

**Instruction Manual
for**



**Modulation Meter
Type AFM2b**

From serial No.166201



This instruction manual is valid for the Modulation Meter, type AFM2, but applies also for the type AFM2S6 when the following specification changes and additions are borne in mind:

1) On page B5 read for AFM2S6

AM distortion:

Carrier frequencies within
the range 5 - 300 MHz:

0.3% distortion at 30% AM and at modulation
frequencies within 20 Hz - 15 kHz.

1.5% distortion at 90% AM and at modulation
frequencies within 10 Hz - 50 kHz.

Carrier frequencies within
the range 300 - 1002 MHz:

1.5% distortion at 30% AM and at modulation
frequencies within 10 Hz - 50 kHz.

2) Signal-to-noise ratio for each stereo channel measured with a psophometer:
Typically 66 dB at ± 40 kHz frequency deviation and RF < 200 MHz. These data apply
only when the level of the RF signal is in the 30 - 100 mV range.

Furthermore, it applies to the Modulation Meter, type AFM2S4S5, when the following
corrections are made on pages B6, B7, D6, E2, and E4:

1) AF Output

Nominally 0 dBm (0.775 V rms into 600 Ω)
when meter reads 3/4 of full-scale deflection,
e.g., at ± 75 kHz deviation in the ± 100 kHz
deviation range.

2) AF Output Terminals

3-pole standard, type ZNA 333874/1



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Modulation Meter

Type AFM2

Section A. Introduction

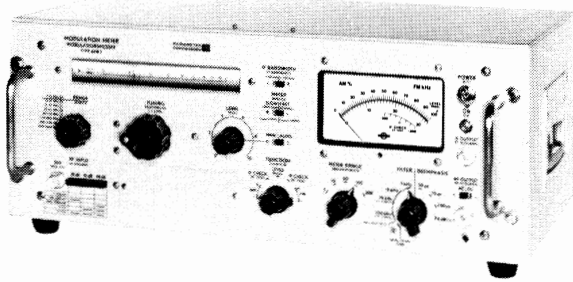


Fig. A1. The Modulation Meter, type AFM2.

The Modulation Meter, type AFM2, is a solid-state, line- or battery-operated precision measuring instrument for accurate measurement of the modulation depth of AM signals and the peak deviation of FM signals in the carrier frequency range from 5 to 1002 MHz. The Modulation Meter is designed for accepting telemetric signals with a modulation frequency up to 200 kHz, and stereo signals for which it features an L/R-separation of 46 dB.

The indicating meter has full-scale deflection for 3, 10, 30, and 100% AM, and ± 3 , ± 10 , ± 30 , ± 100 , and ± 300 kHz FM, peak value. Due to the very small amount of residual modulation generated in the Modulation Meter proper, it is possible to measure residual FM and AM in oscillators, spurious AM on FM signals, and vice versa. Accurate measurements on distorted signals are

rendered easy by a switch that enables the positive and the negative peak value to be measured separately. If increased resolution is desired, an external indicator, such as a voltmeter, can be employed to extend the measuring ranges downwards.

The input signal level necessary for full accuracy is 3 mV in the carrier frequency range 5 to 200 MHz, 20 mV in the range 200 to 600 MHz, and 30 mV in the range 600 to 1002 MHz. The maximum operating input voltage is 10 V. Besides a manual level control, the Modulation Meter features an automatic level control with a regulating range of 40 dB.

To increase the versatility of the Modulation Meter for measurements on narrow-band equipment, it is provided with two IF bandwidths of ± 20 and ± 400 kHz, just as three standard deemphasis networks of 50, 75, and 750 μ s, one non-standard of 6 dB/octave (ref. 1 kHz), four low-pass filters with frequencies of 3, 15, 75, and 200 kHz, and one band-pass filter with 3 dB points at 50 Hz and 15 kHz, ensure optimal measuring conditions for a wide range of applications.

A plug-in Crystal Oscillator Unit, code 900-252, and a plug-in External-Oscillator Amplifier, code 900-253, are available. See SECTION C.

Section B. Specifications

FREQUENCY RANGE OF INPUT SIGNAL 5 - 1002 MHz

FREQUENCY RANGE OF VARIABLE OSCILLATOR 7 - 1000 MHz

Fundamental ranges: 7-12, 12-21, 21-37, 37-65, 65-110, and 110-200 MHz

Harmonic ranges: 200-330, 330-600, and 600-1000 MHz

CALIBRATION ACCURACY 3%

CRYSTAL OPERATION An optional Crystal Oscillator Unit, code 900-252, that accepts up to four switch-selected crystals, ensures low residual FM.

Specification changes due to crystal operation: See SECTION C - ACCESSORIES.

INPUT LEVEL One input socket in connection with a 3-step input attenuator (10 + 10 + 20 dB) adapts the AFM2 to input levels from 3 mV to 10 V.

<u>Carrier frequency ranges:</u>	<u>5-200 MHz</u>	<u>200-600 MHz</u>	<u>600-1000 MHz</u>
Attenuation 0 dB ⁺ :	3-100 mV	20-100 mV	30-100 mV
Attenuation 10 dB:	(10) ⁺⁺ -100-300 mV	(60)-100-300 mV	100-300 mV
Attenuation 20 dB:	(30)-300-1000 mV	(200)-300-1000 mV	300-1000 mV
Attenuation 30 dB:	(0.1)-1-3 V	(0.6)-1-3 V	1-3 V
Attenuation 40 dB:	(0.3)-3-10 V	(2)-3-10 V	3-10 V

⁺ Basic sensitivity range, BSR

⁺⁺ Values in parentheses are derived from minimum level of BSR and from lower limit of overlapping ranges.

Max. safe input level: 10 V

Input level for residual FM and AM measurements:

Min. input level	RF attenuation inserted (dB)
10 mV	0
30 mV	10
100 mV	20
300 mV	30
1 V	40

INPUT IMPEDANCE 50 Ω nominal

LEVEL SETTING

Manual level setting: Continuous within a range of min. 40 dB.

Automatic level settings: The AGC system keeps the level setting within 0.5% for input level variations within the specified input level ranges, inclusive of the overlapping ranges.

Fine adjustment of the automatic level setting is possible.

FREQUENCY MODULATION

Deviation ranges: ± 3 , ± 10 , ± 30 , ± 100 , and ± 300 kHz f.s.d. (peak deviation).

Positive and negative deviation peaks can be measured separately.

Accuracy:

± 75 kHz deviation: 2% of reading + 1% of full scale at modulation frequencies within 20 Hz - 53 kHz

4% of reading + 1% of full scale at modulation frequencies within 10 Hz - 75 kHz.

± 300 kHz deviation: 2% of reading + 1% of full scale at modulation frequencies within 20 Hz - 15 kHz.

7% of reading + 1% of full scale at modulation frequencies within 10 Hz - 125 kHz.

15% of reading + 1% of full scale at modulation frequencies within 125 kHz - 200 kHz.

Notes:

1. To obtain specified accuracy, the upper frequency limit of the built-in low-pass filter should be switched as follows:

<u>Deviation range</u>	<u>upper frequency limit</u>
± 3 kHz	3 kHz
± 10 kHz	15 kHz
± 30 kHz	15 kHz
± 100 kHz	75 kHz
± 300 kHz	200 kHz

(see Bandwidths)

2. The specified accuracies are valid only with the METER switch set to SLOW. In position FAST, the lower frequency limit is 160 Hz.

Distortion

± 75 kHz deviation: 0.1% distortion at modulation frequencies within 10 Hz - 15 kHz.
 0.2% distortion at modulation frequencies within 20 Hz - 53 kHz.
 0.3% distortion at modulation frequencies within 10 Hz - 75 kHz.

± 300 kHz deviation: 0.5% distortion at modulation frequencies within 20 Hz - 15 kHz.
 1.5% distortion at modulation frequencies within 10 Hz - 50 kHz.
 3% distortion at modulation frequencies within 10 Hz - 125 kHz.
 5% distortion at modulation frequencies within 125 kHz - 200 kHz.

LR-separation of FM stereo signals: For an ideal FM stereo signal (FCC and EBU-standard), the LR-separation at modulation frequencies within 40 Hz - 15 kHz is greater than 46 dB.

AF output and meter response (FM):

AF output: Within 40 Hz - 15 kHz, the LR-separation is greater than 46 dB (see above). This corresponds to a departure from a linear phase response of less than 0.5° and a frequency response within +0.25% and -1.5% (40 Hz - 53 kHz).

Note: The built-in 200 kHz low-pass filter is to be used.

Meter response: Within 40 Hz - 53 kHz, the frequency response of the meter is within +0.25% and -1.5%.

Notes:

1. The built-in 200 kHz low-pass filter is to be used.

2. The specified response is valid only with the METER switch set to SLOW. In position FAST, the lower frequency limit is 160 Hz.

Residual FM:

On condition of a quiet test room (noise level < 60 dB rel. 2×10^{-4} μ bar.):

Less than 25 Hz FM (r.m.s.) within the frequency range 5-250 MHz; typically 15 Hz (r.m.s.).

Less than 100 Hz FM (r.m.s.) up to 1002 MHz, typically 50 Hz FM (r.m.s.).

Notes:

1. 0.1% of full deviation range is to be added.
2. Minimum RF input level: See Input Level.
3. The built-in band-pass filter (50 Hz - 15 kHz) or one of the deemphases (50 μ s or 75 μ s) is to be used.

FM due to AM:

Additional residual FM error due to AM is typically less than 50 Hz (r.m.s.) at 50% AM, when the band-pass filter (50 Hz - 15 kHz) is used.

Deemphases:

Standard deemphases:

50, 75, and 750 μ s, switchable.

Deemphasis:

6dB/oct. (ref. 1 kHz). For frequency response of filter, see Fig. B1.

The deemphasis can be switched off.

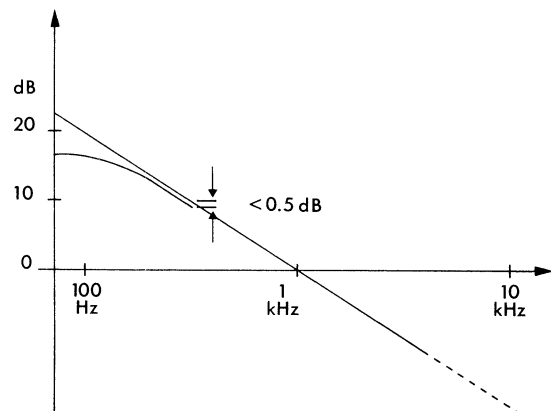


Fig. B1. Frequency response of the 6 dB/oct. filter.

AMPLITUDE MODULATION

Modulation depth range:

3, 10, 30, and 100% AM f.s.d.

Positive and negative modulation peaks can be measured separately.

Accuracy:

Manual level setting:

2% of reading + 1% of full scale at modulation frequencies within 20 Hz - 15 kHz.

5% of reading + 1% of full scale at modulation frequencies within 10 Hz - 50 kHz.

Notes:

1. To obtain specified accuracy, the upper frequency limit of the built-in low-pass filter should be switched as follows:

<u>modulation range</u>	<u>upper frequency range</u>
3% ⁺	3 kHz
10%	15 kHz
30%	75 kHz
100%	200 kHz

⁺By a 10 dB increase in minimum input level, the upper frequency limit can be extended to 15 kHz.

2. The above accuracies are valid for modulation depths up to 90% AM within the carrier frequency range 15-300 MHz, and up to 30% AM within the carrier frequency range 300-1002 MHz.

Automatic level setting:

The following typical values are to be added to the above accuracies:

At a modulation frequency of 20 Hz: 6% of reading.

At a modulation frequency of 50 Hz: 1% of reading.

At modulation frequencies above 100 Hz, the additional error is negligible.

Note: The specified accuracies (manual and automatic level settings) are valid only with the METER switch set to SLOW. In position FAST, the lower frequency limit is 160 Hz.

AM distortion:

Carrier frequencies within the range 5 - 300 MHz:

0.2% distortion at 30% AM and at modulation frequencies within 20 Hz - 15 kHz.

1% distortion at 90% AM and at modulation frequencies within 10 Hz - 50 kHz.

Carrier frequencies within the range 300 - 1002 MHz:

1% distortion at 30% AM and at modulation frequencies within 10 Hz - 50 kHz

Residual AM at CW:

Less than 0.03% AM (r.m.s.) at carrier frequencies up to 200 MHz.

Less than 0.1% AM (r.m.s.) at carrier frequencies up to 500 MHz.

Less than 0.3% AM (r.m.s.) at carrier frequencies up to 1002 MHz.

Notes:

- 0.1% of full AM range to be added.
- Minimum RF input level: See Input Level.
- The built-in band-pass filter (50 Hz - 15 kHz) is to be used.

AM due to FM: Additional error is less than 0.6% AM (r.m.s.) at ± 50 kHz deviation.

AF output (AM)

Manual level settings: The frequency response is within $\pm 0.5\%$ in the range 20 Hz - 15 kHz.

Automatic level setting: The following typical error contributions are to be added to the above frequency response:

At a modulation frequency of 20 Hz: 6%

At a modulation frequency of 50 Hz: 1%

At modulation frequencies above 100 Hz, the error contribution is negligible.

INTERMEDIATE FREQUENCY CHANNEL

Frequency: 2 MHz

Bandwidths: approx. ± 400 kHz/3 dB and ± 25 kHz/3 dB, switch-selected.

IF check: The meter has a separate scale to facilitate correct tuning (IF = 2 MHz).

IF output: 2 MHz IF signal of 0.2 V EMF from 50 Ω source at correct frequency tuning and full scale deflection on meter.

AUDIO FREQUENCY CHANNEL

Bandwidths: four switchable low-pass filters, 3 kHz, 15 kHz, 75 kHz, and 200 kHz, to be used when measuring FM deviation and AM modulation.

3 kHz filter: for mod. freq. up to 3 kHz

15 kHz filter: for mod. freq. up to 15 kHz.

75 kHz filter: for mod. freq. up to 75 kHz and for measurements of FM stereo deviation.

200 kHz filter: for mod. freq. up to 200 kHz and for measurements of stereo L/R separation.

(bandwidth: 10 Hz (0.1 dB) - 350 kHz (3 dB))

50 Hz - 15 kHz filter: Band-pass filter, 50 Hz (3 dB) - 15 kHz (3 dB), to be used when measuring residual FM and AM.

AF output: AF signal of 1 V EMF (peak value) at full scale deflection.

Bandwidth as specified above. A switch provides for ac- or dc-coupling.

ac-coupling: Output impedance: 600 Ω in series with 10 μ F.

dc-coupling: Output impedance: 600 Ω .

dc OUTPUTS

<u>IF level:</u>	dc-voltage of 1 V EMF from 600 Ω source at meter deflection to set level mark.
<u>IF frequency:</u>	dc-voltage of 1 V EMF from 600 Ω source at meter deflection to IF CHECK mark (50 mV/100 kHz).
<u>Modulation:</u>	dc-voltage of 1 V EMF from 600 Ω source at full scale deflection.

POWER SUPPLY

Power line:

Voltages: 110 V and 220 V, $\pm 10\%$.

Frequencies: 48 - 65 Hz.

Consumption: about 25 VA.

The power cord is fixed and provided with a mains plug of the Schuko type.

External dc supply:

dc sources: 0 to +(18 to 25 V) and 0 to -(18 to 25 V).

Current drain: approx. 400 mA from each source.

TERMINALS

RF input and IF output: BNC

AF output: UHF

dc output (AF): Banana jacks

External dc supply: Belling Lee L1436/S

Operating ambient temperature range:

0 - 50°C

DIMENSIONS AND WEIGHT

Height: 197 mm (7 3/4 in.)

Width: 485 mm (19 1/8 in.)

Depth: 245 mm (9 5/8 in.)

Weight: 13 kg (28.6 lbs)

MOUNTING AND FINISH

Steel cabinet finished in grey enamel lacquer.

ACCESSORIES SUPPLIED

1 coaxial cable (50 Ω), code 617-004, with type UG-88/U BNC plugs.

1 battery plug, Belling & Lee, L1436/P, code 805-429.

ACCESSORIES AVAILABLE

Crystal Oscillator, code 900-252.

External-Oscillator Amplifier, code 900-253

1 set of dust covers (top plate and bottom plate) for rack mounting, code 884-002

Section C. Accessories

PLUG-IN CRYSTAL OSCILLATOR UNIT, CODE 900-252

General

The Plug-in Crystal Oscillator Unit, code 900-252, is preferably used within the frequency range 80 - 1000 MHz to achieve low residual FM. It is supplied without crystals.

The Crystal Oscillator Unit contains a crystal-controlled oscillator followed by a doubler stage, and it has room for up to four switch-selected crystals. The crystals are mounted inside the unit and can easily be exchanged. Initial adjustment is made by means of individual

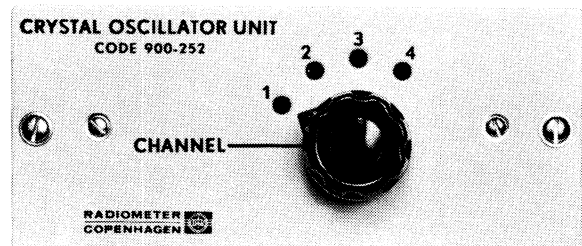


Fig. C1. The Crystal Oscillator Unit, code 900-252.

screw-driver adjustments on the front panel.

The trimmers directly cover a tuning range of 360 - 1000 MHz. In the ranges 80 - 120 MHz and 250 - 360 MHz, a fixed capacitor must be added in parallel with the trimmer.

Specifications

Number of crystals: Sockets for up to 4 crystals.

Frequency of crystals: In order to achieve the highest possible sensitivity of the modulation meter, the frequency of the crystals must be as high as possible. Overtone crystals having frequencies within the range 40 - 100 MHz are recommended. The crystal frequency f_{cr} is determined by

$$f_{cr} = \frac{f_s - 2}{2n} \text{ MHz}$$

where f_s indicates the carrier frequency and n the odd harmonic of the crystal overtone-frequency.

Initial conditions:

The sensitivity specifications, item INPUT LEVEL, are based on the following combinations of carrier frequency, order of harmonic, and range of crystal frequencies.

Carrier frequency f_s	Order of harmonic n	Range of crystal frequencies f_{cr}
250 - 600 MHz	3	40 - 100 MHz
600 - 1000 MHz	5	60 - 100 MHz

Characteristics of the crystals:

Type: HC-25/U

Frequency: See above.

Frequency tolerance: 10×10^{-6} at reference temperature 25°C

Frequency tolerance over operating temperature range: 10×10^{-6} , within $0-50^\circ\text{C}$

Condition of resonance: Series

Mode of operation: 5. overtone

Max. drive level: 2 mW

Max. equivalent series resistance: 60Ω

CHANGE IN SPECIFICATIONS OF AFM2
CAUSED BY THE CRYSTAL OSCILLATOR

Input level:

Frequency ranges:	<u>250 - 600 MHz</u>	<u>600 - 1000 MHz</u>
Attenuation 0 dB ⁺ :	20 - 100 mV	30 - 100 mV
Attenuation 10 dB:	(60) ⁺⁺ - 100 - 300 mV	100 - 300 mV
Attenuation 20 dB:	(200) - 300 - 1000 mV	300 - 1000 mV
Attenuation 30 dB:	(0.6) - 1 - 3 V	1 - 3 V
Attenuation 40 dB:	(2) - 3 - 10 V	3 - 10 V

⁺Basic sensitivity range, BSR

⁺⁺Values in parentheses are derived from minimum level of BSR and from lower limit of overlapping ranges.

Max. safe input level: 10 V

Input level for FM and AM
measurements:

250 - 600 MHz:

Min. input level	RF attenuation inserted (dB)
20 mV	0
60 mV	10
200 mV	20
600 mV	30
2 V	40

600 - 1000 MHz:

Min. input level	RF attenuation inserted (dB)
30 mV	0
90 mV	10
300 mV	20
900 mV	30
3 V	40

Residual FM:

Less than 20 Hz FM (r.m.s.) at carrier frequencies up to 1002 MHz; typically 15 Hz (r.m.s.).

Notes:

1. 0.1% of full deviation range is to be added.
2. Minimum RF input level: See Input Level.
3. The built-in band-pass filter (50 Hz - 15 kHz) or one of the deemphases (50 μ s or 75 μ s) is to be used.

Residual AM at CW: Less than 0.15% (r.m.s.) at carrier frequencies up to 1000 MHz.

Notes:

1. 0.1% of full AM range must be added.
2. Minimum RF input level: See Input Level.
3. The built-in band-pass filter (50 Hz - 15 kHz) is to be used.

EXTERNAL-OSCILLATOR AMPLIFIER,
CODE 900-253

General

The Modulation Meter, type AFM2, is so designed that an optional plug-in External-Oscillator Amplifier, code 900-253, can be used if driving by means of an external oscillator, for example a synthesizer, is required. It will adapt the output of the external oscillator to the level required by the mixer of the AFM2.

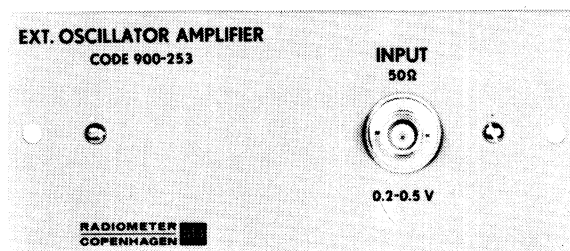


Fig.C2. The External-Oscillator Amplifier, code 900-253.

Specifications

Input Level:	0.3 to 0.5 V depending on the frequency range.
Frequency Range:	90 to 200 MHz. Up to 1 GHz on harmonics.
Input Impedance:	50 Ω (BNC connector).