

◆ 55 kHz to 1360 MHz

- Microprocessor-controlled unit for analyses of modulated RF signal, with simultaneous frequency measurement
- Modulation measurement with AM, FM and ϕ M
- Switch-selected highpass and lowpass filters for various test bandwidths; CCITT and CCIR weighting filters
- Modulating-signal measurement using weighting filters (AF voltmeter or psophometer function)
- IEC-bus-compatible

Characteristics, uses

The **Modulation Analyzer FAM** offers a maximum of convenience for modulation measurements on AM, FM and phase-modulated signals. All functions being microprocessor-controlled, manual operation is reduced to a minimum. Modulation measurements over a range of carrier frequencies from 55 kHz to 1360 MHz are performed more precisely and more easily with the FAM than with previously available equipment. The IEC-bus interface makes the instrument system-compatible and suitable for use in automated test assemblies.

Types of measurements The Modulation Analyzer can be used for measurements otherwise calling for up to five different instruments. It features the following capabilities:

- Measurement of modulation depth, frequency deviation and phase deviation
- Simultaneous carrier-frequency measurement with 1 Hz or 10 Hz resolution
- Measurement of modulation frequency with 0.1 Hz resolution
- Distortion measurement down to <0.1%, also SINAD indication in dB
- AF voltage measurement with weighting filters (psophometer function)
- Evaluation of external AF signals

Unwanted modulation can be measured and weighted accurately on account of switch-selected test bandwidths and standard weighting filters.

Field of application The basic model covers a carrier-frequency range of 55 kHz to 120 MHz and offers a very economical and high-performance solution for measuring tasks in FM and AM broadcasting and certain radiotelephony and other radio services.

The **Frequency-range Extension Option** – which can be retrofitted – extends the frequency range up to 1360 MHz, thus covering practically all radio services.

Special features The FAM exhibits negligible inherent noise and excellent linearity.

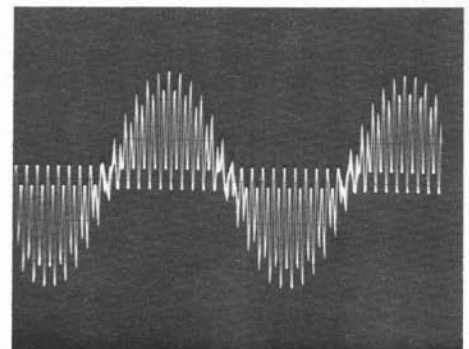
Residual FM being less than 1 Hz in the basic frequency range (proportionally increasing above) with CCITT weighting and 5 Hz with 20 kHz weighting bandwidth, whilst residual AM is as low as 0.01%, the FAM permits unwanted modulation to be measured precisely.

The FM stereo noise of FAM model 54, being -72 dB referred to 40 kHz deviation, CCIR weighting, permits precise S/N-ratio measurements, say, on FM broadcast transmitters.

The **transmission linearity** of the FAM fulfils the exacting demands involved in wideband modulation methods used, for example, in FM broadcasting. Excellent amplitude and phase linearity make distortion-free demodulation of multiplex signals possible; see application example on page 322.

Distortion of less than 0.1% and stereo channel separation of 50 dB guarantee accurate results of measurement.

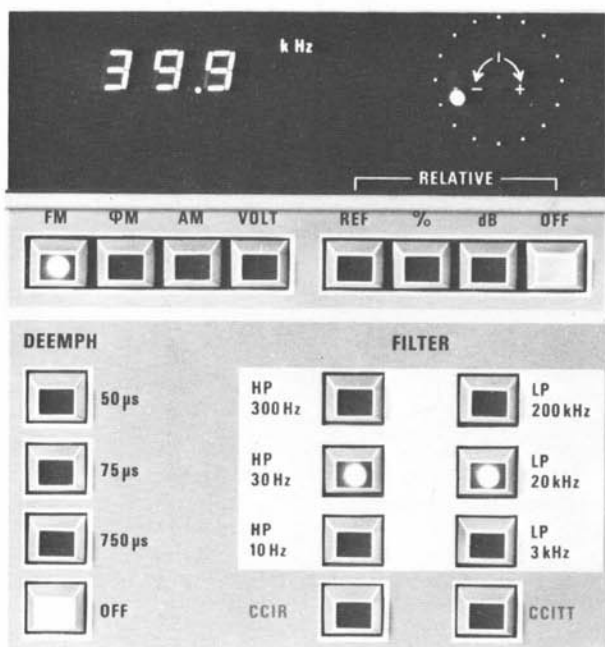
Demodulated stereo signal available at FM output of Modulation Analyzer FAM



Setting, measurement, display

The front panel of the FAM is divided into three functional sections for easy operation and clear presentation of the results, several parameters being displayed simultaneously:

- Left-hand section **Carrier-frequency** display and entry (with manual tuning)
- Middle section **Result** display and setting of operating modes
- Right-hand section **Modulating-signal** display measuring section for modulating frequency, distortion, SINAD



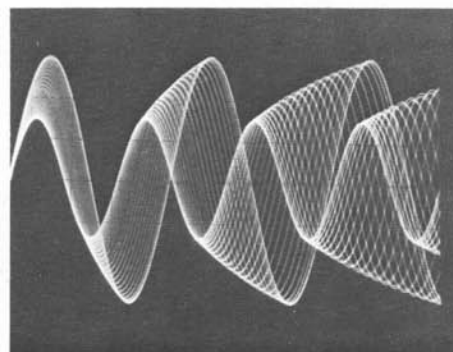
Front panel section; display of modulation measurement results and setting of operating modes

Frequency setting Setting is performed **fully automatically** under microprocessor control; see description on next page. When a signal is applied, the FAM tunes automatically to the input frequency within 3 s and displays this frequency in the l. h. section with a resolution of 10 Hz.

If automatic tuning is not desired in specific cases, the frequency can be **set via the keyboard** (this is important for instance when measuring selective call equipment, with data transmission and other techniques where no continuous signal is available).

For such specific measurements, the other automatic functions can also be suppressed. RF attenuator or AF range can be held at or brought to a particular setting.

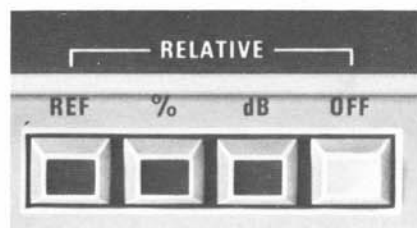
Modulation measurement, display The middle section is used for setting the type of modulation and time constant, selecting the filter and displaying the **modulation measurement result**. An additional, analog display in the form of a light spot moving around a circle greatly facilitates adjustments by providing trend indication. The user simply selects the type of modulation – AM, FM or φM – and, with FM, one of three deemphasis time constants. The Modulation Analyzer demodulates signals of any mode of modulation including simultaneous FM and AM; see photo below.



Modulation signal analysis using FAM: display of an RF signal with simultaneous FM and AM

Weighting Three HP and three LP filters provide a great variety of weighting bandwidths and suppress unwanted signals. CCITT and CCIR standard filters (perceived loudness) can be inserted or retrofitted as options for standard S/N measurements.

Display of results (absolute or relative) The measured modulation can be displayed as an absolute value or relative to a key-entered reference value. This is very convenient if modulation is to be determined as a function of modulation frequency or carrier frequency.



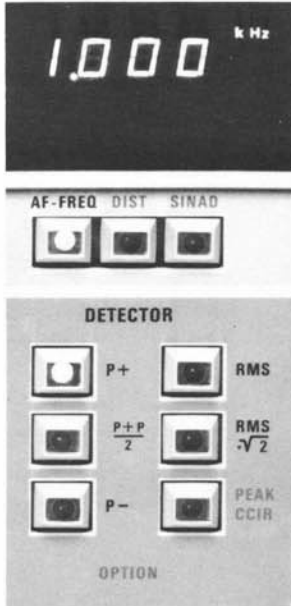
Keyboard and display for relative measurements

The high resolution ($\leq 0.25\%$) and the high accuracy of the modulation depth indication (1.5%) permit precise measurements without needing recalibration.

Type of detection The measurement of the AF modulating-signal amplitude can be performed either with peak responding detection (most frequently employed for measuring wanted modulation) or with rms responding detection (for example for measuring unwanted modulation). The CCIR weighting filter option includes the prescribed quasi-peak responding detector.

FAM

Modulation-frequency / distortion measurement The frequency of the modulating signal is displayed in the r.h. section of the front panel. The 0.1-Hz resolution is required for measuring frequencies of calling signals or code signals for squelch switching.



Front-panel section: r.h. display and keyboard section for modulating-frequency and distortion measurement

Option FAM-B8 is available for measuring the distortion of the modulating signal. Measurements can be made at 30 fixed frequencies from 30 Hz to 20 kHz. The measurement is automatically initiated by the microprocessor when the frequency of the modulating signal lies within the measurement range. The FAM displays either distortion in % or SINAD in dB.

Evaluation of external AF signals The AF section, comprising the weighting filter, frequency counter, detector and distortion meter, can be used for the evaluation of an external AF signal via a separate input socket. The Modulation Analyzer can thus be used as an automatic AF voltmeter and as a psophometer.

IEC-bus interface The Modulation Analyzer has an IEC-bus interface so it can be controlled by an external computer, e.g. the R&S Process Controller PUC. The FAM can receive setting and trigger instructions and can output measured data to the computer, meaning that it can function as both listener and talker. Thus it is suitable for use in automatic measuring systems for testing transmitters and transceivers in development, production and quality control.

Description

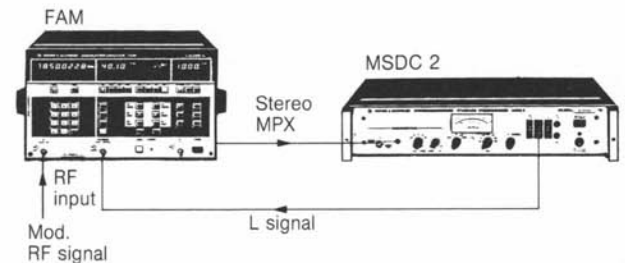
The FAM is made up of RF, IF and AF sections and the microcomputer circuitry. The RF section contains a counter for measuring the frequency of the input signal, an AGC stage and a mixer. The IF section comprises AM and FM demodulators and the AF section evaluates the demodulated signal. The microprocessor handles the settings, data acquisition, and I/O operations of keyboard and display.

Special features of the RF section The input frequency range of the FAM basic unit is 55 kHz to 120 MHz divided into two bands: frequencies up to 3.5 MHz are processed directly in the IF section, those between 3.5 and 120 MHz undergo a single frequency conversion. A frequency-range-extension option adds a third band above 120 MHz with double frequency conversion.

The microprocessor detects the presence of an input signal by a search process using level detectors in the RF and IF sections and a frequency counter. From this information it

derives the setting of the first local oscillator and performs the RF level adjustment.

Input signals above 120 MHz are converted to the range below 120 MHz by the second local oscillator of the 1.36-MHz Frequency-range Extension option. The microprocessor calculates the input frequency from the frequency of the second local oscillator. The input frequency is displayed.



Measurement of stereo multiplex signals using Modulation Analyzer FAM

Extensions (options)

The FAM can be delivered or retrofitted with a number of options to suit different requirements:

1-GHz/1.36-GHz Frequency-range Extensions FAM-B2 extend the frequency range of the FAM up to 1000 or 1360 MHz (two models with otherwise equal characteristics).

CCITT Weighting Filter FAM-B6

for weighted measurement of unwanted modulation using standard perceived-loudness-characteristic filter.

CCIR Weighting Filter FAM-B7

for weighted measurement of unwanted modulation using standard perceived-loudness-characteristic filter. The required quasi-peak-responding detector is built in.

DIST and SINAD Meter FAM-B8

for automatic measurement of modulation distortion, including external signals at 30 fixed frequencies from 30 Hz to 20 kHz.

Reference Oscillator SMS-B1

temperature-controlled, improves the frequency stability (temperature coefficient 1×10^{-7} in the operating temperature range; crystal aging 5×10^{-8} /month).

Specifications

Frequency range	55 kHz to 120 MHz
With option FAM-B2 1.36 GHz	55 kHz to 1360 MHz
With option FAM-B2 1 GHz	55 kHz to 1000 MHz
Frequency setting	automatic ¹⁾ or manual
Display	8 digits
Resolution, $f < 1000$ MHz	10 Hz or 1 Hz
$f \geq 1000$ MHz	100 Hz or 10 Hz
Frequency error and drift	± 1 digit + error of reference freq.
Reference oscillator	standard option SMS-B1
Crystal aging	$< \pm 1 \times 10^{-6}$ /month $< \pm 5 \times 10^{-8}$ /month
Temperature coefficient	$< \pm 1 \times 10^{-6}/^\circ\text{C}$ $< \pm 1 \times 10^{-7}$ over total op. range
RF input	$Z_{in} = 50 \Omega$, BNC female connector
Input level range	
55 kHz to 550 MHz	10 mV to 3 V (-27 to +22.5 dBm)
550 to 1050 MHz	20 mV to 3 V (-21 to +22.5 dBm)
1050 to 1360 MHz	30 mV to 3 V (-17 to +22.5 dBm)
RF attenuator	programmable via IEC bus or keyboard

¹⁾ Frequency measurement and automatic tuning for AM $\leq 80\%$; for $f_{in} \geq 550$ MHz up to 60%.

Amplitude modulation measurement

Modulation frequency range	10 Hz to 200 kHz	10 Hz to 20 kHz for $f_{in} < 3.5$ MHz
Max. measurable modulation depth	100%	
Display	4 digits + analog indication	
Units	absolute: %; relative: % or dB	
Resolution	0.25% (of reading), max.: 0.005% (AM)	
Error (peak-resp. detector)	mod. $\leq 80\%$	mod. $> 80\%$
(plus peak residual AM)		
f_{mod} 30 Hz to 60 kHz	$\leq \pm 2\%$	$\leq \pm 5\%$
60 to 100 kHz	$\leq \pm 4\%$	$\leq \pm 10\%$
Residual AM ²⁾ weighted with CCITT filters (rms.-resp. detector)	≤ 550 MHz	> 550 MHz
Weighting bandwidth		
30 Hz to 20 kHz	$\leq 0.05\%$	$\leq 0.05\%$
CCIR weighting	$\leq 0.05\%$	$\leq 0.1\%$
Incidental AM with FM ³⁾ (f_{mod} 1 kHz, 50 kHz deviation, meas. bandwidth 30 Hz to 3 kHz)	0.1%	
AF distortion (at AF output); f_{mod} 30 Hz to 20 kHz	≤ 120 MHz	> 120 MHz
40% mod.	$\leq 0.2\%$	$\leq 0.4\%$
40 to 80% mod.	$\leq 0.4\%$	$\leq 0.6\%$
AM modulation range programmable (11 ranges)		

Frequency modulation measurement (with input frequ. ≥ 4.25 MHz)

Modulation frequency range	10 Hz to 200 kHz		
Max. measurable frequency deviation	500 kHz (100 kHz for $f_{in} \leq 4.75$ MHz)		
Display	4 digits + analog indication		
Units	absolute: Hz, kHz; relative: %, dB		
Resolution	0.25%, max.: 0.1 Hz		
Error	deviation ≤ 100 kHz	dev. > 100 kHz	
with peak-resp. detector (plus peak residual FM)			
f_{mod} 30 Hz to 60 kHz	$\leq \pm 1.5\%$	$\leq \pm 3\%$	
60 to 100 kHz	$\leq \pm 3\%$	$\leq \pm 6\%$	
with rms.-resp. detector (plus residual FM)			
f_{mod} 30 Hz to 60 kHz	$\leq \pm 3\%$	$\leq \pm 3\%$	
60 to 100 kHz	$\leq \pm 6\%$	$\leq \pm 6\%$	
Residual FM at f	≤ 120 MHz	120 to 550 MHz	550 to 1050 MHz
	550 MHz	1050 MHz	1360 MHz

With CCITT weighting and rms.-resp. detector	≤ 1 Hz	≤ 3 Hz	≤ 6 Hz	≤ 12 Hz
Weighting bandwidth 30 Hz to 20 kHz, with rms.-resp. detector	≤ 5 Hz	≤ 14 Hz	≤ 25 Hz	≤ 50 Hz
With CCIR weighting and deemphasis and squelch	≤ 6 Hz	—	—	—
Stereo S/N ratio (CCIR) ref. to 40 kHz deviation ($f_{in} \leq 120$ MHz, $V_{in} \geq 20$ mV)	72 dB typ.			
Incidental FM with AM (f_{mod} 1 kHz, m = 50%; test bandwidth 30 Hz to 3 kHz)	≤ 20 Hz (plus peak residual FM)			
AF distortion (at AF output); f_{mod} 30 Hz to 20 kHz				
75 kHz deviation	$\leq 0.1\%$			
500 kHz deviation	$\leq 0.5\%$	(input frequ. > 10 MHz)		
Stereo crosstalk at f_{mod} 30 Hz to 15 kHz	≥ 46 (typ. 50) dB	down at stereo output		
f_{mod} 1 kHz	≥ 50 dB	down		
Deemphasis	50/75/750 μ s, switch-selected			
FM modulation range programmable (13 ranges)				

Phase modulation measurement (with input frequency ≥ 4.25 MHz)

Modulation frequency range	300 Hz to 20 kHz		
Maximum measurable phase deviation	500 rad (up to 1 kHz mod.-freq.)		
Display	4 digits + analog indication		
Units	absolute: rad; relative: %, dB		
Resolution	0.25%, max.: 0.001 rad		
Error with peak-resp. detector	$\leq \pm 3.5\%$ + peak residual φM		
with rms.-resp. detector	$\leq \pm 5\%$ + residual φM		
Residual φM at f	≤ 120 MHz	120 to 550 MHz	550 MHz 1050 MHz 1360 MHz
Weighted with CCITT filter: bandwidth 30 Hz to 20 kHz:	rad ≤ 0.002	≤ 0.003	≤ 0.006
AF distortion (at AF output), deviation 4 rad	rad ≤ 0.005	≤ 0.01	≤ 0.02
φM modulation range programmable (13 ranges)			

AF detector

Peak-responding detector	positive or negative peak of AF or their arithmetic mean
Rms-responding detector	true rms response, indication as rms or for sinewave converted to peak; crest factor 10

Weighting filters

High pass (1-dB cutoff frequency)	10 Hz (2 Hz at 3 dB by changing connection), 30 Hz and 300 Hz (12 dB/octave),
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²⁾ With input level 6 dB above minimum; > 250 mV for $f_{in} < 3.6$ MHz.
³⁾ In frequency range specified for FM measurement.
⁴⁾ Only for retrofitting in earlier FAM models.

Low pass (3-dB cutoff frequency)	3/20/200 kHz (24 dB/octave min.)
CCITT filter (option FAM-B6)	weighting network acc. to CCITT Rec. P53
CCIR filter (option FAM-B7)	weighting network acc. to CCIR Rec. 468-2 (Rev. 78) combined with quasi-peak detector

AF frequency display

Frequency range	10 Hz to 200 kHz
Display	4 digits
Resolution	0.1 Hz up to 1 kHz
Error at f > 100 Hz	$\pm 0.1\%$ at S/N > 40 dB
f < 100 Hz	± 0.1 Hz at S/N > 60 dB

Distortion measurement

Test frequencies (total of 30)	with option FAM-B8 30/40 to 100 Hz 200/300 to 1000 Hz 2/3 to 10 kHz 12.5/15/17.5/20 kHz
Automatic tuning (S/N > 30 dB)	tuning range $\pm 3\%$; automatic switchoff when frequency is outside of measurable range

Display	4 digits, THD in % or SINAD in dB
Display range	0.1 to 50%, 6 to 60 dB (SINAD)
Error (THD $\leq 10\%$)	$\leq \pm 10\%$ of rdg or $\leq \pm 1$ dB ± 1 digit
Test frequency programmable	

AF voltmeter

Frequency range	10 Hz to > 200 kHz
Measurement range	0.1 mV to 3 V (max. 5 V peak)
Display	4 digits
Units	absolute: mV; relative: %, dB
Resolution	0.1 mV
Error with LP 3/20 kHz	$\leq \pm 1.5\%$ ± 0.1 mV
without LP	$\leq \pm 1.5\%$ ± 0.4 mV (30 Hz to 60 kHz) $\leq \pm 3\%$ ± 0.4 mV (60 to 100 kHz)
Weighting	all AF measuring facilities in the FAM (detectors, weighting networks, frequency counter, distortion meter) can also be used in voltage measurements (except LP 200 kHz)
Input	$Z_{in} \geq 400$ k Ω 300 pF, floating; BNC female connector

Voltage range programmable (11 ranges)

Outputs

AM signal output (V_{rms})	max. 1 V into 2 k Ω at 100% mod
FM stereo signal output (V_{rms})	1.5 V at 40 kHz dev. corresp. to + 6 dBm into 600 Ω (for crosstalk see FM)
AF output (V_{rms})	350 mV to 1 V depending on modulation of AF voltage

IEC-bus interface

	in accordance with IEC 625-1 (IEEE 488); 24-contact Amphenol connector
Listener and talker functions	AH1, T4, L2, RL1, DC1

Measurement time (frequency, RF and AF ranges programmed, P+ or P-; at fin > 120 MHz: t + 100 ms)

	with frequency resolution	
	10 Hz/100 Hz	1 Hz

For triggered RF and modulation measurement		
FM, φM	≤ 250 ms	≤ 2050 ms
AM	≤ 420 ms	≤ 2300 ms

Automatic RF, modulation and AF measurement

when changing frequency or after applying the RF level	typ. 3.5 s
after warming up	typ. 1.5 s
DIST/SINAD-measurement	typ. 6 s
after warming up	typ. 2 s

General Data

Operating temperature range	+ 5 to +45 $^{\circ}$ C
Storage temperature range	-40 to +70 $^{\circ}$ C
RFI suppression	VDE radio protection mark: DBP 527 GI
Mechanical resistance	shack- and vibration-tested to DIN 40 046, Part 7 and 8 (corresp. to IEC Publ. 68-2-27 and 68-2-6)
Power supply	115/125/220/235 V $\pm 10\%$ 47 to 440 Hz (80 VA), safety class I
Dimensions, weight	347 mm \times 206 mm \times 370 mm, 13.5 kg

Ordering information

Order designation	► Modulation Analyzer FAM
FAM 55 kHz to 120 MHz	334.2015.54
Accessories supplied	power cable, adapter (for PC boards)
Options	
Reference Oscillator	SMS-B1 ... 302.8918.02
1.36-GHz Frequency-range	
Extension	FAM-B2 ... 334.4918.02
1-GHz Frequency-range	
Extension	FAM-B2 ... 334.4918.04
IEC-625-1 Interface ⁴⁾	FAM-B4 ... 334.5914.02
CCITT Filter	FAM-B6 ... 334.5614.02
CCIR Filter	FAM-B7 ... 334.5514.02
DIST/SINAD Meter	FAM-B8 ... 334.5714.02
19" Adapter	FAM-Z9 ... 349.7318.02