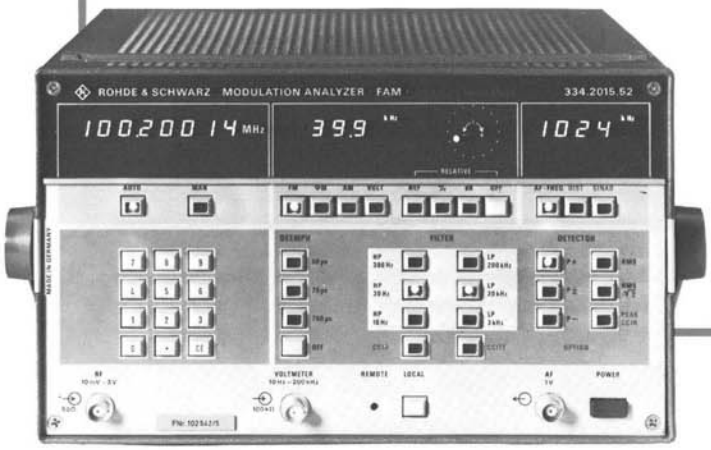
FAM

Modulation Analyzer FAM ♦ 55 kHz to 1360 MHz



- Microprocessor-controlled unit for analysis of modulated RF signal, with simultaneous frequency measurement
- Modulation measurement with AM, FM and φM
- 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

IEC 625 Bus

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-625-1 Interface option 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 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 fitted when the main unit is originally produced, or added later – extends the frequency range up to 1360 MHz, thus covering practically all radio services.

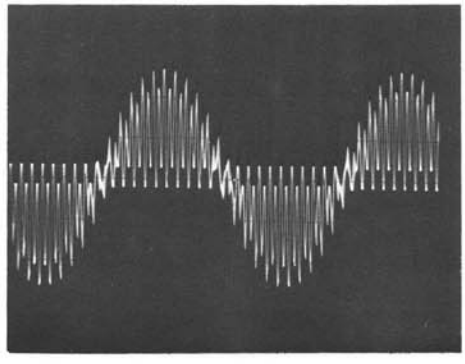
Special features The FAM exhibits negligible inherent noise and excellent linearity.

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 S/N ratio of the FAM amounting to 72 dB (referred to 40 kHz deviation, CCIR weighting) permits precise S/N-ratio measurements, e.g. 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 312.

Distortion of less than 0.1% and crosstalk attenuation of 50 dB guarantee accurate measurement results.

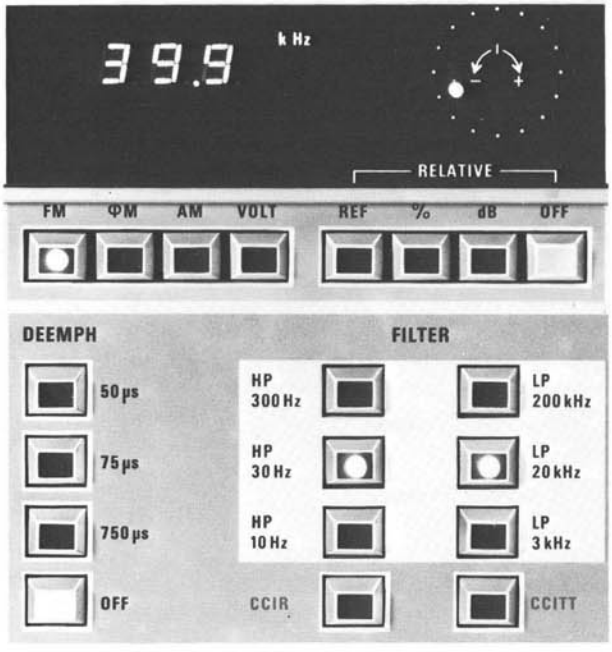


Demodulated stereo signal available at FM output of Modulation Analyzer FAM

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	**Modulation-signal** display measuring section for modulating frequency, distortion, SINAD



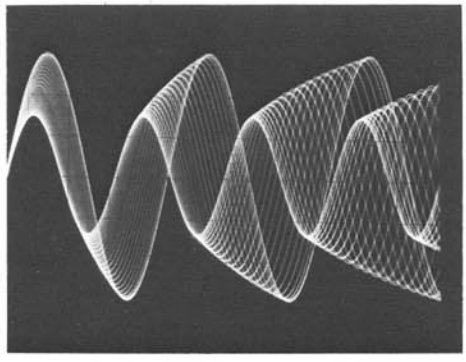
Front panel section: display of modulation measurement results and setting of operating modes

Frequency setting Setting ist 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 calling equipment, with data transmission and other techniques where no continuous signal is available).

For such measurements, the other automatic functions can also be held at the required settings, so that signal-seeking processes are inhibited and setting times are eliminated.

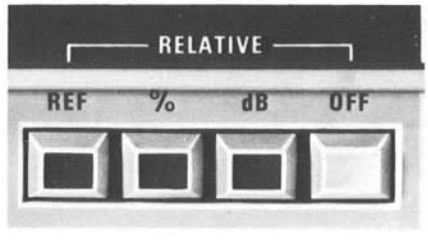
Modulation measurement, display The middle section is used for setting the type of modulation and time constant, selecting the filter and displaying the modulation measurement result. An additional, analog display in the form of a light spot moving around a circle greatly facilitates adjustments by providing 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.



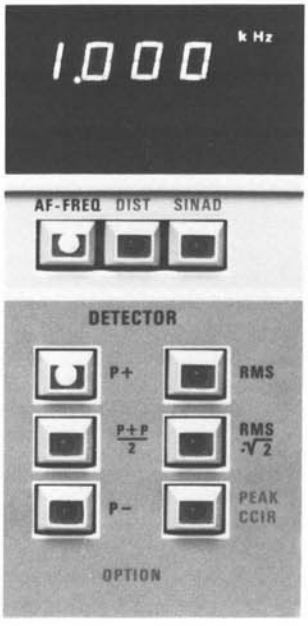
Keyboard and display for relative measurements

The high accuracy of the modulation depth indication (1.5%) permits 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.

Modulation Analyzer FAM, continued

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: display and keyboard 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.

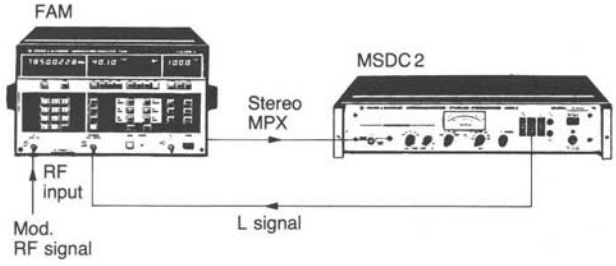
Description

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 when the 1.36-MHz Frequency-range Extension option is used. 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 ≥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	$<\pm1\times10^{-6}$/month	$<\pm5\times10^{-8}$/month
Temperature coefficient	$<\pm1\times10^{-6}$/°C	$<\pm1\times10^{-7}$ in the op. temp. range

[1]) Frequency measurement and automatic tuning for AM ≤80%; for f_{in} ≥550 MHz up to 60%.

RF input ..... Z_{in} = 50 Ω, 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

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. ≤80%	mod. >80%
(plus peak residual AM)		
f_{mod} 30 Hz to 60 kHz	≤±2%	≤±5%
60 to 100 kHz	≤±4%	≤±10%
Residual AM[2]) weighted with CCITT filters (rms.-resp. detector)	≤550 MHz ≤0.01%	>550 MHz ≤0.02%
Weighting bandwidth		
30 Hz to 20 kHz	≤0.05%	≤0.05%
CCIR weighting	≤0.05%	≤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.	≤0.2%	≤0.4%
40 to 80% mod.	≤0.4%	≤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} ≤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	≤±1.5%	≤±3%		
60 to 100 kHz	≤±3%	≤±6%		
with rms.-resp. detector (plus peak residual FM)				
f_{mod} 30 Hz to 60 kHz	≤±3%	≤±3%		
60 to 100 kHz	≤±6%	≤±6%		
Residual FM at f	≤120 MHz	120 to 550 MHz	550 to 1050 MHz	1050 to 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} ≤120 MHz, V_{in} ≥20 mV) ..... 72 dB, typical
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 ..... ≤0.1%
500 kHz deviation ..... ≤0.5% (input freq. >10 MHz)
Stereo separation
at f_{mod} 30 Hz to 15 kHz ..... ≥46 (typ. 50) dB at stereo output
f_{mod} 1 kHz ..... ≥50 dB
Deemphasis ..... 50/75/750 µs, 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 ...	≤±3.5% + peak residual φM			
with rms.-resp. detector	≤+5% +residual φM			
Residual φM at f	≤120 MHz	120 to 550 MHz	550 to 1050 MHz	1050 to 1360 MHz
Weighted with CCITT filter: . rad	≤0.002	≤0.003	≤0.006	≤0.012
bandwidth 30 Hz to 20 kHz: . rad	≤0.005	≤0.01	≤0.02	≤0.04

AF distortion (at AF output), deviation 4 rad ..... ≤0.1%
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

[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.

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),
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	±0.1% at S/N >40 dB
f <100 Hz	±0.1 Hz at S/N >60 dB

Distortion measurement ..... with option FAM-B8

Test frequencies (total of 30)	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 ±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 ≤10%)	≤ ±10% of rdg or ≤±1 dB

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	≤ ±1.5% ±0.1 mV
without LP	≤ ±1.5% ±0.4 mV (30 Hz to 60 kHz) ≤±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} ≥400 kΩ ||300 pF, floating; BNC female connector

Voltage range programmable (11 ranges)

Outputs

AM signal output (V_{rms})	max. 1 V across 2 kΩ at 100% mod
FM stereo signal output (V_{rms})	1.5 V at 40 kHz dev. corresp. to + 6 dBm across 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)

	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 °C
Storage temperature range	−40 to +70 °C
Power supply	115/125/220/235 V ±10% 47 to 440 Hz (80 VA), safety class I
Dimensions, weight	347 mm × 206 mm × 370 mm, 13.4 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