100\ \%$ — f_{mod} 300 Hz		-1.5	....	+ 1.5	%
	1 kHz		-1.5	....	+ 1.5	%
	20 kHz		-1	....	+ 1	%
	100 kHz		-1	....	+ 1	%
	Only option FMA-B1: Low Freq PM					
	Freq.Deviation = 100 kHz					
	$\left(\frac{PM}{FM}\cdot f_{mod}-1\right)\cdot 100\ \%$ — f_{mod} 10 Hz		-1.5	....	+ 1.5	%
	100 Hz		-1.5	....	+ 1.5	%
	1 kHz		-1.5	....	+ 1.5	%
17	**Residual PM**	5.2.7.2				
	Level = -17.5 dBm					
	Weighting / Frequency					
	CCITT, RMS					
	50 kHz		0	....	0.002	rad
	1.9 MHz		0	....	0.002	rad
	2.1 MHz		0	....	0.002	rad
	12.5 MHz		0	....	0.002	rad

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
17	Weighting Frequency	5.2.7.2				
	CCITT. RMS					
	670 MHz		0	....	0.002	rad
	1360 MHz		0	....	0.004	rad
	300 Hz - 23 kHz, RMS					
	50 kHz		0	....	0.005	rad
	1.9 MHz		0	....	0.005	rad
	2.1 MHz		0	....	0.005	rad
	12.5 MHz		0	....	0.005	rad
	670 MHz		0	....	0.005	rad
	1360 MHz		0	....	0.010	rad
	only option FMA-B12/FMB:					
	Level = -11.5 dBm					
	Weighting Frequency					
	CCITT, RMS					
	2710 MHz		0	....	0.008	rad
	4300 MHz		0	....	0.016	rad
	300 Hz - 23 kHz, RMS					
	2710 MHz		0	....	0.020	rad
	4300 MHz		0	....	0.040	rad
18	**AF distortion with PM**	5.2.7.3				
	Level = -17.5 dBm					
	Phase deviation = 4 rad					
	Carrier freq. Dev. Mod. freq.					
	500 kHz 800 Hz 200 Hz		0	....	0.1	%
	4 kHz 1 kHz		0	....	0.1	%
	80 kHz 20 kHz		0	....	0.1	%
	1.9 MHz 800 Hz 200 Hz		0	....	0.1	%
	4 kHz 1 kHz		0	....	0.1	%
	80 kHz 20 kHz		0	....	0.1	%
	12.5 MHz 800 Hz 200 Hz		0	....	0.1	%
	4 kHz 1 kHz		0	....	0.1	%
	80 kHz 20 kHz		0	....	0.1	%
19	**Voltmeter unbalanced**	5.2.8.1				
	Input impedance		98	....	102	kΩ
	Offset voltage		-1	....	+ 1	mV
	Offset voltage after cal.		-0.03	....	+ 0.03	mV

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
19		5.2.8.1				
	DC measuring accuracy (after offset calibration)					
	Lowpass DC voltage					
	3 kHz					
	1 mV		0.865	....	1.135	mV
	3 mV		2.855	....	3.145	mV
	10 mV		9.82	....	10.18	mV
	30 mV		29.72	....	30.28	mV
	100 mV		99.37	....	100.63	mV
	300 mV		298.3	....	301.7	mV
	5 Hz (only FMA-B1)					
	1 mV		0.955	....	1.045	mV
	3 mV		2.945	....	3.055	mV
	10 mV		9.91	....	10.09	mV
	30 mV		29.81	....	30.19	mV
	100 mV		99.46	....	100.54	mV
	300 mV		298.4	....	301.6	mV
	3 kHz or 5 Hz					
	1 V		0.995	....	1.005	V
	3 V		2.985	....	3.015	V
	10 V		9.95	....	10.05	V
	20 V		19.9	....	20.1	V
	RMSmeasuring accuracy					
	Volt.. HP LP Freq.					
	1 mV 20 Hz 100 kHz 1 kHz		0.96	....	1.04	mV
	· 20 kHz		0.96	....	1.04	mV
	without 100 kHz		0.88	....	1.12	mV
	· 200 kHz		0.87	....	1.13	mV
	3 mV 20 Hz 100 kHz 1 kHz		2.94	....	3.06	mV
	· 20 kHz		2.94	....	3.06	mV
	without 100 kHz		2.84	....	3.16	mV
	· 200 kHz		2.81	....	3.19	mV
	10 mV 20 Hz 100 kHz 1 kHz		9.87	....	10.13	mV
	· 20 kHz		9.87	....	10.13	mV
	without 100 kHz		9.70	....	10.30	mV
	· 200 kHz		9.60	....	10.40	mV
	30 mV 20 Hz 100 kHz 1 kHz		29.67	....	30.33	mV
	· 20 kHz		29.67	....	30.33	mV
	without 100 kHz		29.30	....	30.70	mV
	· 200 kHz		29.00	....	31.00	mV
	100 mV 20 Hz 100 kHz 1 kHz		98.97	....	101.3	mV
	· 20 kHz		98.97	....	101.3	mV
	without 100 kHz		97.90	....	102.10	mV
	· 200 kHz		96.90	....	103.10	mV

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
19	Volt. HP LP Freq.	5.2.8.1				
	300 mV 20 Hz 100 kHz 1 kHz		297	....	303	mV
	· 20 kHz		297	....	303	mV
	without 100 kHz		293.9	....	306.1	mV
	· 200 kHz		290.9	....	309.1	mV
	1 Vwithout 100 kHz 10 Hz		0.98	....	1.02	V
	· · 30 Hz		0.99	....	1.01	V
	20 Hz · 1 kHz		0.99	....	1.01	V
	· · 20 kHz		0.99	....	1.01	V
	· without 100 kHz		0.98	....	1.02	V
	· · 200 kHz		0.97	....	1.03	V
	3 V 20 Hz 100 kHz 1 kHz		2.97	....	3.03	V
	· 20 kHz		2.97	....	3.03	V
	without 100 kHz		2.94	....	3.06	V
	· 200 kHz		2.91	....	3.09	V
	10 V 20 Hz 100 kHz 1 kHz		9.9	....	10.1	V
	· 20 kHz		9.9	....	10.1	V
	without 100 kHz		9.8	....	10.2	V
	· 200 kHz		9.7	....	10.3	V
20	**Voltmeter balanced**	5.2.8.2				
	Input impedance		594	....	606	Ω
	Offset voltage		-3	....	+ 3	mV
	Offset voltage after cal.		-0.03	....	+ 0.03	mV
	DC measuring accuracy (after offset calibration)					
	Lowpass DC voltage					
	3 kHz oder 5Hz					
	1 V		0.995	....	1.005	V
	10 V		9.95	....	10.05	V
	RMS measuring accuracy					
	Volt. HP LP Freq.					
	1 V without 100 kHz 10 Hz		0.98	....	1.02	V
	· · 30 Hz		0.99	....	1.01	V
	20 Hz · 1 kHz		0.99	....	1.01	V
	· · 20 kHz		0.99	....	1.01	V
	· without 100 kHz		0.98	....	1.02	V
	· · 200 kHz		0.97	....	1.03	V
	10 V 20 Hz 100 kHz 1 kHz		9.9	....	10.1	V
	· 20 kHz		9.9	....	10.1	V
	without 100 kHz		9.8	....	10.2	V
	· 200 kHz		9.7	....	10.3	V

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
21	**AF weighting filter**	5.2.9				
	Frequency response referred to display without filter					
	Filter / Frequency					
	HP 10 Hz / 3 Hz		-23.5	....	-19.5	dB
	10 Hz		-3.5	....	-2.5	dB
	30 Hz		0.04	....	+ 0.04	dB
	HP 20 Hz / 10 Hz		-20.5	....	-16.5	dB
	20 Hz		-3.5	....	-2.5	dB
	31.5 Hz		-0.5	....	+ 0.5	dB
	60 Hz		-0.04	....	+ 0.04	dB
	HP 300 Hz / 100 Hz		-22	....	-18	dB
	300 Hz		-3.5	....	-2.5	dB
	1000 Hz		-0.04	....	+ 0.04	dB
	LP 3 kHz / 1 kHz		-0.04	....	+ 0.04	dB
	3 kHz		-3.5	....	-2.5	dB
	6 kHz		-25.5	....	-21.5	dB
	LP 23 kHz / 1 kHz		-0.04	....	+ 0.04	dB
	16 kHz		-0.5	....	+ 0.5	dB
	23.5 kHz		-3.5	....	-2.5	dB
	47 kHz		-25.5	....	-21.5	dB
	LP 100 kHz / 30 kHz		-0.04	....	+ 0.04	dB
	100 kHz		-3.5	....	-2.5	dB
	200 kHz		-25.5	....	-21.5	dB
	Mod.59					
	LP 200 kHz / 50 kHz		-0.04	....	+ 0.04	dB
	200 kHz		-3.5	....	-2.5	dB
	400 kHz		-25.5	....	-21.5	dB
22	**AF weighting filter Option FMA-B1**	5.2.10.1				
	Frequency response referred to desplay without filter					
	Filter / Frequency					
	CCIR Wght. / 31.5 Hz		-31.7	....	-28.1	dB
	100 Hz		-20.6	....	-19.0	dB
	1 kHz		-0.08	....	+ 0.08	dB
	6.3 kHz		+ 12.0	....	+ 12.4	dB
	20 kHz		-24.0	....	-20.4	dB
	CCITT / 50 Hz		-65	....	-61	dB
	300 Hz		-11.6	....	-9.6	dB
	800 Hz		-0.08	....	+ 0.08	dB

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
22	Filter / Frequency	5.2.10.1				
	CCITT 3 kHz		-6.6	....	-4.6	dB
	3.5 kHz		-10.5	....	-6.5	dB
	5 kHz		-39	....	-33	dB
	LP 5 Hz 5 Hz		-4	....	-2	dB
	30 Hz		-	....	-60	dB
	LP 30 kHz 2 kHz		-0.04	....	+ 0.04	dB
	5 kHz		-0.15	....	+ 0.15	dB
	30 kHz		-4	....	-2	dB
	100 kHz		-28.5	....	-24.5	dB
	LP 120 kHz 8 kHz		-0.04	....	+ 0.04	dB
	20 kHz		-0.15	....	+ 0.15	dB
	120 kHz		-4	....	-2	dB
	300 kHz		-22	....	-18	dB
	LP 4.5 kHz 60 Hz		-0.2	....	+ 0.2	dB
	1 kHz		-0.08	....	+ 0.08	dB
	3 kHz		-0.2	....	+ 0.2	dB
	4 kHz		-1	....	+ 0.2	dB
	4.5 kHz		-	....	-40	dB
	20 kHz		-	....	-40	dB
23	**Phase linearization of AC coupling** Only option FMA-B1 LP 30 kHz, no highpass Meas. accuracy with ± pk/2: Square 4 V_{pp}, 5 Hz	5.2.10.2	2	....	2.3	V
24	**Psophometer (CCIR 468-4)** Only option FMA-B1 Quasipeak + CCIR Wght. Measurement range 1 V Fundamental accuracy Sinewave signal 0.775 V, 1 kHz	5.2.10.3	0.767	....	0.783	V
	Relative measurement with reference = Sine 0.775 V, 5 kHz Single pulse display 5-kHz burssts, duration 1 ms		0.135	....	0.214	1

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
24		5.2.10.3				
	5-kHz bursts, duration					
	2 ms		0.224	....	0.316	1
	5 ms		0.340	....	0.460	1
	50 ms		0.500	....	0.680	1
	200 ms		0.680	....	0.920	1
	Pulse sequence display 5-kHz-bursts, duration 5 ms					
	2 bursts/s		0.43	....	0.53	1
	10 bursts/s		0.72	....	0.82	1
	100 bursts/s		0.94	....	1.00	1
	Overload immunity					
	5-kHz bursts, duration 0.6 ms Reference: 10 V_{pk} = 0 dB 1 V_{pk}		-21	....	-19	dB
	Polarity reversal error					
	Quasipeak + CCIR Wght.					
	DC pulses 1 ms, 100 Hz Reference: + 0.8 V = 0 dB -0.8 V		-0.5	....	+ 0.5	dB
25		5.2.11				
	AF counter accuracy					
	200 mV RMS Frequency					
	10 Hz		9.995	....	10.004	Hz
	100 Hz		99.991	....	100.01	Hz
	1000 Hz		999.94	....	1000.1	Hz
	100 kHz		99.994	....	100.01	kHz
	300 kHz		299.97	....	300.02	kHz
26	**Distortion measurement**	5.2.12				
	Only option FMA-B2					
	Inherent distortion display and noise					
	Volt. Lowpass Freq.					
	10 mV LP 100 k 10 Hz		0	....	0.15	%
	1 kHz		0	....	0.15	%
	20 kHz		0	....	0.15	%
	no LP 100 kHz		0	....	0.4	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
26	Volt. / Lowpass / Freq.	5.2.12				
	2 V / LP 100 k / 10 Hz		0	....	0.015	%
	1 kHz		0	....	0.015	%
	20 kHz		0	....	0.015	%
	no LP / 100 kHz		0	....	0.080	%
	Measuring accuracy (SINAD)					
	Freq. / Harmonie / Att.					
	20 Hz / 40 Hz / 20 dB		19	....	21	dB
	50 dB		48.6	....	51.4	dB
	60 Hz / 20 dB		19	....	21	dB
	50 dB		48.6	....	51.4	dB
	1 kHz / 2 kHz / 10 dB		9.4	....	11.4	dB
	20 dB		19	....	21	dB
	30 dB		29	....	31	dB
	40 dB		38.9	....	41.1	dB
	50 dB		48.6	....	51.4	dB
	60 dB		57.8	....	62.4	dB
	3 kHz / 20 dB		19	....	21	dB
	50 dB		48.6	....	51.4	dB
	20 kHz / 40 kHz / 20 dB		19	....	21	dB
	50 dB		48.6	....	51.4	dB
	60 kHz / 20 dB		19	....	21	dB
	50 dB		48.6	....	51.4	dB
	100 kHz / 200 kHz / 20 dB		18	....	22	dB
	40 dB		37.3	....	42.7	dB
	300 kHz / 20 dB		18	....	22	dB
	40 dB		37.3	....	42.7	dB
27	**Outputs**	5.2.13				
	IF output: max.level into 50 Ω		-1.5	....	-0.5	dBm
	AM output: max. voltage with 95 % AM		0.795	....	0.896	V
	FM/PM output: FM: 40-kHz deviation		1.522	....	1.569	V
	PM: 40-Rad deviation		1.499	....	1.592	V
	AF output: max. voltage		2.800	....	2.857	V
	min. voltage		0.696	....	0.718	V
	Only option FMA-B2: Distortion output max. voltage		0.95	....	1.05	V

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
27	**Outputs**	5.2.13				
	Stereo decoder outputs (Only FMA-B3/FMAB)					
	MPX input: in the channel + 6 dBm (= 1.545 V)					
	Freq. 1 kHz, Pilot -9.5 dBm					
	Outputs:		5.82	....	+ 6.17	dBm
	L		5.82	....	+ 6.17	dBm
	R		5.82	....	+ 6.17	dBm
	M		5.82	....	+ 6.17	dBm
	S					
28	**Stereo decoder**	5.2.14				
	Only options FMA-B3/FMAB Crosstalk attenuation (RMS)					
	Frequency					
	L→R 30 Hz		60	....	-	dB
	1 kHz		60	....	-	dB
	5 kHz		60	....	-	dB
	10 kHz		60	....	-	dB
	15 kHz		60	....	-	dB
	R→L 30 Hz		60	....	-	dB
	1 kHz		60	....	-	dB
	5 kHz		60	....	-	dB
	10 kHz		60	....	-	dB
	15 kHz		60	....	-	dB
	M→S 30 Hz		50	....	-	dB
	1 kHz		50	....	-	dB
	5 kHz		50	....	-	dB
	10 kHz		50	....	-	dB
	15 kHz		50	....	-	dB
	S→M 30 Hz		50	....	-	dB
	1 kHz		50	....	-	dB
	5 kHz		50	....	-	dB
	10 kHz		50	....	-	dB
	15 kHz		50	....	-	dB
	Frequency response referred to display with 1 kHz (RMS)					
	Channel Frequency					
	L 30 Hz		-0.1	....	+ 0.1	dB
	100 Hz		-0.1	....	+ 0.1	dB
	300 Hz		-0.1	....	+ 0.1	dB
	3 kHz		-0.1	....	+ 0.1	dB
	10 kHz		-0.1	....	+ 0.1	dB
	15 kHz		-0.1	....	+ 0.1	dB

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
28	Channel Frequency					
	R 30 Hz		-0.1	....	+ 0.1	dB
	100 Hz		-0.1	....	+ 0.1	dB
	300 Hz		-0.1	....	+ 0.1	dB
	3 kHz		-0.1	....	+ 0.1	dB
	10 kHz		-0.1	....	+ 0.1	dB
	15 kHz		-0.1	....	+ 0.1	dB
	M 30 Hz		-0.1	....	+ 0.1	dB
	100 Hz		-0.1	....	+ 0.1	dB
	300 Hz		-0.1	....	+ 0.1	dB
	3 kHz		-0.1	....	+ 0.1	dB
	10 kHz		-0.1	....	+ 0.1	dB
	15 kHz		-0.1	....	+ 0.1	dB
	S 30 Hz		-0.1	....	+ 0.1	dB
	100 Hz		-0.1	....	+ 0.1	dB
	300 Hz		-0.1	....	+ 0.1	dB
	3 kHz		-0.1	....	+ 0.1	dB
	10 kHz		-0.1	....	+ 0.1	dB
	15 kHz		-0.1	....	+ 0.1	dB
	Level difference between left and right channel	5.2.14				
	Frequency 1 kHz		-0.1	....	+ 0.1	dB
	Measuring error (RMS) channel + 6 dBm, freq. 1 kHz Pilot -9.5 dBm 57- kHz carrier -14 dBm					
	L		5.82	....	+ 6.17	dBm
	R		5.82	....	+ 6.17	dBm
	M		5.82	....	+ 6.17	dBm
	S		5.82	....	+ 6.17	dBm
	Pilot		-9.68	....	-9.33	dBm
	57- kHz carrier		-14.44	....	-13.57	dBm
	AM 57- kHz carrier m = 60 %, f_{mod} = 54 Hz		58.9	....	61.3	%
	Nonlinear distortion Distortion factor (THD)					
	Level Channel Frequency					
	+ 6 dBm L 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7,5 KHz		-	....	0.1	%
	R 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7.5 kHz		-	....	0.1	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
28	Level Channel Frequency					
	+6 dBm M 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7.5 KHz		-	....	0.1	%
	S 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7.5 kHz		-	....	0.1	%
	+12.5 dBm L 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 khz		-	....	0.1	%
	7.5 KHz		-	....	0.1	%
	R 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7.5 kHz		-	....	0.1	%
	M 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7.5 kHz		-	....	0.1	%
	S 30 Hz		-	....	0.1	%
	1 kHz		-	....	0.1	%
	5 kHz		-	....	0.1	%
	7.5 kHz		-	....	0.1	%
	Intermodulation factor $f_1 = 13$ kHz. $f_2 = 14$ kHz	5.2.14				
	Level Channel Product					
	+6 dBm L d2		-	....	0.05	%
	d3		-	....	0.1	%
	R d2		-	....	0.05	%
	d3		-	....	0.1	%
	M d2		-	....	0.05	%
	d3		-	....	0.1	%
	S d2		-	....	0.05	%
	d3		-	....	0.1	%
	+12.5 dBm L d2		-	....	0.05	%
	d3		-	....	0.1	%
	R d2		-	....	0.05	%
	d3		-	....	0.1	%
	M d2		-	....	0.05	%
	d3		-	....	0.1	%
	S d2		-	....	0.05	%
	d3		-	....	0.1	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unitt
28	Suppression of subcarrier					
	Carrier Channel					
	Pilot tone L		90	....	-	dB
	R		90	....	-	dB
	RDS/ARI L		80	....	-	dB
	R		80	....	-	dB
	S/N ratio referred to + 6 dBm (L only) Deemphase 50 µs					
	CCIR-Unweighted		80	....	-	dB
	CCIR-Weighted		80	....	-	dB

5.4 Testing the Rated Specifications Using a Calibrator Including FMAV

Note: *The limit values given in the test report correspond to the total error of the data sheets for FMA and calibrator.*
The typical residual AM/FM of the calibrator increases the display with broadband measurement using the FMA. This influence has already been taken into account in the test report (+ 0.05% AM absolute or 20 Hz FM with LP100 kHz).
Take the errors of the test instruments used into account when testing the special analog outputs of the FMAV.

5.4.1 Test Instruments and Utilities

Item	Type of instrument	Required specifications	Suitable R&S instrument	Order No.	Application
1	Calibrator	NF, HF, AM, FM VOR / ILS / TACAN signale	Calibrator FMA-B4	855.6008.52	all measurements
2	Distortion meter	10 Hz to 20 kHz ± 1 dB ± 0.03 % THD	DIST/SINAD meter FMA-B2	855.0000.52	distortion measurements
3	Stereo decoder	Channel crosstalk 30 Hz to 15 kHz: ≥ 60 dB	FM-Stereo decoder FMA-B3	856.0003.52	crosstalk attenuation
4	AC/DC voltmeter	300 mV to 3 V, peak measurement 15 Hz to 10 kHz: ≤ 0,5 % DC resolution 0.1 mV	URE3	350.5315.03	only FMAV
5	AF counter	Δt measurement			only FMAV

5.4.2 Test Run with CALIBRATOR

FMAV:
The special features of the FMAV can partially only be approved of using the calibrator which is why the test run for the FMAV is only described in this Section. The particular analog outputs of the FMAV can only be measured using a voltmeter and a delta-t (for phase measurement) meter, in addition.

Test setup:
The subsequent connections must be made for all measurements unless otherwise specified:

10-MHz calibrator output (CAL) to RF input (RF). AF output of the calibrator (AF1) to voltmeter input (UNBAL).

Operating the calibrator:
Refer to Section 3.3.7 for operating instructions. The signals required are given in the test report.

5.4.2.1 Accuracy and Sensitivity of the RF Counter

FMA: Manual tune 10 MHz; RF frequency display, counter resolution 0.1 Hz; Auto Level for measurements without AM, Manual level for mesurements with AM;

Measurement: Check RF frequency display of the FMA acc. to the test report setting various levels with and without AM. Since the calibrator level of -10 dBm cannot be varied with AM, the level must be attenuated to -25 dBm by the attenuator.

5.4.2.2 RF Power Measurement

FMA: RF level measurement, Auto Level

Measurement: Check the power display of the FMA acc. to the test report with various levels.Lt.

5.4.2.3 Amplitude Modulation

a) AM Measuring Accuracy

FMA: Auto Level; Manual Tune 10 MHz; demodulation AM, Auto Range;
detector ± peak/2;
filter: LP 100 kHz to 20 kHz, no LP >20 kHz

Measurement: Check AM display of the FMA with various modulation depths and modulation frequencies acc. to the test report.

b) Synchronous AM

FMA: Manual Tune 10 MHz; Auto Level, demodulation AM, Auto Range;
detector ± peak/2; HP 20 Hz, LP 3 kHz

Measurement: FM-modulate RF signal acc. to the test report and check the AM display of the FMA.

c) AF distortion with AM

If the distortion meter FMA-B2 is not fitted, connect distortion meter of the AF output to the FMA.

FMA: Manual tune 10 MHz; Auto Level, Demodulation AM, Auto Range; LP 100 kHz; Audio Dist. (%)

Measurement: Check the AF distortion with various modulation depths and modulation frequencies acc. to test report using the distortion meter.

5.4.2.4 Frequency Modulation

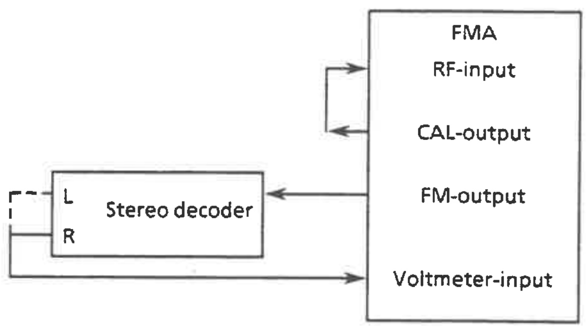
a) FM measuring accuracy

FMA: Manual tune 10 MHz; Autolevel; demodulation FM, Autorange; detector ± peak/2; filter: LP 100 kHz down to 20 kHz, no LP >20 kHz

Measurement: Check FM display of the FMA with various deviations and modulation frequencies acc. to test report.

b) Stereo crosstalk attenuation

Test setup: If the option FMA-B3 is not fitted, an external stereo decoder is required. The latter must be connected as illustrated below.



Internal stereo decoder:

FMA: Manual tune 10 MHz; Autolevel; demodulation FM stereo, noise LP off;

Measurement: Generate a frequency-modulated MPX signal L-only or R-only on the 10-MHz carrier using a calibrator. Wanted deviation (without pilot) on one channel = 40 kHz, pilot-tone deviation = 6.72 kHz. Switch to the modulated channel in the FM stereo menu, store the deviation displayed as reference value and switch over to "Relativ" dB. Subsequent to switching over to the unmodulated channel, the crosstalk attenuation is indicated directly in dB.
Perform measurement for various AF frequencies and both channels acc. to test report.

External stereo decoder:

FMA: Manual tune 10 MHz; Autolevel; demodulation FM, noise LP off; voltmeter AC unbal, Autorange, RF on; LP 100 kHz

Measurement: Set calibrator as described above.
Measure the output voltage of the modulated channel on the stereo decoder using a voltmeter, store the result as reference value and switch over to "Relativ" dB. The crosstalk attenuation can be read off the FMA directly in dB.
Repeat measurement with various frequencies and both channels acc. to test report.

c) AF distortion with FM

Test setup: If the distortion-meter option FMA-B2 is not fitted, connect a distortion meter to the AF output of the FMA.

FMA: Autolevel; demodulation FM, Autorange; filter: LP 100 kHz down to 20 kHz, no lowpass >20 kHz
With distortion meter: audio dist.(%)

Measurement: Check the AF distortion with various modulation frequencies and deviations acc. to test report using the distortion meter.

d) Synchronous FM

FMA: Manual tune 10 MHz; Autolevel; demodulation FM, Autorange, detector ± peak/2; HP 20 Hz, LP 3 kHz

Measurement: AM-modulate calibration signal acc. to test report and check FM display of the FMA.
The residual FM cannot be neglected, it must be measured without modulation and be subtracted from the displayed value.
The measuring error due to the synchronous FM of the calibration signal can be eliminated by performing one measurement with normal sideband and one measurement with inverted sideband (RF special menu), respectively and then averaging the measured values.

e) Deemphasis

FMA: Manual tune 10 MHz; Autolevel; demodulation FM, Autorange; detector ± peak/2; LP 23 kHz
Deemphase acc. to test report

Measurement: Set deviation and f_{mod} of the calibration signal acc. to test report.
Measure deviation without deemphasis, store measured value as reference value and switch over to "Relativ" dB. Switch on deemphasis acc. to test report and read off attenuation.

5.4.2.5 Phase Modulation

a) PM measuring accuracy

FMA: Manual tune 10 MHz; Autolevel; demodulation FM or PM , Autorange; detector ± peak/2; LP 100 kHz additionally with filter option: low freq. PM;

Measurement: The demodulation is performed via the FM demodulator which is followed by a weighting filter with 1/f frequency response. It should be checked that the accuracy of this filter versus the modulation frequency is such that:
[Error of PM filter] < [perm. PM measuring error] - [perm. FM measuring error]
Read off FM and PM display with deviation and f_{mod} acc. to test report. The additional measuring error with PM compared to FM is calculated as follows:
Error of the PM filter = (f_{mod} * PM(FM -1) * 100%

b) AF distortion with PM

Test setup: If the distortion meter FMA-B2 is not fitted, connect a distortion meter to the AF output of the FMA.

FMA: Manual tune 10 MHz; Autolevel; demodulation PM, Autorange; LP 100 kHz
With distortion meter: audio dist.(%)

Measurement: Check the AF distortion with various deviations and modulation frequencies acc. to test report using the distortion meter.

5.4.2.6 Voltmeter

a) Unbalanced input

Offset voltage

Test setup: Short-circuit unbal. voltmeter input.

FMA: Voltmeter DC unbal., Autorange

Measurement: Actuate Calibrate, Single Cal, Voltmeter and read off voltage display, subsequently.

RMS measuring accuracy

FMA: Voltmeter AC unbal., Autorange; filter acc. to test report

Measurement: Check FMA display at various voltages and frequencies acc. to test report.

b) Balanced input

Offset voltage

Test setup: Leave the balanced voltmeter input open.

FMA: Voltmeter DC balanced, Autorange

Measurement: Actuate Calibrate, Single Cal, Voltmeter and read off voltage display, subsequently.

RMS measuring accuracy

Test setup: Connect the two AF outputs of the calibrator AF1 and AF2 to balanced voltmeter input (both internal conductors)

FMA: Voltmeter AC balanced, Autorange; filter acc. to test report

Measurement: Check FMA display at various voltages and frequencies acc. to test report.

Caution: *Output impedance of the calibrator with balanced operation: 20 Ω. Input impedance of the voltmeter: 600 Ω. Therefore: FMA display = 0.96774 * set voltage. This systematic attenuation has been taken into account in the test report.*

5.4.2.7 AF Weighting Filter

FMA: Voltmeter AC unbal., Manual Range 2V, relative dB; filter acc. to test report

Measurement: Measure the voltage with 2 V RMS at each frequency acc. to test report without filter and store the result as reference value, subsequently switch on the filter and measure its attenuation.

5.4.2.8 FMA-B1 Filter Option AF Weighting Filter

FMA setting and measurement as 5.5.7

Exceptions: Measure all attenuations >30 dB in autorange mode!
CCIR Wght. Aways use Autorange for measurements on the filter.

5.4.2.9 FMA-B1 Filter Option Psophometer (CCIR 468-1 Detector)

FMA: Voltmeter AC unbal., Manual Range 1 V;
Filter CCIR Wght.; quasipeak detector

Measurement: Check FMA display using calibration signal acc. to test report.

5.4.2.10 AF Counter Accuracy

FMA: Voltmeter AC unbal., Autorange; no filter; audio-frequency measurement

Measurement: Check AF frequency display of the FMA with 200 mV and various frequencies acc. to test report.

5.4.2.11 FMA-B2 Distortion Meter Option

Inherent distortion and noise

FMA: Voltmeter AC unbal, Autorange; no highpass, lowpass acc. to test report; audio DistSinad, dist. [%], Auto Range, Auto Tune

Measurement: Check inherent distortion of the FMA at various voltages and frequencies acc. to test report.

Measuring accuracy (SINAD display)

FMA: Voltmeter AC unbal, Autorange; no filter; Audio DistSinad, Sinad [dB], Auto Range, Man Tune f1 (f1 = fundamental)

Measurement: Set dual-tone signal on the calibrator acc. to test report.
Level of the fundamental: 2 V

Harmonics suppression	10 dB	20 dB	30 dB	40 dB	50 dB	60 dB
Harmonics level	632 mV	200 mV	63.2 mV	20 mV	6.32 mV	2 mV

The SINAD value is calculated as follows:
SINAD = 10 dB $\cdot$ log[1 + $10^{(a/10dB)}$] with a = harmonics suppression in dB
for a $\geq$ 20 dB applies: SINAD $\approx$ a

5.4.2.12 Stereo Decoder Option FMA-B3

All measurements performed on the stereo decoder need the two AF outputs of the calibrator (AF1 and AF2) to be connected to the balanced stereo-decoder input (DEC IN).

The subsequent calibrator setting applies for all measurements:
Destin AF output, 20 Ω Bal; units dBm 600 Ω;

Crosstalk attenuation

FMA: Calibrate generator MPX, channel L only or L = R, level +6 dBm, freq. 1 kHz, pilot level -9.5 dBm;
RMS detector; demodulation FM stereo extern.,Auto Range, unit dBm, channel see measurement;

Measurement: Switch to the modulated channel (L or M) in the FM stereo menu, store the value displayed as reference value under "Relativ" and switch to X/Ref dB. Subsequent to switching over to the unmodulated channel (R or S), the crosstalk attenuation is displayed directly in dB.
Perform measurement for various AF frequencies acc. to test report.

Frequency response

FMA: Calibrate generator MPX, channel L only / R only / L = R / L = -R level +6 dBm, freq. 1 kHz, pilot level -9.5 dBm;
RMS detector; demodulation FM stereo extern., Auto Range, unit dBm, channel L / R / M / S;

Measurement: Switch to the modulated channel (L/R/M/S) in the FM stereo menu, store the displayed value as reference value under "Relativ" and switch to X/Ref dB.
Perform measurement for various AF frequencies acc. to test report. The frequency response is displayed directly in dB.
Perform the reference measurement with 1 kHz in all channels.

Level difference between left and right channel

FMA: Calibrate generator MPX, channel L = R, level +6 dBm, freq. 1 kHz, pilot level -9.5 dBm;
RMS detector; demodulation FM stereo extern., Auto Range, unit dBm, channel see measurement;

Measurement: Select left channel in the FM stereo menu, store the value displayed as reference value under "Relativ" and switch to X/Ref dB.
Select right channel and read off difference in dB.

Measuring error

FMA: Calibrate generator MPX, channel L only / R only / L = R / L = -R level +6 dBm, freq. 1 kHz, pilot level -9.5 dBm; RMS detector; demodulation FM stereo extern., Auto Range, unit dBm, channel L / R / M / S / pilot;

Measurement: Switch to the modulated channel (L/R/M/S) and pilot tone in the FM stereo menu and check level display, respectively.

RDS carrier

FMA: Calibrate generator MPX, carr-57-kHz, level -14 dBm demodulation FM stereo, channel RDS Carr Check level display.

Distortion

FMA: Calibrate generator MPX, channel L only / R only / L = R / L = -R level +6 dBm / +12.5 dBm, freq. see measurement, pilot level -9.5 dBm; demodulation FM stereo extern., Auto Range, channel L/R/M/S; With FMA-B2*): Audio Dist Sinad, Dist %, Auto Range, Auto Tune;

Measurement: Switch to the modulated channel (L/R/M/S) and measure distortion with various AF frequencies and levels acc. to test report.

*) If FMA-B2 is not fitted, a distortion meter must be connected successively to the outputs L/R/M/S of the stereo decoder.

S/N ratio

FMA: Calibrate generator MPX, channel L only, level +6 dBm, freq. 500 Hz, pilot level -9.5 dBm;
with FMA-B1*): quasipeak detector; CCIR unweighted filter;
demodulation FM stereo extern., Auto Range, unit dBm, deemphase 50 µs, channel L;

Measurement: Store the displayed value as reference value under "Relativ" and switch to X/Ref dB. Subsequent to switching off the modulation on the calibrator (channel off), the S/N ratio (unweighted) is displayed directly in dB.
Switch on CCIR-weighted filter. The weighted S/N ratio is displayed (no new reference measurement).

*) If FMA-B1 is not fitted, an audio analyzer must be connected to the L-output of the stereo decoder.

5.4.2.13 FMAV

a) VOR/ILS/TACAN measurements

FMA: AM demodulation, Avion, type of measurement acc. to test report

Measurement: The 10-MHz calibration signal is AM-modulated using VOR/ILS/TACAN signals acc. to test report. Check the FMAV display with the respective measurements.

b) Analog outputs DSP1, DSP2

DC offset

FMA: AM demodulation, Avion, ILS, DDM

Measurement: Set unmodulated 10-MHz calibration signal (-10 dBm). Measure offset voltage at the outputs DSP1 and DSP2 using a DC voltmeter.

AM scaling and amplitude difference

FMA: AM demodulation, Avion, ILS, DDM

Measurement: The amplitude modulation of the 10-MHz calibration signal is performed with the ILS signal acc. to test report.
Measure voltages at the outputs DSP1 and DSP2 (measuring bandwidth 100 kHz) using an AC peak voltmeter.

FM scaling

FMA: AM demodulation, Avion, VOR, dev 9.96 k

Measurement: The amplitude modulation of the 10-MHz calibration signal is performed by means of a VOR signal acc. to test report.
Measure voltage at the output DSP1 (measuring bandwidth 100 kHz) using an AC peak voltmeter.

Phase difference

FMA: AM demodulation, Avion, ILS/VOR/TACAN phase, respectively

Measurement: The amplitude modulation of the 10-MHz calibration signal is performed using ILS/VOR/TACAN signals acc. to test report.
Measure the phase difference between the two outputs DSP1 and DSP2.

A phase meter can only be used for VOR. ILS and TACAN require a delta-t meter (special function of a counter).

Measurement should be performed with DC coupling due to the low frequencies. It must be taken into account, however, that offset voltages and different trigger thresholds cause measuring errors.

TACAN: (integer frequency ratio)

- Period measurement 135 Hz: → T
- delta T measurement: → ΔT
  Start: trigger at 15 Hz
  Stop: trigger at 135 Hz

Phase of the 135-Hz signal referred to 15 Hz:
$0 \leq \Delta T \leq T/2 \equiv 0° \text{ to } -180°$
$T/2 \leq \Delta T \leq T \equiv +180° \text{ to } 0°$

ILS:

ILS has no integer frequency ratio. The phase of the 150-Hz signal referred to 80 Hz is only unambiguous in the range ± 60°.

- Period measurement 150Hz: → T
- delta T measurement: → ΔT
  Start: trigger at 90 Hz 90 Hz
  Stop: trigger at 150 Hz 150 Hz

The measurement of the time difference supplies 3 different values, alternatingly. Delta T is selected such that :

	$0 \leq \Delta T \leq T/6$	oder	$5/6T \leq \Delta T \leq T$.
This correponds to the phases:	0 ° to -60 °	und	+ 60 ° to 0 °.

5.4.3 Test Report

Note: *The data given in the data sheet of the calibrator have been considered with the tolerance limits in this report!*

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
1	**RF counter accuracy and sensitivity**	5.4.2.1				
	Frequency MHz / Level dBm / AM/1 kHz m %			Deviation		
	10 / -37.5 / 0		-0.1	....	+ 0.1	Hz
	10 / -25 / 80		-0.1	....	+ 0.1	Hz
2	**RF power measurement**	5.4.2.2				
	FMA without option FMA-B12:					
	Level/dBm / Frequency/MHz					
	-37.5 / 10		-41.4	....	-35.0	dBm
	-10 / 10		-11.1	....	-8.9	dBm
	-4 / 10		-5.2	....	-2.8	dBm
	FMA with opt. FMA-B12/FMB:					
	Level/dBm / Frequency/MHz					
	-37.5 / 10		-40.6	....	-35.4	dBm
	-10 / 10		-10.4	....	-9.6	dBm
	-4 / 10		-4.5	....	-3.5	dBm
3	**AM measuring accuracy**	5.4.2.3/a				
	Level = -10 dBm					
	Carrier freq. / m / Mod. freq.					
	10 MHz / 20 % / 30 Hz		19.78	....	20.22	%
	1 kHz		19.80	....	20.20	%
	20 kHz		19.78	....	20.22	%
	80 % / 30 Hz		79.20	....	80.80	%
	1 kHz		79.28	....	80.72	%
	20 kHz		79.20	....	80.80	%
	95 % / 10 Hz		92.81	....	97.19	%
	1 kHz		93.86	....	96.14	%
	100 kHz		93.38	....	96.62	%
4	**Synchronous AM**	5.4.2.3/b				
	Level = -10 dBm					
	FM-modulated with 1 kHz Meas. bandwidth 20 Hz to 3 kHz					
	FM deviation / Frequency 50 kHz / 10 MHz		0	....	0.15	%
5	**AF distortion with AM**	5.4.2.3/c				
	Level = -10 dBm					
	Carrier freq. / m / Mod. freq.					
	10 MHz / 40 % / 10 Hz		0	....	0.3	%
	1 kHz		0	....	0.3	%
	20 kHz		0	....	0.3	%
	80 % / 10 Hz		0	....	0.5	%
	1 kHz		0	....	0.5	%
	20 kHz		0	....	0.5	%

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
6	**FM measuring accuracy** Level = -10 dBm Carrier freq. Deviation Mod. freq 10 MHz 20 kHz 10 Hz 30 Hz 1 kHz 20 kHz 100 kHz 100 kHz 1 kHz 20 kHz 100 kHz	5.4.2.4/a	19.44 19.44 19.84 19.74 19.64 99.3 98.8 98.3	....	20.56 20.26 20.16 20.26 20.36 100.7 101.2 101.7	kHz kHz kHz kHz kHz kHz kHz kHz
7	**Stereo crosstalk attenuation** Deviation = 40 kHz without noise filter Carrier freq. Channel AF 10 MHz L→R 30 Hz 1 kHz 15 kHz R→L 30 Hz 1 kHz 15 kHz	5.4.2.4/b	50 56 50 50 56 50	....	- - - - - -	dB dB dB dB dB dB
8	**NF distortion with FM** Level = -10 dBm Carrier freq. Deviation Mod. freq 10 MHz 75 kHz 30 Hz 1 kHz 20 kHz	5.4.2.4/c	0 0 0	....	0.15 0.15 0.15	% % %
9	**Synchrone FM** Level = -10 dBm 50 % AM-modulated with 1 kHz Meas bandwith 20 Hz to 3 kHz Frequency 10 MHz	5.4.2.4./d	0	....	20	Hz
10	**Deemphases** RF = 10 MHz Deviation = 40 kHz Deemphases Deviation at f_{mod} 50 µs 3.183 kHz 75 µs 2.122 kHz 750 µs 212.2 Hz	5.4.2.4/e	2.9 2.9 2.9	....	3.1 3.1 3.1	dB dB dB
11	**PM measuring accuracy** 10 MHz/-10 dBm Additional error by the PM filter compared to FM: Frequency deviation = 100 kHz $(\frac{PM}{FM} \cdot f_{mod} - 1) \cdot 100$ % — f_{mod} 300 Hz 1 kHz 20 kHz 100 kHz	5.4.2.5/a	-1.5 -1.5 -1 -1	....	+ 1.5 + 1.5 + 1 + 1	% % % %

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
11	**Only option FMA-B1:**	5.4.2.5/a				
	Low freq PM					
	$(\frac{PM}{FM} \cdot f_{mod} - 1) \cdot 100$ % f_{mod} 10 Hz		-1.5	....	+ 1,5	%
	HP 20 Hz 100 Hz		-1.5	....	+ 1.5	%
	HP 20 Hz 1 kHz		-1.5	....	+ 1.5	%
12	**AF distortion with PM**	5.4.2.5/b				
	Level = -10 dBm Phase deviation = 4rad					
	Carrier freq. / Deviation / Mod. freq					
	10 MHz 1 kHz 250 Hz		0	....	0.2	%
	4 kHz 1 kHz		0	....	0.2	%
	80 kHz 20 kHz		0	....	0.2	%
13	**Voltmeter unbalanced**	5.4.2.6/a				
	Offset voltage after Cal.		-0.03	....	+ 0.03	mV
	RMS measuring accuracy					
	Volt. / HP / LP / Freq.					
	1 mV 20 Hz 100 kHz 1kHz		0.95	....	1.105	mV
	100 kHz 20 kHz		0.95	....	1.05	mV
	without 100 kHz		0.87	....	1.13	mV
	3 mV 20 Hz 100 kHz 1 kHz		2.93	....	3.07	mV
	100 kHz 20 kHz		2.93	....	3.07	mV
	without 100 kHz		2.82	....	3.18	mV
	10 mV 20 Hz 100 kHz 1 kHz		9.85	....	10.15	mV
	100 kHz 20 kHz		9.85	....	10.16	mV
	without 100 kHz		9.66	....	10.34	mV
	30 mV 20 Hz 100 kHz 1 kHz		29.61	....	30.30	mV
	100 kHz 20 kHz		29.60	....	30.40	mV
	without 100 kHz		29.20	....	30.80	mV
	100 mV 20 Hz 100 kHz 1 kHz		98.86	....	101.14	mV
	100 kHz 20 kHz		98.76	....	101.24	mV
	without 100 kHz		97.59	....	102.41	mV
	300 mV 20 Hz 100 kHz 1 kHz		296.7	....	303.3	mV
	100 kHz 20 kHz		296.4	....	303.6	mV
	without 100 kHz		292.7	....	307.3	mV
	1 V without 1 00 kHz 10 Hz		0.978	....	1.022	V
	30 Hz		0.988	....	1.012	V
	20 Hz 1 kHz		0.989	....	1.011	V
	20 kHz		0.988	....	1.012	V
	without 100 kHz		0.977	....	1.023	V
	3 V 20 Hz 100 kHz 1 kHz		2.967	....	3.033	V
	100 kHz 20 kHz		2.964	....	3.036	V
	without 100 kHz		2.931	....	3.069	V
	7 V 20 Hz 100 kHz 1 kHz		6.923	....	7.077	V
	100 kHz 20 kHz		6.916	....	7.084	V
	without 100 kHz		6.839	....	7.161	V
14	**Voltmeter balanced**	5.4.2.6/b				
	Offset voltage after cal.		-0.03	....	+ 0.03	mV
	RMS measuring accuracy					
	Volt. / HP / LP / Freq.					
	1 V without 100 kHz 10 Hz		0.946	....	0.989	V
	without 30 Hz		0.956	....	0.979	V
	20 Hz 1 kHz		0.957	....	0.978	V
	20 kHz		0.956	....	0.979	V
	without 100 kHz		0.945	....	0.990	V
	7 V 20 Hz 100 kHz 1 kHz		6.699	....	6.849	V
	100 kHz 20 kHz		6.692	....	6.856	V
	without 100 kHz		6.618	....	6.931	V

Item No.	Characteristics		Test according to section	Min.	Actual	Max.	Unit
15	**AF weighting filter**		5.4.2.7				
	Frequency response referrend to display without filter						
	Filter	Frequency					
	HP 10 Hz	10 Hz		-3.5	....	-2.5	dB
		30 Hz		-0.04	....	+0.04	dB
	HP 20 Hz	10 Hz		-20.5	....	-16.5	dB
		20 Hz		-3.5	....	-2.5	dB
		31.5 Hz		-0.5	....	+0.5	dB
		60 Hz		-0.04	....	+0.04	dB
	HP 300 Hz	100 Hz		-22	....	-18	dB
		300 Hz		-3.5	....	-2.5	dB
		1000 Hz		-0.04	....	+0.04	dB
	LP 3 kHz	1 kHz		-0.04	....	+0.04	dB
		3 kHz		-3.5	....	-2.5	dB
		6 kHz		-25.5	....	-21.5	dB
	LP 23 kHz	6 kHz		-0.04	....	+0.04	dB
		16 kHz		-0.5	....	+0.5	dB
		23.5 kHz		-3.5	....	-2.5	dB
		47 kHz		-25.5	....	-21.5	dB
	LP 100 kHz	30 kHz		-0.04	....	+0.04	dB
		100 kHz		-3.5	....	-2.5	dB
	Mod. 59						dB
	LP 200 kHz	50 kHz		-0.04	....	+0.04	dB
		100 kHz		-0.5	....	+0.4	dB
16	**AF weighting filter Option FMA-B1**		5.4.2.8				
	Frequency response referrend to display without filter				....		
	Filter	Frequency					
	CCIR Wght	31.5 Hz		-31.7	....	-28.1	dB
		100 Hz		-20.6	....	-19.0	dB
		1 kHz		-0.08	....	+0.08	dB
		6.3 kHz		+12.0	....	+12.4	dB
		20 kHz		-24.0	....	-20.4	dB
	CCITT	50 Hz		-65	....	-61	dB
		300 Hz		-11.6	....	-9.6	dB
		800 Hz		-0.08	....	+0.08	dB
		3 kHz		-6.6	....	-4.6	dB
		3.5 kHz		-10.5	....	-6.5	dB
		5 kHz		-39	....	-33	dB
	LP 5 Hz	10 Hz		-16	....	-10	dB
		30 Hz		-	....	-60	dB
	LP 30 kHz	2 kHz		-0.04	....	+0.04	dB
		5 kHz		-0.15	....	+0.15	dB
		30 kHz		-4	....	-2	dB
		100 kHz		-28.5	....	-24.5	dB
	LP 120 kHz	8 kHz		-0.04	....	+0.04	dB
		20 kHz		-0.15	....	+0.15	dB
		100 kHz		-3.3	....	-1.3	dB
	LP 4.5 kHz	60 Hz		-0.2	....	+0.2	dB
		1 kHz		-0.08	....	+0.08	dB
		3 kHz		-0.2	....	+0.2	dB
		4 kHz		-1	....	+0.2	dB
		4.5 kHz		-	....	-40	dB
		20 kHz		-	....	-40	dB

Item No.	Characteristics			Test according to section	Min.	Actual	Max.	Unit
17	**Psophometer (CCIR 468-1)**			5.4.2.9				
	Only option FMA-B1							
	Quasipeak + CCIR Wght.							
	Meas. range 1 V							
	Fundamental accuracy							
	Sin wave signal 0.775 V, 1 kHz				0.766	....	0.784	V
18	**AF counter accuracy**			5.4.2.10				
	200 mV	RMS	Frequency					
			10 Hz		9.995	....	10.004	Hz
			100 Hz		99.991	......	100.01	Hz
			1000 Hz		999.94	....	1000.1	Hz
			100 kHz		99.994	....	100.01	kHz
19	**Distortion measurement**			5.4.2.11				
	only option FMA-B2							
	Inherent distortion and noise							
	Voltage	Lowpass	Frequency					
	10 mV	LP100 k	10 Hz		0	....	0.27	%
			1 kHz		0	......	0.27	%
			20 kHz		0	....	0.27	%
		no LP	100 kHz		0	....	0.7	%
	2 V	LP100 k	10 Hz		0	....	0.035	%
			1 kHz		0	....	0.035	%
			20 kHz		0	....	0.035	%
		no LP	100 kHz		0	....	0.180	%
	Measuring accuracy (SINAD)							
	Frequency	Harmonic	Harmonic suppression					
	20 Hz	40 Hz	20 dB		19	....	21	dB
			50 dB		48.6	....	51.4	db
		60 Hz	20 dB		19	....	21	db
			50 dB		48.6	....	51.4	db
	1 kHz	2 kHz	10 dB		9.4	....	11.4	db
			20 dB		19	....	21	db
			30 dB		29	....	31	db
			40 dB		38.9	....	41.1	db
			50 dB		48.6	....	51.4	db
			60 dB		57.8	....	62.4	db
		3 kHz	20 dB		19	....	21	db
			50 dB		48.6	....	51.4	db
	20 kHz	40 kHz	20 dB		19	....	21	db
			50 dB		48.6	....	51.4	db
		60 kHz	20 dB		19	....	21	db
			50 dB		48.6	....	51.4	db
20	**Stereo decoder**			5.4.2.12				
	only option FMA-B3/FMAB							
	Crosstalk attenuation (RMS)							
	L→R		Frequency					
			30 Hz		60	....	-	dB
			1 kHz		60	....	-	dB
			5 kHz		60	......	-	dB
			10 kHz		60	....	-	dB
			15 kHz		60	....	-	dB

Item No.	Characteristics		Test according to section	Min.	Actual	Max.	Unit
20	**Stereo decoder**		5.4.2.12				
	only option FMA-B3/FMAB						
	Crosstalk attenuation (RMS)						
	M→S	Frequency					
		30 Hz		50	....	-	dB
		1 kHz		50	....	-	dB
		5 kHz		50	....	-	dB
		10 kHz		50	....	-	dB
		15 kHz		50	....	-	dB
	Frequency response referredt to disply with 1kHz (RMS)						
	Channel	Frequency					
	L	30 Hz		-0.1	....	+ 0.1	dB
		100 Hz		-0.1	....	+ 0.1	dB
		300 Hz		-0.1	....	+ 0.1	dB
		3 kHz		-0.1	....	+ 0.1	dB
		10 kHz		-0.1	....	+ 0.1	dB
		15 kHz		-0.1	....	+ 0.1	dB
	R	30 Hz		-0.1	....	+ 0.1	dB
		100 Hz		-0.1	....	+ 0.1	dB
		300 Hz		-0.1	....	+ 0.1	dB
		3 kHz		-0.1	....	+ 0.1	dB
		10 kHz		-0.1	....	+ 0.1	dB
		15 kHz		-0.1	....	+ 0.1	dB
	M	30 Hz		-0.1	....	+ 0.1	dB
		100 Hz		-0.1	....	+ 0.1	dB
		300 Hz		-0.1	....	+ 0.1	dB
		3 kHz		-0.1	....	+ 0.1	dB
		10 kHz		-0.1	....	+ 0.1	dB
		15 kHz		-0.1	....	+ 0.1	dB
	S	30 Hz		-0.1	....	+ 0.1	dB
		100 Hz		-0.1	....	+ 0.1	dB
		300 Hz		-0.1	....	+ 0.1	dB
		3 kHz		-0.1	....	+ 0.1	dB
		10 kHz		-0.1	....	+ 0.1	dB
		15 kHz		-0.1	....	+ 0.1	dB
	Level difference between left and right channel						
	Frequency: 1 kHz			-0.1	....	+ 0.1	dB
	Measuring error (RMS) Channel + 6 dBm. freq. 1 kHz Pilot -9.5 dBm 57-kHz carrier -14 dBm						
	L			5.82	....	+ 6.17	dBm
	R			5.82	....	+ 6.17	dBm
	M			5.82	....	+ 6.17	dBm
	S			5.82	....	+ 6.17	dBm
	Pilot			-9.68	....	-9.53	dBm
	57-kHz carrier			-14.44	....	-13.57	dBm

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
20	**Stereo decoder**	5.4.2.12				
	Distortion (THD)					
	Level / Channel / Frequency					
	+ 6 dBm L 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	R 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	M 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	S 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	+ 12.5 dBm L 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	R 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	M 30 Hz		-	....	0.13	%
	12 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	S 30 Hz		-	....	0.13	%
	1 kHz		-	....	0.13	%
	5 kHz		-	....	0.13	%
	7.5 kHz		-	....	0.13	%
	S/N Ratio referred to + 6 dBm (L only) Deemphasis 50 µs					
	CCIR-Unweighted		77	....	-	dB
	CCIR-Weighted		77	....	-	dB
21	**VOR/ILS/TACAN Measurement**	5.4.2.13/a				
	only FMAV					
	Carrier frequency: 10 MHz Level: -10 dBm					
	VOR-Signal					
	Signal (by calibrator):					
	m ID = 10 % m 30 Hz = 30 % m 9.96 kHz = 30 % Dev 9.96 k = 480 Hz VOR Phase = 0 ° f ID = 1020 Hz f 30 Hz = 30 Hz f 9.96 kHz = 9960 Hz					

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
21	**VOR/ILS/TACAN Measurements**	5.4.2.13/a				
	Measurements					
	m 30 Hz		29.76	....	30.24	%
	Audio frequency		29.994	....	30.006	Hz
	m 9.96 kHz		29.76	....	30.24	%
	Audio frequency		9959.4	....	9960.6	Hz
	m ID		9.88	....	10.12	%
	Audio frequency		1019.9	....	1020.1	Hz
	Dev 9.96 kHz		476	....	484	Hz
	Audio frequency		29.994	....	30.006	Hz
	Phase		359.96	....	0.04	°
	Phase = +270 °					
	Phase		269.96	....	270.04	°
	ILS signal					
	Signal (by calibrator):					
	m ID = 10 %					
	m ILS = 20 %					
	DDM = 0					
	ILS Phase = 0 °					
	f ID = 1020 Hz					
	f 90 = 90 Hz					
	Measurements:					
	m 90 Hz		19.9	....	20.1	%
	Audio frequency		89.991	....	90.009	Hz
	m 150 Hz		19.9	....	20.1	%
	Audio frequency		149.98	....	150.02	Hz
	m ID		9.88	....	10.12	%
	Audio frequency		1019.8	....	1010.2	Hz
	DDM		-0.00025	....	+0.00025	DDM
	Phase		-0.3	....	+0.3	°
	DDM = +0.04/Phase = +30 °					
	DDM		0.03967	....	0.04033	DDM
	Phase		29.7	....	30.3	°
	Signal as above, but m ILS = 40 %					
	m 90 Hz		39.8	....	40.2	%
	m 150 Hz		39.8	....	40.2	%
	m ID		9.88	....	10.12	%
	DDM = 0/Phase = 0 °					
	DDM		-0.0006	....	+0.0006	DDM
	Phase		-0.3	....	+0.3	°
	DDM = -0.1/Phase = -30 °					
	DDM		-0.0992	....	-0.1008	DDM
	Phase		-29.7	....	-30.3	°
	TACAN signal					
	Signal (by calibrator):					
	m 15 Hz = 40 %					
	m 135 Hz = 10 %					
	TAC Phase = 0 °					
	f 15 = 15 Hz					
	Measurements:					
	m 15 Hz		39.8	....	40.2	%
	Audio frequency		14.995	....	15.005	Hz
	m 135 Hz		9.95	....	10.05	%
	Audio frequency		134.98	....	135.02	Hz
	Phase		-0.75	....	+0.75	°
	Phase = +90 °			....		
	Phase		89.25	....	90.75	°

Item No.	Characteristics	Test according to section	Min.	Actual	Max.	Unit
22	**Analog outputs DSP1, DSP2**	5.4.2.13/b				
	only FMAV					
	DC offset:					
	DSP1		-3	....	+3	mV
	DSP2		-3	....	+3	mV
	AM scaling:					
	ILS signal (by calibrator): m ID = 10 % m ILS = 40 % DDM = 0 ILS Phase = 0 ° f ID = 1020 Hz f 90 = 90 Hz					
	DDM measurement					
	DSP1 (peak)		1.574	....	1.626	V
	DSP2 (peak)		1.574	....	1.626	V
	Amplitude difference (relative) 100 % * (DSP2-DSP1)/DSP1		-0.2	....	+ 0.2	%
	FM scaling:					
	VOR signal (by calibrator): m ID = 10 % m 30 Hz = 30 % m 9.96 kHz = 30 % Dev 9.96 k = 480 Hz VOR Phase = 0 ° f 30 Hz = 30 Hz f ID = 1020 Hz f 9.96 kHz = 9960 Hz					
	Dev 9.96 k measurement DSP1 (peak)		1.886	....	1.954	V
	Phase difference:					
	a) with ILS Signal as with AM scaling		-0.6	....	+ 0.6	°
	b) with VOR Signal as with FM scaling		-0.09	....	+ 0.09	°
	c) with TACAN Signal (by calibrator): m 15 Hz = 40 % m 135 Hz = 40 % TAC Phase = 0 ° f 15 = 15 Hz		-0.95	....	+ 0.95	°

5.5 FMAS

Additional measurements for FMAS only

The following applies for all receiver measurements described below:

- The FMAS must be tuned to the frequency of the information signal ±1 kHz in order to synchronize to the center frequency of the IF filter. Source and FMAS are preferably synchronized via an external reference.
- All measurements are performed in the Receiver operating mode and Low Distortion mode.

5.5.1 Additional Test Instruments and Utilities

Item	Type of instrument	Required specifications	Suitable R&S instrument	Order No.	Application
1	Signal generator	RF: 1 MHz to 1 GHz Level: 0 to -100 dBm AM: m to 90% FM: deviation up to 75 kHz fmod: 30 Hz to 15 kHz	SMX SMX-B2	826.4517.52 826.9619.02	FMAS only
2	Two-tone and MPX generator	Difference-frequency distortion <0.1% up to 53 kHz Stereo crosstalk attenuation: 60 dB Distortion <0.1% up to 15 kHz stereo and mono	FMA-B4	855.6008.52	FMAS only

5.5.2 Test Sequence

5.5.2.1 Selectivity Measurements

All selectivity measurements relate to the weighted S/N ratio at the unmodulated useful signal with influence from a spurious signal.

Test setup: The FMAS is connected to two signal generators (useful and spurious signal) via a-6dB power divider (2 ·50Ω). The levels given in the test report apply for the transmitter mode. The 6-dB attenuation has been taken into account.

FMAS: RF Auto level, demodulation FM stereo, deemphasis 50µs, channel L or R with "stereo" or M with "mono"; filter wght to CCIR (or unwght., see measurement)

Meas.ment: Test signals and FMAS setting according to test report. A reference measurement with modulated information signal is first required: measure 40kHz deviation, f_{mod}=500Hz to CCIR unwght. and store as reference value. Switch off modulation of the useful signal and measure weighted S/N ratio to CCIR. Select relative measurement dB.

Common-Channel Selectivity

Measure weighted S/N ratio using test signals and FMAS setting acc. to test report.

Selectivity Close and Remote to Carrier

Measure weighted S/N ratio using test signals and FMAS setting acc. to test report.
The measurements with noise levels -9dBm und -1dBm are performed with MAN level -25dBm. (With Auto level, the RF attenuation would be switched on due to the high noise levels, such that the required S/N ratio cannot be obtained with any noise signal.)

IF and Image Frequency Rejection

Measure weighted S/N ratio using test signals and FMAS setting acc. to test report.

5.5.2.2 Linear Distortion

Test setup: The FMAS is connected to an FM test source. The test source is modulated by an AF and MPX signal generator. It is advisable to use an AC calibrator for measuring the frequency response.

Frequency Response of the Amplitude

FMAS: Auto level; demodulation FM; detector ±pk/2; no filter

Meas.ment: Test signals and FMAS setting acc. to test report. First, perform a reference measurement with f_{mod} = 500Hz and store the measured value as reference. Select relative measurement dB and measure frequency response.

Stereo Channel Crosstalk

FMAS: Auto level; demodulation FM stereo, channel L or R (see measurement); detector RMS·√2; no filter

Meas.ment: Test signals and FMAS setting acc. to test report. First, perform reference measurement with f_{mod} = 1kHz in the modulated channel (L) and store measured value as reference. Select relative measurement dB and measure crosstalk attenuation in the unmodulated channel (R) .

5.5.2.3 Nonlinear Distortion

Test setup: The FMAS is connected to an FM test source, which is modulated by a two-tone and MPX signal generator.

Distortion without Decoder

FMAS: RF auto level; demodulation FM; audio dist.Sinad, dist. %, selective THD d2-dn, n=8;

Meas.ment: Test signals and FMAS setting acc. to test report. Modulation is effected using a sinewave signal. Measure distortion (THD).

Distortion with Decoder

FMAS: RF auto level; demodulation FM stereo, channel M or L (acc. to test report); audio dist.Sinad, dist. %, selective THD d2-dn, n=8;

Meas.ment: Test signals and FMAS setting acc. to test report. Modulation is effected using a MPX-signal, L=R. The deviation applies for the useful signal without pilot tone. The pilot deviation should be approx. 6.7 kHz. Measure distortion (THD).

Difference-Frequency Distortion

FMAS: RF auto level; demodulation FM; audio intermod, diff. dist. d2 or d3 (acc. to test report), tune freq. tone 1, freq. tone 2 (acc. to test report), units%

Meas.ment: Test signals and FMAS setting acc. to test report. Modulation is effected using a two-tone signal. The deviation applies for the total signal. Measure difference-frequency distortion (diff. dist.).

5.5.2.4 Weighted S/N Ratio

Test setup: The FMAS is connected to a signal generator.

FMAS: RF auto level, receiver low noise; demodulation FM stereo, deemphasis 50µs, channel L or R with "Stereo" or M with "Mono"; filter weighted or unweighted to CCIR (see measurement)

Meas.ment: Test signals and FMAS setting acc. to test report. A reference measurement with modulated signal generator is first required: measure deviation 40kHz, f_{mod}=500Hz tp CCIR Unwght. and store as reference value. Switch off modulation and measure weighted S/N ratio acc. to CCIR. Select relative measurement dB.

5.5.2.5 TV 2-Tone

All measurements are performed with IF filter: TV Sound
The measurements are taken via stereo decoder in the channel M to use the 15-kHz lowpass.

Deviation Measurement Accuracy with TV 2-Tone

Test setup: An FM test source is first connected to a spectrum analyzer for calibration and then connected to the FMAS. The test source is modulated by an AF generator. It is advisable to use an AC calibrator.

Calibration: The deviations 30kHz and 70kHz are calibrated acc. to the Bessel zero method. The carrier suppression is checked using the spectrum analyzer. The modulation frequency response is measured from the reference points, respectively.

Reference deviation	Modulation frequency	η	# Carrier zero crossing
30 kHz	5.4348 kHz	5.5200	2
70 kHz	12.6812 kHz	5.5200	2

FMAS: Auto level; demodulation FM stereo, channel M; detector ±pk/2; no filter

Meas.ment: Test signals and FMAS setting acc. to test report. Check the deviation display of the FMAS, respectively.

Channel Crosstalk Attenuation with TV 2-Tone

Test setup: The FMAS is connected to two signal generators via a -6dB power divider (2 ·50Ω). The levels given below apply for the transmitter mode. The 6-dB attenuation has been taken into account.

FMAS: Tune freq. 800MHz, auto level; demodulation FM stereo, channel M, deemphasis 50µs; detector RMS·√2; filter HP10Hz, LP100kHz;

Meas.ment: Test signals and FMAS setting according to test report. First, perform reference measurement with modulated channel 2, 800MHz, deviation = 30kHz, f_{mod} = 500Hz and store measured value as reference. Switch off modulation in channel 2. Select relative measurement dB and measure crosstalk attenuation.

5.5.2.6 LO Noise Voltage

Test setup: Connect spectrum analyzer to RF input of the FMAS.

FMAS: Receiver, MAN level -20dBm (→ 0 dB RF-attenuation, RF preamplifier off)

Meas.ment: Tune FMAS to the frequencies acc. to test report (Tune Freq.) and measure level at the LO frequency using the spectrum analyzer.

5.5.2.7 Input Reflection

Test setup: Connect network analyzer to the RF input of the FMAS via VSWR bridge.

FMAS: Receiver, man. level -20dBm (→ 0 dB RF attenuation, RF preamplifier off)

Meas.ment: The measurement can only be performed at specified frequencies, since the preselection of the FMAS must be tuned simultaneously via Tune Freq. Tune FMAS to the frequencies acc. to the test report (Tune Freq.) and measure the respective VSWR using the network analyzer.

5.5.2.8 Level Measuring Accuracy

Test setup: Connect signal generator to the terminating measuring head of an RF level meter and to the RF input of the FMAS via a -6-dB power divider (2 ·50Ω).

FMAS: Receiver, IF filter/mode FM wide/low dist., level (auto/man, see below), disp tuned

Meas.ment: Adjust level on the signal generator such that the level display on the power divider corresponds to the levels given in the test report. Tune FMAS to the frequencies acc. to test report (Tune Freq.) and check level display, respectively.

a) Check frequency response of preselection filter without RF preamplifier with -20 dBm
FMAS: Man level -20dBm

b) Check frequency response with RF preamplifier with -30dBm
FMAS: Man Level -30dBm

c) Check errors of the IF amplifiers with levels between -87 and -7dBm prüfen
FMAS: Auto level

d) Check error of the IF filter FM narrow with -20dBm
FMAS: Man level -20dBm, IF filter FM narrow

5.5.3 Test Report

Only MODULATION ANALYZER FMAS

Item	Characteristic	Measure-ment	min.	actual	max.	Unit
1	**Common-channel selectivity**	5.5.2.1				
	Weighted S/N ratio IF filter: wide Information signal: 100 MHz, -10 dBm Spurious signal: 100.006 MHz Decod. / Level / Modulation					
	Stereo -59 dBm without		54	....	-	dB
	-73 dBm deviation 40 kHz f_{mod} 500 Hz		54	....	-	dB
	Mono -59 dBm without		54	....	-	dB
	-54 dBm deviation 40 kHz f_{mod} 500 Hz		54	....	-	dB
2	**Selectivity close and remote to carrier**	5.5.2.1				
	Weighted stereo S/N ratio Useful signal: 100 MHz, -35 dBm Spurious signal:modulation deviation 75 kHz, f_{mod} 500 Hz IF filter / Frequency / Level					
	wide 99.9 MHz -99 dBm		54	....	-	dB
	99.8 MHz -60 dBm		54	....	-	dB
	99.7 MHz -40 dBm		54	....	-	dB
	narrow 100.1 MHz -96 dBm		54	....	-	dB
	100.2 MHz -46 dBm		54	....	-	dB
	100.3 MHz -20 dBm		54	....	-	dB
	Weighted mono S/N ratio Useful signal: 100 MHz, -55 dBm Spurious signal: modulation 75 kHz, f_{mod} 500 Hz IF filter / Frequency / Level					
	wide 99.9 MHz -62 dBm		54	....	-	dB
	99.8 MHz -62 dBm		54	....	-	dB
	99.7 MHz -59 dBm		54	....	-	dB
	99.4 MHz -29 dBm		54	....	-	dB
	98.8 MHz -1 dBm		54	....	-	dB
	narrow 100.1 MHz -59 dBm		54	....	-	dB
	100.2 MHz -55 dBm		54	....	-	dB
	100.3 MHz -39 dBm		54	....	-	dB
	100.6 MHz -9 dBm		54	....	-	dB
	101.2 MHz -1 dBm		54	....	-	dB
3	**IF and Image Frequency Rejection**	5.5.2.1				
	Weighted stereo S/N ratio IF filter: wide Useful signal / spurious signal: modulation -35 dBm / FM: 75 kHz, f_{mod} 500 Hz AM: 90%, f_{mod} 500 Hz Frequency / Frequency / Level					
	108 MHz 158.506 MHz -15 dBm		54	....	-	dB
	184 MHz 158.506 MHz -50 dBm		54	....	-	dB
	5 MHz 208.506 MHz -50 dBm		54	....	-	dB
	182 MHz 208.506 MHz -50 dBm		54	....	-	dB
	274 MHz 208.506 MHz -50 dBm		54	....	-	dB
	351 MHz 208.506 MHz -25 dBm		54	....	-	dB
	100 MHz 417.006 MHz -25 dBm		54	....	-	dB
	272 MHz 589.006 MHz -45 dBm		54	....	-	dB
	5 MHz 422.006 MHz -45 dBm		54	....	-	dB
	349 MHz 766.006 MHz -45 dBm		54	....	-	dB
	419 MHz 836.006 MHz -45 dBm		54	....	-	dB
	100 MHz 97.006 MHz -25 dBm		54	....	-	dB
	900 MHz 897.006 MHz -45 dBm		54	....	-	dB
	100 MHz 117.006 MHz -25 dBm		54	....	-	dB
	900 MHz 917.006 MHz -45 dBm		54	....	-	dB

Item	Characteristic		Measure-ment	min.	actual	max.	Unit
4	**Frequency response of the amplitude**		5.5.2.2				
	Test signal: 100 MHz -10 dBm, deviation 40 kHz						
	IF filter	f_{mod}					
	wide Reference meas.ment	500 Hz			0		dB
		40 Hz		-0.1	....	+0.1	dB
		15 kHz		-0.1	....	+0.1	dB
		33 kHz		-0.1	....	+0.1	dB
		43 kHz		-0.1	....	+0.1	dB
		53 kHz		-0.1	....	+0.1	dB
		61 kHz		-0.2	....	+0.2	dB
		70 kHz		-0.5	....	+0.5	dB
		75 kHz		-1.5	....	+1.5	dB
	narrow Reference meas.ment	500 Hz			0		dB
		40 Hz		-0.1	....	+0.1	dB
		15 kHz		-0.1	....	+0.1	dB
		33 kHz		-0.1	....	+0.1	dB
		43 kHz		-0.1	....	+0.1	dB
		53 kHz		-0.3	....	+0.3	dB
		61 kHz		-1.0	....	+1.0	dB
		70 kHz		-3.0	....	+3.0	dB
		75 kHz		-5.0	....	+5.0	dB
5	**Stereo channel crosstalk** (L→R) Test signal: 100 MHz, -10 dBm Deviation 40 kHz, L only		5.5.2.2				
	IF filter	f_{mod}					
	wide	40 Hz		50	....	-	dB
		1 kHz		50	....	-	dB
		5 kHz		50	....	-	dB
		8 kHz		44	....	-	dB
		10 kHz		44	....	-	dB
		15 kHz		44	....	-	dB
	narrow	40 Hz		37	....	-	dB
		1 kHz		37	....	-	dB
		5 kHz		37	....	-	dB
		8 kHz		31	....	-	dB
		10 kHz		31	....	-	dB
		15 kHz		31	....	-	dB
6	**Distortion without decoder**		5.5.2.3				
	Test signal: 100 MHz -10 dBm, deviation 75 kHz						
	IF filter	f_{mod}					
	wide	40 Hz		-	....	0.25	%
		1 kHz		-	....	0.25	%
		5 kHz		-	....	0.25	%
		15 kHz		-	....	0.25	%
	narrow	40 Hz		-	....	0.50	%
		1 kHz		-	....	0.50	%
		5 kHz		-	....	0.50	%

Item	Characteristic	Measurement	min.	actual	max.	Unit
7	**Distortion with decoder**	5.5.2.3				
	Test signal: 100 MHz -10 dBm, deviation 75 kHz					
	IF filter / decod. / f_{mod}					
	wide mono (M) 40 Hz		-	....	0.25	%
	1 kHz		-	....	0.25	%
	5 kHz		-	....	0.25	%
	7.5 kHz		-	....	0.25	%
	stereo (L) 40 Hz		-	....	0.30	%
	1 kHz		-	....	0.30	%
	5 kHz		-	....	0.30	%
	7.5 kHz		-	....	0.30	%
	narrow mono (M) 40 Hz		-	....	0.50	%
	1 kHz		-	....	0.50	%
	5 kHz		-	....	0.50	%
	7.5 kHz		-	....	0.50	%
	stereo (L) 40 Hz		-	....	0.80	%
	1 kHz		-	....	0.80	%
	5 kHz		-	....	0.80	%
	7.5 kHz		-	....	0.80	%
8	**Difference frequency distortion**	5.5.2.3				
	Test signal: 100 MHz -10 dBm, deviation 75 kHz					
	IF filter / product / f_{mod1} / f_{mod2}					
	wide d2 5 / 5.1 kHz		-	....	0.10	%
	15 / 15.1 kHz		-	....	0.10	%
	38 / 38.1 kHz		-	....	0.20	%
	53 / 53.1 kHz		-	....	0.20	%
	d3 5 / 5.1 kHz		-	....	0.15	%
	15 / 15.1 kHz		-	....	0.15	%
	38 / 38.1 kHz		-	....	0.30	%
	53 / 53.1 kHz		-	....	0.30	%
	narrow d2 5 / 5.1 kHz		-	....	0.25	%
	15 / 15.1 kHz		-	....	0.25	%
	38 / 38.1 kHz		-	....	0.50	%
	53 / 53.1 kHz		-	....	0.50	%
	d3 5 / 5.1 kHz		-	....	0.37	%
	15 / 15.1 kHz		-	....	0.37	%
	38 / 38.1 kHz		-	....	0.75	%
	53 / 53.1 kHz		-	....	0.75	%
9	**S/N ratio** (weighted to CCIR ref. to 40 kHz deviation)	5.5.2.4				
	IF filter: wide Mode: low noise					
	Decoder / Test signal frequency / level					
	Stereo 100 MHz 2 mV		58	....	-	dB
	20 mV		70	....	-	dB
	469 MHz 2 mV		58	....	-	dB
	20 mV		63	....	-	dB
	1000 MHz 2 mV		56	....	-	dB
	20 mV		60	....	-	dB
	Mono 100 MHz 200 µV		58	....	-	dB
	2 mV		76	....	-	dB
	469 MHz 200 µV		58	....	-	dB
	2 mV		76	....	-	dB
	1000 MHz 200 µV		58	....	-	dB
	2 mV		74	....	-	dB

Item	Characteristic	Measure-ment	min.	ist	max.	Unit
10	**Deviation measuring accuracy withTV 2-tone**	5.5.2.5				
	IF filter: TV Sound					
	Test signal: 400 MHz, -10 dBm					
	Hub f_{mod}					
	30 kHz 30 Hz		29.7	....	30.3	kHz
	1 kHz		29.7	....	30.3	kHz
	5 kHz		29.7	....	30.3	kHz
	5 kHz		29.7	....	30.3	kHz
	70 kHz 30 Hz		69.3	....	70.7	kHz
	1 kHz		69.3	....	70.7	kHz
	5 kHz		69.3	....	70.7	kHz
	15 kHz		69.3	....	70.7	kHz
11	**Channel crosstalk attenuation with TV 2-tone**	5.5.2.5				
	IF filter: TV Sound					
	Test signals: channel 2 (unmod.) 800 MHz, 10 mV					
	channel 1 799.758 MHz, 22.4 mV					
	deviation: 55 kHz, f_{mod}					
	30 Hz		80	....	-	dB
	1 kHz		80	....	-	dB
	5 kHz		80	....	-	dB
	7.5 kHz		80	....	-	dB
	15 kHz		80	....	-	dB
12	**LO noise voltage**	5.5.2.6				
	0 dB RF attenuation					
	Tune frequency LO frequency					
	5 MHz 213.5 MHz		-	....	60	µV
	100 MHz 258.5 MHz		-	....	20	µV
	272 MHz 430.5 MHz		-	....	60	µV
	349 MHz 557.5 MHz		-	....	60	µV
	419 MHz 627.5 MHz		-	....	60	µV
	699 MHz 907.5 MHz		-	....	60	µV
	1000 MHz 120.5 MHz		-	....	60	µV
13	**Input reflection (VSWR)**	5.5.2.7				
	0 dB RF attenuation					
	Tune frequency					
	5 MHz		-	....	2.5	1
	50 MHz		-	....	2.5	1
	87.5 MHz		-	....	2.5	1
	100 MHz		-	....	2.5	1
	108 MHz		-	....	2.5	1
	182 MHz		-	....	2.5	1
	184 MHz		-	....	2.5	1
	272 MHz		-	....	2.5	1
	274 MHz		-	....	2.5	1
	349 MHz		-	....	2.5	1
	351 MHz		-	....	2.5	1
	419 MHz		-	....	2.5	1
	421 MHz		-	....	2.5	1
	500 MHz		-	....	2.5	1
	699 MHz		-	....	2.5	1
	701 MHz		-	....	2.5	1
	850 MHz		-	....	2.5	1
	1000 MHz		-	....	2.5	1

Item	Characteristic		Measure-ment	min.	actual	max.	Unit
14	**Level measuring accuracy (selective)**		5.5.2.8				
	IF filter: wide						
	Level/dBm	Frequency/MHz					
	-20	5		-22	....	-18	dBm
		50		-22	....	-18	dBm
		87.5		-22	....	-18	dBm
		100		-22	....	-18	dBm
		108		-22	....	-18	dBm
		150		-22	....	-18	dBm
		200		-22	....	-18	dBm
		300		-22	....	-18	dBm
		400		-22	....	-18	dBm
		500		-22	....	-18	dBm
		600		-23	....	-17	dBm
		800		-23	....	-17	dBm
		1000		-23	....	-17	dBm
	-30	5		-32	....	-28	dBm
		50		-32	....	-28	dBm
		100		-32	....	-28	dBm
		200		-32	....	-28	dBm
		400		-32	....	-28	dBm
		800		-33	....	-27	dBm
		1000		-33	....	-27	dBm
	-87	100		-93.1	....	-83.1	dBm
	-82			-86.1	....	-78.9	dBm
	-77			-80.1	....	-74.4	dBm
	-72			-74.6	....	-69.6	dBm
	-67			-69.3	....	-64.8	dBm
	-62			-64.2	....	-59.9	dBm
	-57			-59.1	....	-54.9	dBm
	-52			-54	....	-50	dBm
	-47			-49	....	-45	dBm
	-42			-44	....	-40	dBm
	-37			-39	....	-35	dBm
	-32			-34	....	-30	dBm
	-27			-29	....	-25	dBm
	-22			-24	....	-20	dBm
	-17			-19	....	-15	dBm
	-12			-14	....	-10	dBm
	-7			-9	....	-5	dBm
	IF filter: narrow						
	Level/dBm	Frequency/MHz					
	-20	100		-22	....	-18	dBm

5.6 FMAV with FMA-B9

Complementary Measurements only for FMAV with FMA-B9 Option

The following applies for all measurements described below:

- The FMAV must be tuned exactly to the frequency of the information signal (deviation < ±50 Hz!). Preferably, source and FMAV are synchronized via an external reference.
- All measurements are performed in the receiver operating mode.

5.6.1 Additional Test Instruments and Utilities

Item	Type of instrument	Required specifications	Suitable R&S instrument	Order No.	Application
1	Signal generator	RF: 1 MHz to 1 GHz Level: 0 to -100 dBm AM: m to 90% FM: deviation up to 75 kHz fmod: 30 Hz to 15 kHz	SMX SMX-B2	826.4517.52 826.9619.02	FMAS only
2	VOR/ILS generator	10 MHz, -10 dBm AM accuracy: 0.25 % VOR: phase error 0.01° ILS: DDM error 0.0002 DDM	FMA-B4	855.6008.52	FMAS only

5.6.2 Test Sequence

5.6.2.1 Selectivity Measurements

Bandwidth, Selectivity Close and Remote to Carrier

The static selectivity of the IF filter is checked.

Test setup: The FMAV is connected to an unmodulated signal generator.

FMAV: Tune freq. 330 MHz, level: auto level, disp. tuned

Meas.ment: First, a reference measurement with a 330-MHz test signal is required. Store measured level as reference value and select relative measurement dB. Set signal generator to the frequencies acc. to test report and check level display of the FMAV.

IF and Image Frequency Selectivity

Test setup: The FMAV is connected to an unmodulated signal generator.

FMAV: Level: auto level, disp. tuned

Meas.ment: A reference measurement with test-signal frequency = tune freq. (117MHz) is first required. Store measured level as reference value and select relative measurement dB. Set signal generator and FMAV to the frequencies acc. to test report and check level display of the FMAV.

Intermodulation Ratio

Test setup: The FMAV is connected to two signal generators via a -6dB power divider (2 ·50Ω). The levels given in the test report apply for the transmitter mode. The 6-dB attenuation has been taken into account. Connect a spectrum analyzer to the IF output of the FMAV.

FMAV: Tune freq. and man level acc. to test report

Meas.ment: Set the two signal generators to the frequencies and levels acc. to the test report. A reference measurement is required for each setting, the FMAV being tuned to one of the two frequencies of the signal generators. The IF level is measured using the spectrum analyzer (reference value). Then, the FMAV is tuned to the upper intermodulation product and the IF level is measured relative to the reference value.

5.6.2.2 LO Noise Voltage

Test setup: Connect spectrum analyzer to the RF input of the FMAV.

FMAV: Man level -20dBm (→ 0-dB RF attenuation, RF preamplifier off)

Meas.ment: Tune FMAV to the frequencies acc. to test report (Tune Freq.) and measure respective levels on the LO frequency using the spectrum analyzer.

5.6.2.3 Level Measuring Accuracy

Test setup: Connect signal generator to the terminating measuring head of an RF level meter and to the RF input of the FMAV via a -6-dB power divider (2 ·50Ω).

FMAV: Auto/man level see below, disp. tuned

Meas.ment: Adjust level on the signal generator such that the level display on the power divider corresponds to the levels given in the test report. Tune FMAV to the frequencies acc. to test report (Tune Freq.) and check level display, respectively.

a) Check frequency response of preselection filter without RF preamplifier with -20 dBm
FMAV: Man level -20dBm

b) Check frequency response with RF preamplifier with -30dBm
FMAV: Man level -30dBm

c) Check errors of the IF amplifiers with levels between -87 and -7dBm
FMAV: Auto Level

5.6.2.4 Input Reflection

Test setup: Connect network analyzer to the RF input of the FMAS via VSWR bridge.

FMAV: Man level -20 dBm for 0-dB RF attenuation
Man level -10 dBm for 10-dB RF attenuation

Meas.ment: The measurement can only be performed at specified frequencies, since the preselection of the FMAV must be tuned simultaneously via Tune Freq. Tune FMAV to the frequencies acc. to the test report (Tune Freq.) and measure the respective VSWR using the network analyzer.

5.6.2.5 AVIONIC Measurements in the Receiver Operating Mode

Test setup: Connect RF input of the FMAV to VOR/ILS modulating RF generator.

FMAV: Auto level, demodulation AM Avion, ILS, VOR test parameters acc. to test report

ILS Measuring Accuracy

Set ILS signals acc. to test report and check FMAV display acc. to test report.

VOR Measuring Accuracy

Set VOR signals acc. to test report and check FMAV display acc. to test report.

5.6.3 Test Report

Only MODULATION ANALYZER FMAV with FMA-B9 Option

Item	Characteristic	Measure-ment	min.	actual	max.	Unit
1	**Bandwidth, selectivity close and remote to carrier**	5.6.2.1				
	Test signal: 20 dBm					
	Frequency					
	Reference meas.ment 330 MHz			0		dB
	329.9915 MHz		-2	....	-4	dB
	330.0085 MHz		-2	....	-4	dB
	329.95 MHz		-60	....	-	dB
	330.05 MHz		-60	....	-	dB
	330.1 MHz		-60	....	-	dB
	330.2 MHz		-60	....	-	dB
	330.4 MHz		-60	....	-	dB
	331 MHz		-60	....	-	dB
2	**IF and image frequency rejection**	5.6.2.1				
	FMAV Test signal -20 dBm					
	Tune freq. Frequency					
	117 MHz Ref. meas.ment 117 MHz			0		dB
	158.725 MHz		-60	....	-	dB
	434.45 MHz		-60	....	-	dB
	134.45 MHz		-60	....	-	dB
	114.452 MHz		-60	....	-	dB
	330 MHz 208.725 MHz		-60	....	-	dB
	747.45 MHz		-60	....	-	dB
	347.45 MHz		-60	....	-	dB
	327.452 MHz		-60	....	-	dB
3	**Intermodulation ratio**	5.6.2.1				
	FMAV					
	Tune freq. Test signals					
	110.2 MHz 110 MHz, 110.1 MHz					
	Man level resp. level					
	-17.5 dBm -14.5 dBm		-60	....	-	dB
	-22.5 dBm -19.5 dBm		-60	....	-	dB
	-27.5 dBm -24.5 dBm		-60	....	-	dB
	-37.5 dBm -34.5 dBm		-60	....	-	dB
	-47.5 dBm -44.5 dBm		-60	....	-	dB
	FMAV					
	Tune freq. Test signals					
	330.2 MHz 330 MHz, 330.1 MHz					
	Man level resp. level					
	-17.5 dBm -14.5 dBm		-60	....	-	dB
4	**LO noise voltage**	5.6.2.2				
	0 dB RF attenuation					
	Tune frequency LO frequency					
	5 MHz 213.725 MHz		-	....	60	µV
	108 MHz 266.725 MHz		-	....	20	µV
	117 MHz 275.725 MHz		-	....	20	µV
	272 MHz 430.725 MHz		-	....	60	µV
	349 MHz 557.725 MHz		-	....	60	µV
	400 MHz 608.725 MHz		-	....	60	µV

Item	Characteristic		Measure-ment	min.	actual	max.	Unit
5	**Level measuring accuracy (selective)**		5.6.2.3				
	Level/dBm	Frequency/MHz					
	-20	5		-22	....	-18	dBm
		50		-22	....	-18	dBm
		108		-22	....	-18	dBm
		117		-22	....	-18	dBm
		150		-22	....	-18	dBm
		200		-22	....	-18	dBm
		300		-22	....	-18	dBm
		400		-22	....	-18	dBm
	-30	5		-32	....	-28	dBm
		50		-32	....	-28	dBm
		100		-32	....	-28	dBm
		200		-32	....	-28	dBm
		400		-32	....	-28	dBm
	-87	110		-93.1	....	-83.1	dBm
	-82			-86.1	....	-78.9	dBm
	-77			-80.1	....	-74.4	dBm
	-72			-74.6	....	-69.6	dBm
	-67			-69.3	....	-64.8	dBm
	-62			-64.2	....	-59.9	dBm
	-57			-59.1	....	-54.9	dBm
	-52			-54	....	-50	dBm
	-47			-49	....	-45	dBm
	-42			-44	....	-40	dBm
	-37			-39	....	-35	dBm
	-32			-34	....	-30	dBm
	-27			-29	....	-25	dBm
	-22			-24	....	-20	dBm
	-17			-19	....	-15	dBm
	-12			-14	....	-10	dBm
	-7			-9	....	-5	dBm
6	**Input reflection (VSWR)**		5.6.2.4				
	0 dB RF attenuation						
	Tune frequency						
	5 MHz			-	....	2.7	1
	50 MHz			-	....	2.7	1
	108 MHz			-	....	2.7	1
	110 MHz			-	....	2.7	1
	117 MHz			-	....	2.7	1
	182 MHz			-	....	2.7	1
	184 MHz			-	....	2.7	1
	272 MHz			-	....	2.7	1
	274 MHz			-	....	2.7	1
	330 MHz			-	....	2.7	1
	349 MHz			-	....	2.7	1
	351 MHz			-	....	2.7	1
	400 MHz			-	....	2.7	1
	10 dB RF attenuation						
	5 MHz			-	....	1.4	1
	110 MHz			-	....	1.4	1
	330 MHz			-	....	1.4	1
	400 MHz			-	....	1.4	1

Item	Characteristic	Measure-ment	min.	actual	max.	Unit
7	**ILS measuring accuracy (receiver operating mode)**	5.6.2.5				
	Test signal: 10 MHz, -10 dBm with ILS modulation m ILS = 40%, DDM=0, φ=0 mID=10%, f=1020 Hz					
	m90		39.80	....	40.20	%
	m150		39.80	....	40.20	%
	mID		9.92	....	10.08	%
	DDM		-0.0005	....	+0.0005	DDM
	ILS Phase		-0.2	....	+0.2	°
	Test signal as above, DDM=+0.1					
	DDM		+0.0994	....	+0.1006	DDM
8	**VOR measuring accuracy (receiver operating mode)**	5.6.2.5				
	Test signal: 10 MHz, -10 dBm with VOR-modulation m 30 = 30%, φ=0 m 9.96 kHz = 30%, dev. = 480 Hz mID=10%, f=1020 Hz					
	m30		29.76	....	30.24	%
	m9.96 kHz		29.76	....	30.24	%
	mID		9.92	....	10.08	%
	Dev 9.96k		477.5	....	482.5	Hz
	VOR Phase		-0.03	....	+0.03	°
	Test signal as above, φ=+90°					
	VOR Phase		89.97	....	90.03	°

ADDENDUM 1

This manual contains the following additional information:

Calibrating Procedures for FMA-B4 Calibrator (VOR/ILS Capability)

CIVS System Configuration

ROHDE&SCHWARZ

Calibrating Instructions for FMA-B4 Calibrator (VOR/ILS Capability) Rev. 2.1

This procedure describes the performance verification for the option FMA-B4 Calibrator within the VOR/ILS Modulation Analyzer FMAV as part of the CIVS. The limits herein are derived from the CIVS specifications as given in the U.S.AIR FORCE STANDARD SPECIFICATION FOR A CALIBRATOR FOR ILS AND VOR SIGNALS (MLEE97PA02-Revision 4), RFP 33660-97-R-7012. They take into account that the option FMA-B4 is used to calibrate the VOR/ILS Modulation Analyzer FMAV. The limits stated here therefore allow to use the option FMA-B4 to calibrate the FMAV to the specifications of the CIVS.

The following annotation is used when indicating key entries:

FMAV setting notation: [hardkey] <softkey in menu>

Measuring equipment	Recommended
Power meter, 0,001dB resolution	HP 438A or HP437B (Hewlett Packard)
Thermal power sensor, 10MHz	mandatory: HP 8482A (Hewlett Packard)
10 dB low distortion amplifier, harmonic suppression 70 dB at 10 MHz and 0dBm output power.	ZHL-1A or ZHL-2 (Mini Circuits) 16dB power amplifiers *) with 6dB attenuator at input side to reduce gain to 10dB
6dB fixed attenuator *)	
1dB step attenuator	RSP (R&S) or HP8494B (Hewlett Packard)
Digital oscilloscope	for example TDS744A (Tektronix)
Modulation analyzer with distortion meter, AM distortion <0,1%	FMAV (R&S)
frequency counter, accuracy < 10^{-5} at 10MHz	
AC Voltmeter 90...150Hz <0,1% (1V range) 30Hz ... 10kHz <0,3% (1V range)	HP3458A (Hewlett Packard)

The following test are to be performed :

1. AM accuracy
1.1 AM distortion
1.2 AM modulation depth accuracy, absolute
2. DDM
3. Deviation of 9.96 kHz subcarrier
4. VOR phase
5. Baseband output
6. FM accuracy

Remark:
The DDM error consists of two parts, the error at DDM = 0 and the DDM error depending on the reading. These are tested separately. Chapter 1.2 verifies the DDM reading depending on setting through a verification of the

absolute accuracy of the modulation depth. Chapter 2 verifies the error at DDM = 0, which can only be caused by frequency response between 90 and 150 Hz.

1. AM Accuracy

1.1 AM distortion

Possible errors with AM modulation (especially when checked with a power meter) can be caused by non linearity of the FMA-B4 analogue AM modulator.
Therefore the AM nonlinearity of the FMA-B4 Calibrator needs to be checked.

Test setup

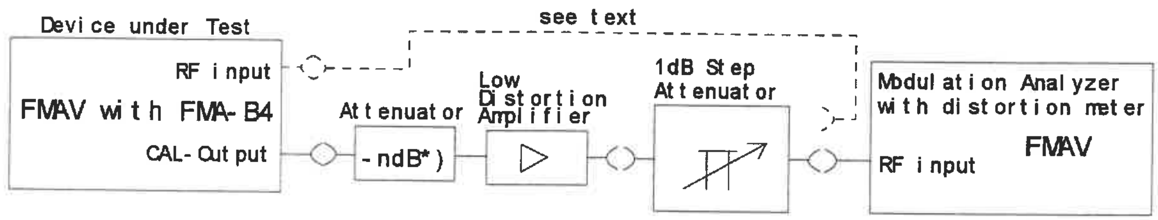


fig. 1.1

*) If an amplifier having a gain of more than 13 dB is used, the input level of the amplifier should be reduced with a fixed attenuator for minimum distortion. The total gain (together with the fixed attenuator) should be 10...13dB.

Set step attenuator to 0 dB.

Remark: If no proper low distortion modulation analyzer (FMAV recommended) is available, the signal can be connected to the RF input of the D.U.T. as well. The calibrator output to be checked is completely independent of the AM demodulator and distortion meter inside the same unit.

Modulation analyzer setting (if available, or D.U.T. itself)

The modulation analyzer is set to AM demodulation and distortion measurement at the frequencies 30 Hz, 90 Hz, 150 Hz and 9.96 kHz.

Instrument setting when using a FMAV as distortion analyzer:

[PRESET]
[DEMOD] <AM>
[AUDIO] <DistSinad> <selective> <THD d2-dn>

Remark: AM distortion of the FMAV analogue AM Demodulator is significantly less than stated in FMAV data sheet, typ. 0,03%)

FMAV/FMA-B4 setting (D.U.T.)

The calibrator is set to AM modulation 80% with various modulation frequencies 30Hz, 90Hz, 150Hz and 9960Hz.

[CALIBRATE] <Generator> <Destin> <AM>
[MENU BACK] <AF> <Level 1?> [8] [0] [x1] <Freq 1?> [3] [0] [x1]

Check AM THD reading (FMAV: read "Audio" display) and continue with other frequencies
FMAV/FMA-B4: <Freq 1?> [9] [0] [x1] and so on.

THD < 0.1 % at modulation frequencies 90Hz and 150 Hz, < 0.2 % at 30Hz and 9960 Hz

1.2 AM accuracy absolute

Test set-up

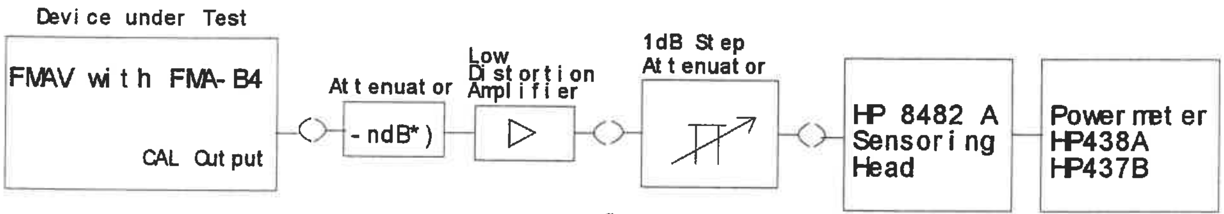


fig. 1.2

*) see chapter 1.1

Make sure, all instruments are sufficiently warmed up including the low distortion amplifier (approx. 30min.).

Power meter must be calibrated (refer to HP manual).

Power meter setting
Set range to 0dBm (do not use auto range!)
Set frequency to 0,01 GHz
Set resolution to 0,001dB
(HP438A only: Filter set 6)

Important: A "zero" adjustment should be done directly before measurements. Disconnect cable at step attenuator input and press the [ZERO] key at the power meter. Then reconnect cable.

FMAV setting (D.U.T.)

The calibrator is set to AM modulation 80% and 0 % with various modulation frequencies 30Hz, 90Hz, 150Hz and 9960Hz. The setting is the same as before (1.1 AM distortion)

Attenuator setting

Set step attenuator to achieve maximum power indication without overrange at 80% AM, i.e. power meter reading between 0dBm and –1dBm.

Procedure

FMAV/FMA-B4:

Select frequency (for example 90Hz)
[CALIBRATE] <Generator> <AF> <Freq 1?> [9] [0] [x1]

Set AM to 80%
[CALIBRATE] <Generator> <AF> <Level 1?> [8] [0] [x1]

Set power meter to relative measurement (HP437B: press [REL] key)
Power meter must read 0,000 dB REL

Set AM to 0%
<Level 1?> [0] [x1]

Check power meter indication: Δ dB REL
(expected value: 1.206 dB)

Calculate AM depth m with the following formula:

$$m = 100 \cdot \sqrt{2 \cdot \left(10^{\Delta dB/10} - 1\right)} \ \%$$

Repeat with other frequencies 30, 90, 150, 9960 Hz

Maximum allowed error:

Modulation frequency	Limit	Limit, mod. depth m	Limits, power meter rel reading [dB]
90Hz and 150Hz	≤ 0,2% of setting,	79,84 % ... 80,16%	1.202 ... 1.210
30Hz and 9960Hz	≤ 0,4% of setting,	79,68 % ... 80,32%	1.197 ... 1.214

2.) AM DDM (ILS-Signal)

Test set-up as shown in fig. 1.2.
Step attenuator setting as in 1.2.

Using the power meter, the difference between 90Hz and 150Hz modulation is checked. Only a single tone modulation is allowed and to achieve high resolution, the modulation depth should be 80%. This is obtained by setting the ILS modulation depth to 40% and the DDM first to +0.8 (→ 90Hz only, 80% AM) then to –0.8. (→ 150Hz only, 80% AM).

FMAV setting (D.U.T.)

[CALIBRATE] <Generator> <Destin> <AM>
[MENU BACK] <Avionic> <ILS> <Depth> <m ILS ?> [4] [0] [x1] <DDM ?> [.] [8] [x1]
Press once < ID On> to switch identifier off: [ ] ID On (toggle key, ■=on / [ ] =off)

Due to m = 40% and DDM = +0.8 the modulation is now 80% at 90Hz and 0% at 150Hz

Set power meter to relative measurement (HP437B: press [REL] key)
Power meter must read 0,000 dB REL

FMAV: <DDM ?> [-] [.] [8] [x1]

Due to m = 40% and DDM = -0.8 the modulation is now 0% at 90Hz and 80% at 150Hz

Check Power meter indication. The following table relates the power difference to DDM valid at 80% modulation depth. (It is not necessary to measure the modulation depth itself, as it is known to be approximately 80%.)

power meter indication dB REL	0.000	+/- 0.001	+/- 0.002	+/- 0.003	+/- 0.004	+/- 0.005
calculated DDM value at 80%	0.0000	-/+ 0.0004	-/+ 0.0008	-/+ 0.0011	-/+ 0.0015	-/+ 0.0019

Any deviation from zero DDM is due to frequency response in the analogue circuits. Therefore at lower modulation depth (40% , 20%), the DDM error is proportionally smaller (1/2 , 1/4) compared to the measured value at 80%.

Maximum allowed difference: ≤ 0,0008 DDM

3.) Calibration of FM at 9,96 kHz sub carrier

FM modulation of the 9,96 kHz VOR sub carrier is done via digital signal processing and therefore needs no calibration.

4.) VOR phase

General

Generation of the VOR signal is done via digital signal processing. A phase error can be caused only by variation in group delay at 9,96 kHz related to low frequencies. The only source of error is the analogue anti aliasing filter between the D/A converter and the wideband AM modulator. The group delay of this filter needs to be checked. To avoid a network analyzer measurement, which only can be done on the opened FMA-B4 board, an indirect method is used. At the rear panel output AF1 of the FMAV/FMA-B4 the signal after the antialiasing filter, i.e. the signal which is fed to the AM modulator, can be monitored.
The calibrator generates a two tone test signal with equal amplitude and frequency ratio 3:1. The higher frequency is set to 9960Hz. This signal (AF1 output) is measured with an oscilloscope. The symmetry of the sum signal depends on phase (fig. 4.1 and 4.2).
This method checks delay of 9960 Hz subcarrier against 3320 Hz not against 30 Hz as virtually required. But due to DC coupling, delay errors cannot occur at lower frequencies. A faulty antialiasing filter however will cause most of the delay at the higher frequency end, i.e. between 3320 Hz and 9960 Hz.

Two tone signal with frequency ratio 3:1
tone 1: 9960 Hz
tone 2: 3320 Hz

The signals with equal amplitude add as follows:

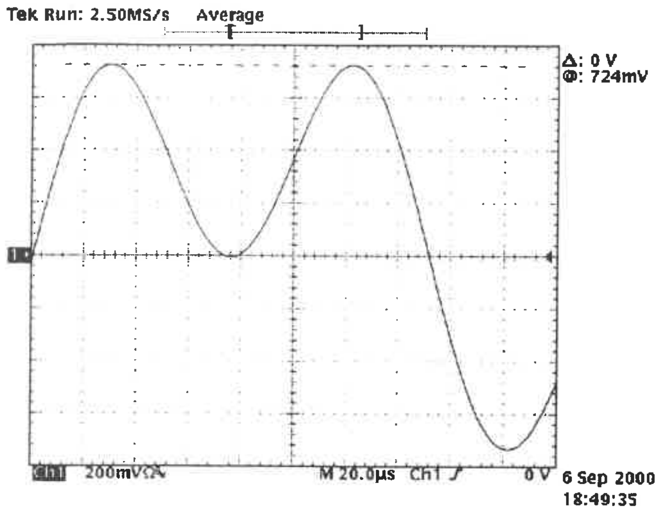


fig. 4.1 Sum signal with 0 deg. phase difference

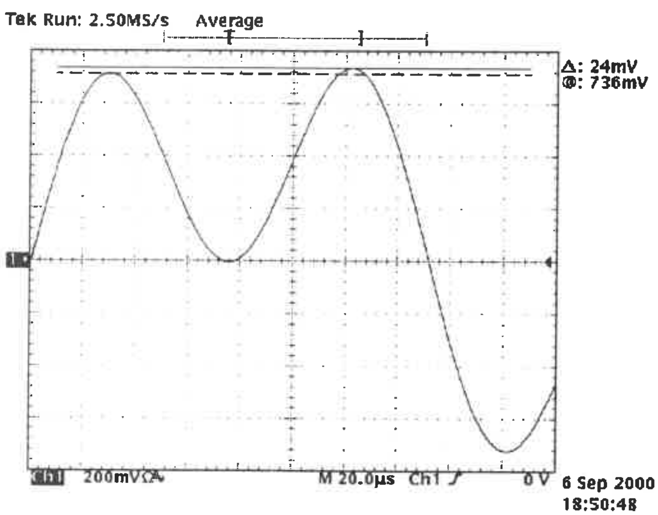


fig. 4.2 Sum signal with 5 deg. phase shift of the 9960 Hz tone.

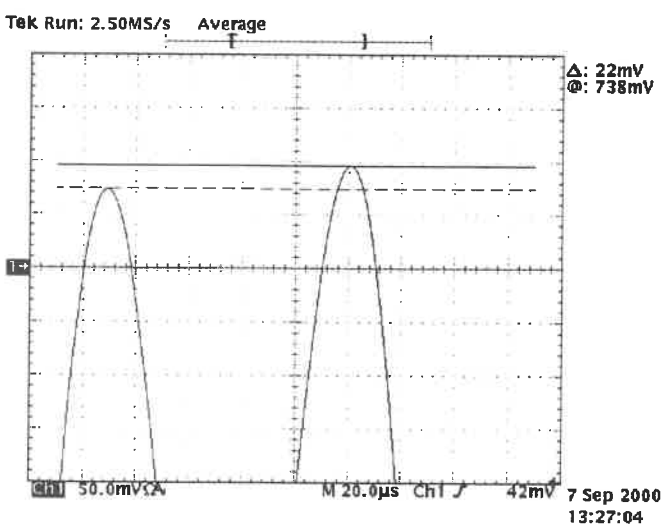


fig. 4.3 Sum signal with 5 deg. phase shift of the 9960 Hz tone, magnified (50mV / DIV)

Calculation of VOR phase

The VOR phase must be checked to be within 0 ± 0.02 deg.
A 0.02 deg. phase shift at 30 Hz corresponds with a delay of 1.85 us.

The 30 Hz signal is frequency modulated on a 9960 Hz subcarrier. Thus if the subcarrier is delayed, the 30 Hz modulation on it endures the same delay. The task is to check the delay of the subcarrier to be < 1.85 us.
This is easy, as a delay of 1.85 us causes a phase shift of 6.64 deg. on the subcarrier due the much higher frequency compared to 30 Hz.
For additional margin, the phase shift of the 9960 Hz subcarrier is checked to be < 5 deg.
Fig. 4.2 and 4.3 show the symmetry error caused by 5 deg. phase shift. The peak amplitude difference is 22mV with a peak to peak amplitude of 1460mV (relative 1.5 %).
To achieve higher resolution, it is recommended to measure in a more sensitive range (50mV /DIV). The peaks can be shifted on screen with offset or position setting (fig. 4.3)

Test setup

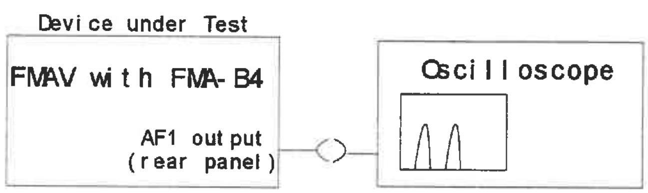


fig. 4.4

FMAV setting
[Calibrate] <Generator> <Destin> <AF output>
AF1 output unbalanced must be selected: ■ AF1 unbal
[Menu Back] [Menu Back] <AF> <Freq. 1?> [3] [3] [2] [0] [x1]
[Menu Back] <Freq. 2 ?> [9] [9] [6] [0] [x1] [Menu Back]
With 50 ohms termination at oscilloscope: < Level 1 ?> [0] [.] [4] [7] [x1] < Level 2 ?> [0] [.] [4] [7] [x1]
With high impedance at oscilloscope: < Level 1 ?> [0] [.] [3] [3] [x1] < Level 2 ?> [0] [.] [3] [3] [x1]

Measurement
Measure voltage difference of the peaks according to fig. 4.3

Maximum allowed difference: ±22mV

Measurement on AM Output

To ckeck the complete signal path including the AM modulator, the envelope of the 10MHz signal has to be observed in the same way as the modulating signal.

To achieve higher resolution, it is recommended to measure in a more sensitive range (10mV /DIV). The peaks can be shifted on screen with offset or position setting (fig. 4.7)

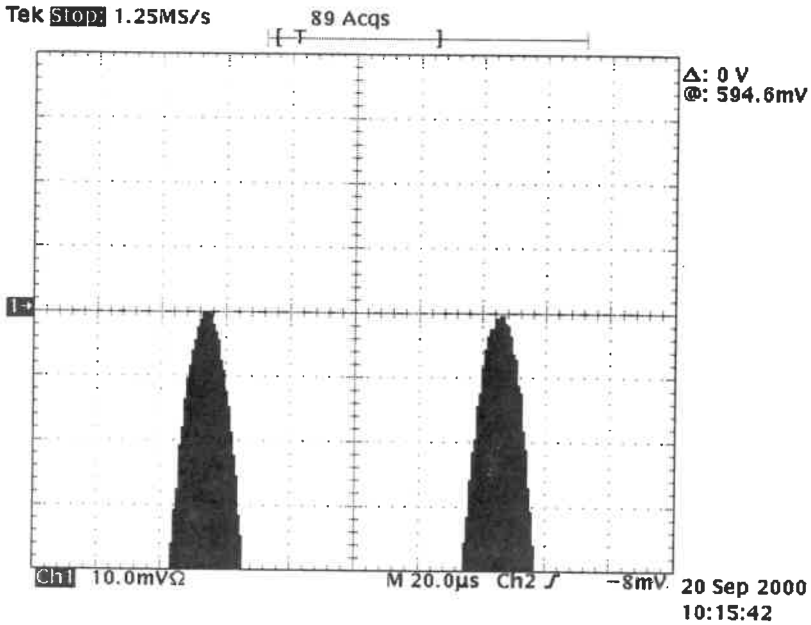


fig. 4.7 10 MHz envelope, peaks magnified, perfect signal (no phase shift)

Measure voltage difference of the peaks according to fig. 4.8

Maximum allowed difference: ±8mV

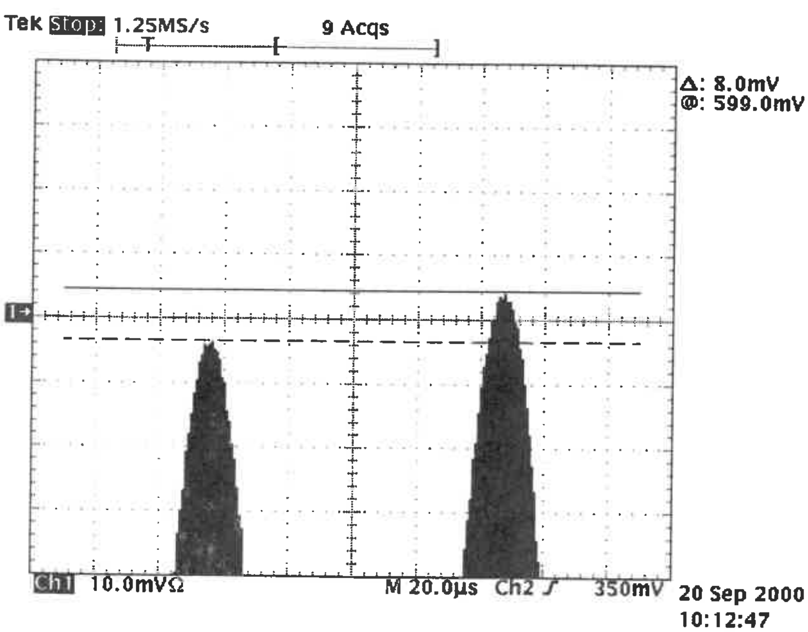


fig. 4.8 10 MHz envelope, peaks magnified, 5 deg. phase shift

5. Baseband signal output

As the AF outputs of the FMAV/FMA-B4 are used in the CIVS to provide a modulation signal to the SMY, the outputs are checked.

Test setup

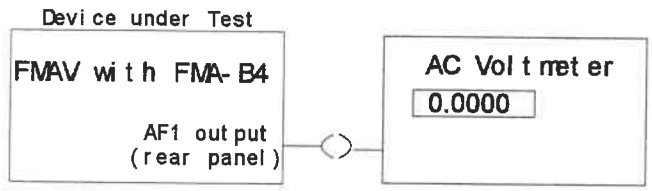


fig. 5.1

FMAV setting

[Calibrate] <Generator> <Destin> <AF output>
AF1 output unbalanced must be selected: ■ AF1 unbal
[Menu Back] [Menu Back] <AF>
Tone 1 must be selected, Tone 2 off: Tone 1 ■ [] Tone 2
<Level 1?> [.] [7] [x1]
<Freq 1?> [9] [0] [x1]

Read and note voltmeter display: voltage(rms) = V90

FMAV: [1] [5] [0] [x1]

Read voltmeter display: voltage(rms) = V150

Check V90 = 700mV ±2%
Check difference V90-V150 < ± 0.7mV (0.1% of setting)

FMAV: [3] [0] [x1]
Read and note voltmeter display: voltage(rms) = V30

FMAV: [9] [9] [6] [0] [x1]

Read voltmeter display: voltage(rms) = V9960

Check V30 = 700mV ±2%
Check difference V30-V9960 < ± 2.1mV (0.3% of setting)

6.) FM Accuracy in PLL mode

The calibrator generates a square wave FM signal with 100 kHz deviation. The deviation is very accurate as the frequencies are synthesized by a PLL. This signal is used during the internal self adjustment of the FMAV FM

demodulator. The function of this PLL has to be checked. Therefore it can be switched into a static mode by means of service functions, whereat the frequencies easily can be measured with a counter.
Although this function is not used in the CIVS it should be verified as this signal is used to internally check the analog FM deviation. A malfunction will result in a selfcheck error indication, even when the FMAV itself is working properly.

Test setup

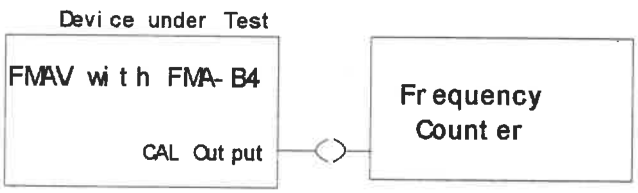


fig. 6.1

FMAV setting

[CALIBRATE] <Generator > <Destin> <FM special>
[SPEC FUNC] <Service> [1] [0] [.] [2] [.] [1] [x1]

Read and note counter display: frequency = f1 (approx. 10.1 MHz)

FMAV: [1] [0] [.] [2] [.] [2] [x1]

Read counter display: frequency = f2 (approx. 9.9 MHz)

Check difference f1-f2 = 200kHz ± 0,1% (199.8 ... 200.2 kHz)

CIVS SYSTEM CONFIGURATION

FOR PRECISION VOR / ILS MEASUREMENTS

Use the following procedure when configuring the CIVS system for precision VOR/ILS measurements.

1. Power-up the SMY01 Signal Generator and FMAV Modulation Analyzer.

2. Allow fifteen (15) minutes for warm-up.

3. Depress the "PRESET" pushbutton on the SMY01 and FMAV.

4. Connect the FMAV rear panel "AF1 OUT" to the SMY01 "AM EXT" input.

5. Connect the SMY01 front panel "RF 50Ω" output to the FMAV front panel "RF 50Ω" input.

6. Set the SMY01 as follows:
   A. RF frequency: 108.0 MHz
   B. Level: 0 dBm
   C. Modulation Input/Coupling: EXT DC
   D. Modulation: 30%

7. Set the FMAV as follows to read modulation depth of VOR 30 Hz:
   A. Demod to: "AM AVION"
   B. VOR: " m 30 Hz"
   C. Audio Frequency ID: Off

8. Set FMAV as follows:
   A. Calibrate - Generator - Avionics - VOR
   B. Press "MENU BACK" pushbutton to reach the Generator AF-RF menu and select: "AF units - AM extern"
   C. Enter AM extern value (press "AM extern" a second time): "approximately 0.03 %/mV"

9. Check FMAV modulation depth reading on middle display. It should be close to 30%. Adjust "AM extern" value if necessary

10. Activate FMAV phase readout: Press "Demod" (hit the key twice, to go to last used submenu, VOR) or : Demod - AM Avionics - VOR - VOR phase

(Continued)

CIVS Configuration Procedure (Continued)

11. Set the FMAV as follows:
    A. Calibrate - Generator - Avionics - VOR - Phase
    B. Set phase to: 90 °

12. Read the phase value from the right display of the FMAV. Phase readings should be within (≤) 0.1°.

Operating Hints:

1. Softkeys in many cases have dual functions. They serve as a switch, which turns on a specific function (e.g. VOR) and that function's submenu. The primary function is switched on at the first press of that softkey. As soon as it is switched on (you can tell from the filled out box), a further press of that softkey will call up the submenu.

2. To eliminate multi submenu levels, double click on the main function keys (e.g. Demod, RF, etc.) to call up the last used submenu under each main function key.

3. If phase accuracy readings (Step 12) are consistently off by 3° to 5°, ensure that the Audio Frequency ID (Step 7 C) is set to "off".