Section D. General Description

DESCRIPTION

As can be seen on the simplified block-diagram shown in Fig.D1, the RF input signals to the 50 Ω coaxial connector are fed to a diode mixer via an input attenuator providing for 10, 20, 30, and 40 dB attenuation and thus accommodating RF signals from 3 mV to 10 V r.m.s. The mixer, which is balanced and highly linear, so that distortion of amplitude-modulated signals is avoided, is coupled to the local tuning oscillator. For RF input signals in the range from 5 to 200 MHz, mixing is realized with the fundamental frequency of the local oscillator, whilst it takes place with the third and fifth harmonics in the range from 200 to 1002 MHz. This results in an IF signal of 2 MHz. The mixer can also be coupled to an optional Crystal Oscillator Unit, code 900-252, which can accommodate four crystals, thereby enabling measurements at four predetermined, fixed frequencies.

The signal from the mixer is passed through an IF filter, which is a phase-linear band-pass filter with a bandwidth of ±400 kHz, a high degree of phase-linearity being necessary in order to pass a multiplex stereo signal with minimum distortion.

From the IF filter, the IF signal is fed to an IF preamplifier which acts as a buffer. At the same time, the IF preamplifier provides for amplification of the IF signal. This amplification, together with ideal coupling to the IF filter, keeps the noise level down to a minimum at all input levels.

The IF preamplifier is followed by a diode attenuator whose biasing current can be controlled by the potentiometer LEVEL, accessible on the front panel of the Modulation Meter. Level control can be performed within a range of 40 dB. Alternatively, the IF attenuator can be driven by a voltage proportional to the IF level amplified in an AGC amplifier. This provides for automatic level control within 40 dB. Fine adjustment is nevertheless also possible by means of the potentiometer LEVEL.

The IF signal from the IF attenuator is then fed to an IF amplifier which consists of two wideband amplifier stages. The IF amplifier brings the IF signal to the level required by the AM detector.

The amplified IF signal is then passed either through a band-pass filter or through a phase-compensator, according to the position of the IF BANDWIDTH control. The band-pass filter has a bandwidth of ±25 kHz and is phase-linear just as the IF filter. It is intended for use when measuring on weak signals from narrow-band equipment. The phase compensator leaves the initial bandwidth unchanged.

A buffer amplifier separates filters, AM detector and IF output amplifier. It consists of a unity-gain amplifier with low output impedance and serves to suppress any influence from the IF output which is available for external monitoring from a coaxial connector on the front panel.

The IF signal from the buffer amplifier is fed both to the AM detector and to the IF output amplifier. The AM detector is an amplifier with a mean-value detector in the feedback loop which also provides for the large amount of linearity required. The AM detector has a dc and an ac output. The first of these is coupled to the meter of the instrument via the FUNCTION selector.

In the corresponding position of the FUNCTION selector, the meter indicates the value of the AM detector's dc current - in other words: the IF level. The second output of the AM detector is coupled to the AF section (described below) via the selector FUNCTION.

As stated above, the IF signal from the buffer amplifier is also fed to the IF output amplifier which provides for amplification so that the level required for driving a following limiter is obtained.

The limiter transforms the IF signal into a square wave, the zero crossing of which is controlled by variations in the peak-to-peak value being compared with variations in the mean value. Subsequent limiting action takes place in the following limiter section. The resulting signal is fed via a buffer amplifier to the FM detector section which consists of a monostable multivibrator and an output amplifier.

The signal from the last limiter section is used to trigger a monostable multivibrator which provides for pulses of constant width. The pulses from the multivibrator are amplified in an output amplifier. The output amplifier is provided with a regulating loop consisting of a peak detector and an amplifier. This regulating loop keeps the value of the peak-to-peak voltage of the output amplifier constant. Hence, as the amplitude and the width of the pulses are constant, the mean value of the signal will vary according to the number of pulses per second. The mean value is utilized when the FUNCTION selector is in position IF CHECK for reading the value of the intermediate frequency. To ensure a high degree of accuracy and an extremely low hum level, both the multivibrator and the output amplifier are furnished with their own regulated power supply.

From the AM or FM detector, the signal is fed to a low-pass filter via a relay controlled by the FUNCTION selector. The low-pass filter features the high degree of phase-linearity required for passing stereo information without any disturbing influence on L/R separation.

The low-pass filter is followed by a two-section, 4 x 10 dB precision attenuator which determines the metering ranges. It is followed by an amplifier providing for amplification of the AF signal to the level required by the next stages.

The AF amplifier is followed by deemphasis networks providing for the standard deemphases of 50, 75, and 750 µs, and the non-standard deemphasis of 6 dB/oct. The amplified AF signal can also be passed through one of four low-pass filters with frequencies of 3, 15, 75 and 200 kHz, or through a band-pass filter with 3 dB points at 50 Hz and 15 kHz, ensuring a wide range of applications.

These networks and filters are followed by an AF amplifier. The output signal from this amplifier is available on the front panel via the AF OUTPUT connector for distortion measurements or external monitoring. Loading of the AF OUTPUT does not interfere with the meter indication. The output voltage from the first AF amplifier is also fed to another AF amplifier providing for the voltage necessary for the AF detector. The signal from the AF OUTPUT can either be dc-coupled or ac-coupled to

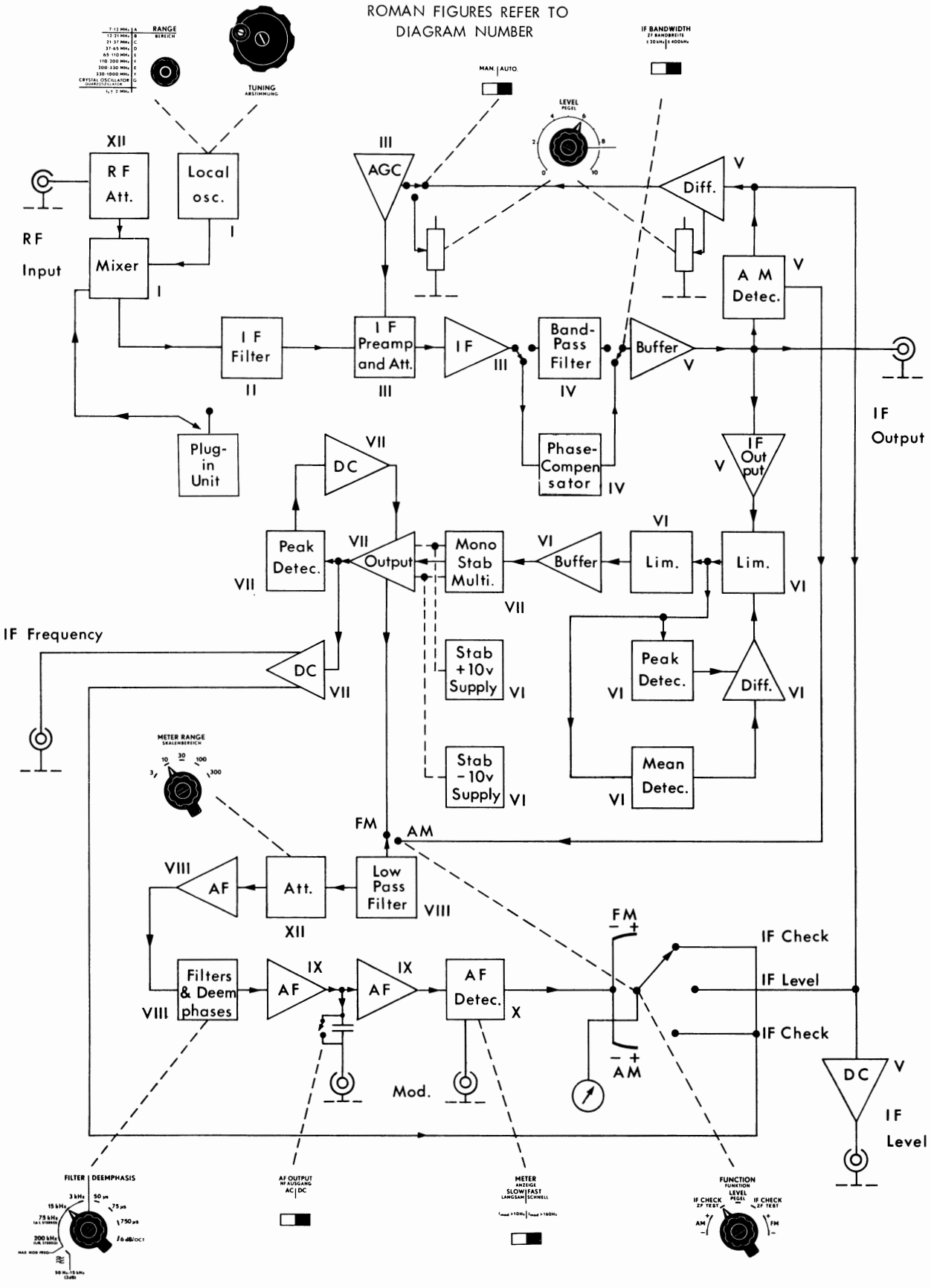


Fig.D1. Block-diagram of the Modulation Meter, type AFM2.

the AF OUTPUT connector by sliding the switch.

The AF detector gives the true peak value of any AF signal. Depending on the position of the FUNCTION selector, the positive or the negative modulation peak can be measured. The AF detector has two time constants, thereby furnishing two meter responses.

The AF detector is followed by an impedance-matching network providing for low output impedance to the meter.

CONTROLS, METER, AND TERMINALS

General

As can be seen in Fig. D2 and D4, the Modulation Meter, type AFM2, is provided with the following controls, meter, and terminals:

Controls, Meter, and Front Plate Terminals (see Fig. D2)

Power Lamp and ON switch (1)

The power switch ON is a toggle switch monitored by the lamp POWER.

RANGE Selector and Drum Scale (2)

The selector RANGE is an eight-position rotary switch. In the first six positions, the RANGE selector provides for selection of the frequency ranges according to the table printed on the front plate of the instrument. (Note that the ranges E and F each cover two frequency bands.) The next position is a rest position. In the last position, the plug-in Crystal Oscillator Unit (if any) is connected. The selector RANGE is monitored by the drum scale immediately above.

TUNING Knob (3)

The knob TUNING provides for adjustment of the local oscillator frequency at 2 MHz from the signal frequency. It is monitored by a cursor on the drum scale.

LEVEL Potentiometer (4) and MAN.-AUTO. Switch (5)

The potentiometer LEVEL has two functions according to the position of the switch MAN.-AUTO.

When the switch MAN.-AUTO. is in position MAN., the LEVEL potentiometer is used to vary the sensitivity of the instrument manually within a range of min. 40 dB.

When the switch MAN.-AUTO. is in position AUTO., the LEVEL potentiometer is used for fine-adjustment of the automatically adjusted sensitivity of the instrument.

FUNCTION Selector (6)

The selector FUNCTION is a seven-position rotary switch. The position LEVEL is used when searching the signal (i.e., tuning) and monitoring the IF level. When measuring, the positions IF CHECK are used to tune the instrument to the exact carrier frequency. (See under "Meter" below) The percentage of amplitude modulation of AM signals can be measured by placing the selector in position AM + or AM - according to the sign of the modulation peak to be measured. The frequency deviation of FM signals can be measured by placing the selector in position FM + or FM - according to the sign of the modulation peak to be measured.

METER RANGE Selector (7)

The selector METER RANGE is a five-position rotary switch. Each position corresponds to the full-scale range of the meter, viz: AM 3 - 10 - 30 - 100%, FM 3 - 10 - 30 - 100 - 300 kHz.

METER Switch (8)

The switch METER is a sliding switch. In position SLOW f_{mod} >10 Hz, the meter response is slow. This position should not be used when measuring on signals with modulating frequencies higher than 160 Hz. In position FAST f_{mod} >160 Hz, the meter response is fast.

IF BANDWIDTH (9)

The switch IF BANDWIDTH is a sliding

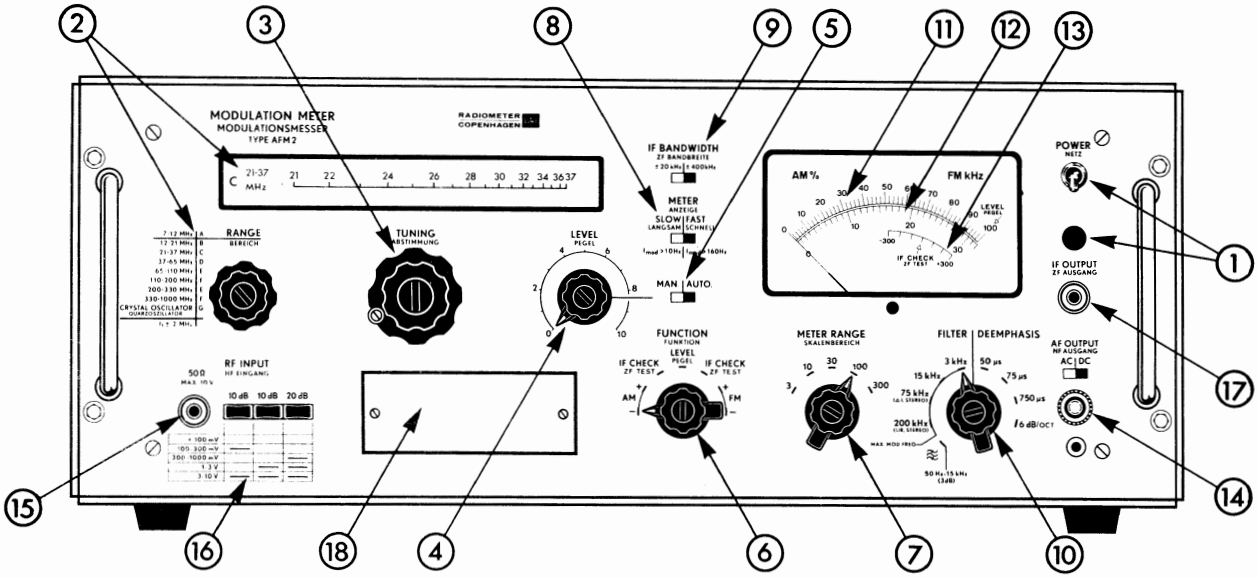


Fig.D2. Front plate of the Modulation Meter, type AFM2.

switch. It provides for switching from the band-pass filter to the phase-comparator and vice versa, i.e., from a bandwidth of ±25 kHz to one of ±400 kHz.

AF FILTER/DEEMPHASIS Selector (10)

The selector AF FILTER/DEEMPHASIS is a nine-position rotary switch. In the first position - 50 Hz—15 kHz (3 dB) - a band-pass filter is switched in. It is used when measuring residual AM and FM. In the next four positions - 200 kHz (L/R STEREO), 75 kHz (Δf, STEREO), 15 kHz, and 3 kHz - four low-pass filters are switched in. They are used when measuring FM deviation or AM modulation. The 3 kHz and 15 kHz filters are used for modulation frequencies up to 3 kHz and 15 kHz, respectively.

The 75 kHz filter is used for modulation frequencies up to 75 kHz and for measurements of FM stereo deviation. The last filter - 200 kHz - is used for modulation frequencies up to 200 kHz and for measurements of stereo L/R separation (bandwidth: 10 Hz (0.1 dB) - 350 kHz (3 dB)).

The last four positions of the AF FILTER/DEEMPHASIS selector introduce four deemphases of 50 µs, 75µs (European and American standard for stereo work), 750 µs (narrow-band equipment) and a 6 dB/oct (non-standard).

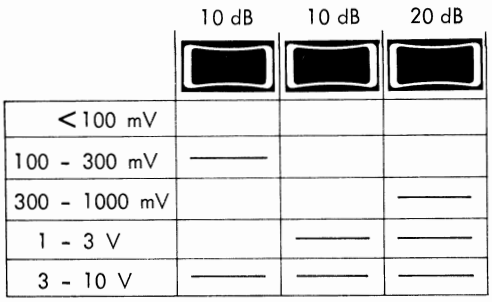
Meter

The meter of the Modulation Meter, type AFM2, is of the taut-band suspension type. It is provided with three scales.

The upper scale (11) provides for reading in the AM ranges from 0 to 10% or 0 to 100%, and in the FM ranges from 0 to 10 kHz or 0 to 100 kHz deviation, according to the positions of the FUNCTION selector and the METER RANGE selector. It is also provided with a LEVEL mark to permit setting of the IF level.

The middle scale (12) provides for reading in the AM ranges from 0 to 3% or 0 to 30%, and in the FM ranges from 0 to 3 kHz, 0 to 30 kHz, or 0 to 300 kHz deviation, according to the position of the FUNCTION and METER RANGE selectors.

The lower scale (13) is utilized when checking the frequency of the converted signal. It is graduated for ±300 kHz deviation around the 2 MHz intermediate frequency. An IF CHECK mark provides for exact tuning to the intermediate frequency.



ATTENUATION	FREQUENCY RANGE		
	15 - 200 MHz	200 - 600 MHz	600 - 1000 MHz
0 dB	3 - 100 mV	20 - 100 mV	30 - 100 mV
10 dB	100 - 300 mV	100 - 300 mV	100 - 300 mV
20 dB	300 - 1000 mV	300 - 1000 mV	300 - 1000 mV
30 dB	1 - 3 V	1 - 3 V	1 - 3 V
40 dB	3 - 10 V	3 - 10 V	3 - 10 V

Fig. D3. Attenuation and sensitivity ranges.

AF OUTPUT Switch and AF OUTPUT Connector (14)

The AF OUTPUT switch is a sliding switch used for selection of the mode of coupling of the AF signal. With the switch in the left-hand position, the AF signal is ac-coupled (600 Ω in series with 10 μF). With the switch in the right-hand position, the AF signal is dc-coupled (600 Ω). The AF signal of 1 V EMF (peak value) at full-scale deflection is delivered via a UHF connector.

RF INPUT Connector (15)

The BNC connector RF INPUT provides for connection of the RF signal to be measured on.

Input Attenuator (16)

The input attenuator is a three-step attenuator (10 + 10 + 20 dB). It is used to adapt the Modulation Meter, type AFM2, to input levels from 3 mV to 10 V. As can be seen in Fig. D3, the degree of attenuation to be selected depends on the input voltage range, and the sensitivity of the instrument on the frequency range.

IF OUTPUT (17)

The UHF connector IF OUTPUT provides for connection of the 2 MHz IF signal to, for example, external monitors. It delivers a 2 MHz IF signal of 0.2 V EMF from a 50 ohms source at correct frequency tuning and full deflection on the meter.

Plug-in Unit Receptacle (18)

The Modulation Meter, type AFM2, is so designed that two optional plug-in units, i.e., Crystal Oscillator Unit, code 900-252, and External-Oscillator Amplifier, code 900-253, can be easily plugged in. (See SECTION C - ACCESSORIES.)

Rear Terminals (see Fig. D4)

IF LEVEL (DC) (1)

The terminal IF LEVEL consists of two banana jacks (600 Ω) and delivers a dc output voltage of 1 V EMF at meter deflection to SET LEVEL mark.

IF FREQ. (DC) (2)

The terminal IF FREQ. consists of two banana jacks (600 Ω) and delivers a dc output voltage of 1 V EMF at meter deflection to IF CHECK mark.

MOD. LEVEL (DC) (3)

The terminal MOD. LEVEL (DC) consists of two banana jacks (600 Ω) and delivers a dc output voltage (meter current) of 1 V EMF at full-scale deflection.

Line Voltage Indicator (4)

The line voltage indicator shows the line voltage to which the instrument is switched: either 110 V or 220 V - 48 to 65 Hz. When the two screws (5) and (6) are loosened, the voltage indicator can be turned to the appropriate position. (For further details see SECTION E - OPERATING INSTRUCTIONS.)

Battery (7)

The terminals BATTERY are of the Belling & Lee L1436/5 type and provide for connection of the instrument to an external dc supply be means of a Belling & Lee L1436P Plug supplied with the instrument.

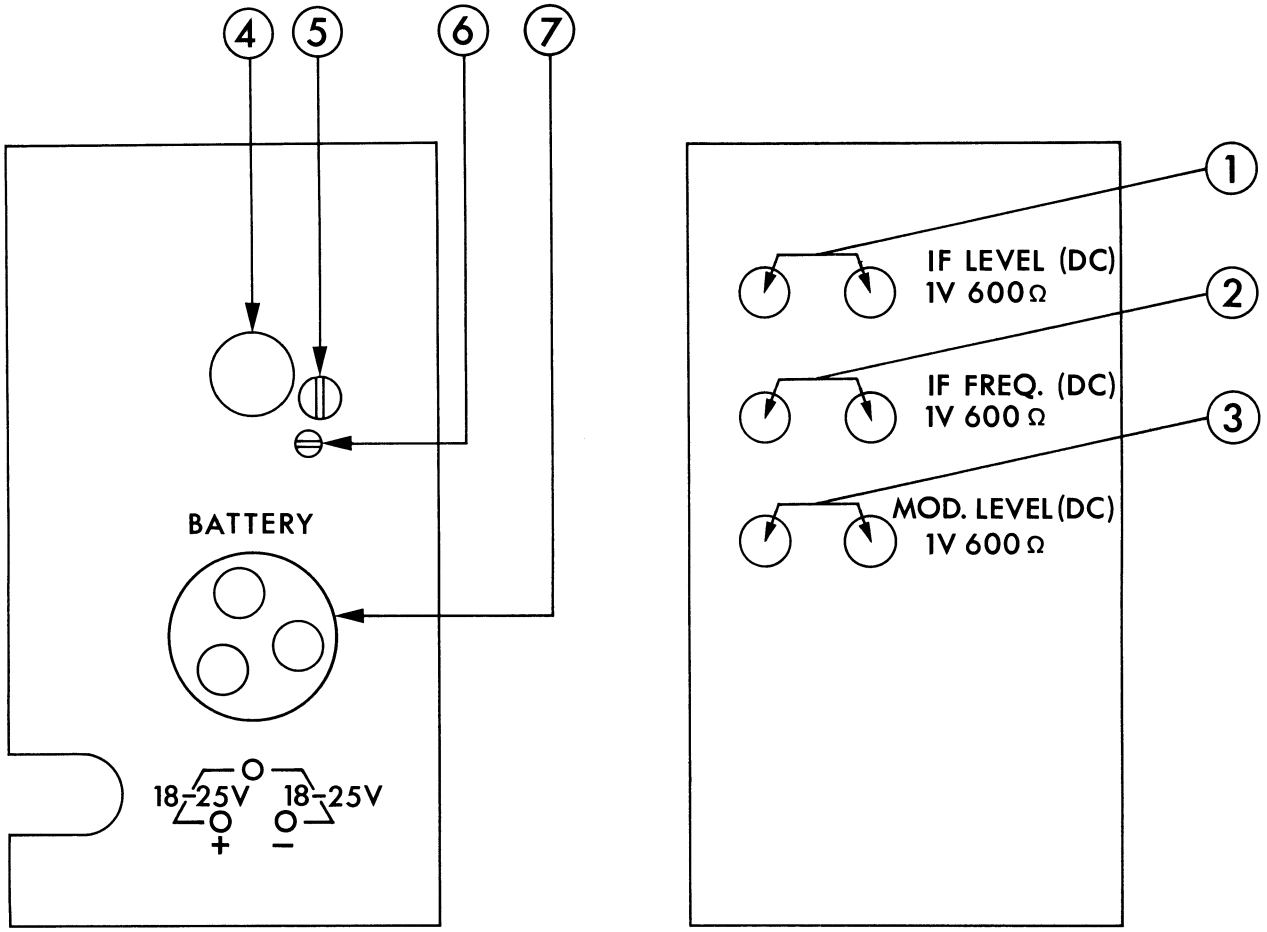


Fig. D4. Rear terminals of the Modulation Meter, type AFM2.

Section E. Operating Instructions

CONNECTING THE INSTRUMENT

Before connecting the instrument to the power line, make sure that the supply transformer and the line voltage indicator are set to the voltage of the power line.

To prepare the instrument for 110 V or 220 V line voltage operation, refer to diagram XI and proceed as follows:

1) If the instrument must be used at a line voltage of 110 V, interconnect lugs 3 and 5 and lugs 4 and 6 on the supply transformer.

2) If the instrument must be used at a line voltage of 220 V, interconnect lugs 4 and 5 on the supply transformer.

Then loosen the screws on the voltage indicator and set the indicator to the desired voltage.

MEASURING AMPLITUDE MODULATION PERCENTAGE

Modulation Percentage of AM Signals

1) Feed the signal to be measured to the RF INPUT connector. Bear in mind that the max. applicable signal is 10 V r.m.s., and that the input impedance is 50 Ω.

2) Use the RF input attenuator according to the instructions printed on the front panel, or refer to Fig.D3 in SECTION D - GENERAL DESCRIPTION.

3) Set the switch BANDWIDTH to ±400 kHz when measuring on broad-band equipment, or to ±25 kHz when measuring on narrow-band equipment.

4) Set the switch METER to SLOW if the modulation frequency of the signal is less than 160 Hz; otherwise set it to FAST.

5) Set the switch MAN.-AUTO. to MAN.

6) Set the drum scale to the desired frequency range by using the RANGE selector.

7) Set the selector FUNCTION to LEVEL.

8) Set the tuning knob so that the cursor on the drum scale indicates the signal frequency ±2 MHz, and then tune so as to obtain maximum meter deflection.

9) Turn the selector FUNCTION to IF CHECK.

10) Make a fine adjustment with the TUNING knob so that the meter reads IF CHECK.

11) Set FUNCTION to LEVEL. When using MAN.-AUTO. in position MAN. readjust to the LEVEL mark, if necessary by means of the LEVEL potentiometer. When using MAN.-AUTO. in position AUTO., fine level-adjustment can

be accomplished by means of LEVEL. It is recommended to use the MAN.-AUTO. switch in position AUTO. when performing AM measurements, as the inevitable level variations of the signal then are equalized.

12) In order to obtain the best accuracy, select the low-pass filter corresponding to the modulation frequency of the signal under test. See Fig. E1, and refer to SECTION B - SPECIFICATIONS under "AM MODULATION Accuracy".

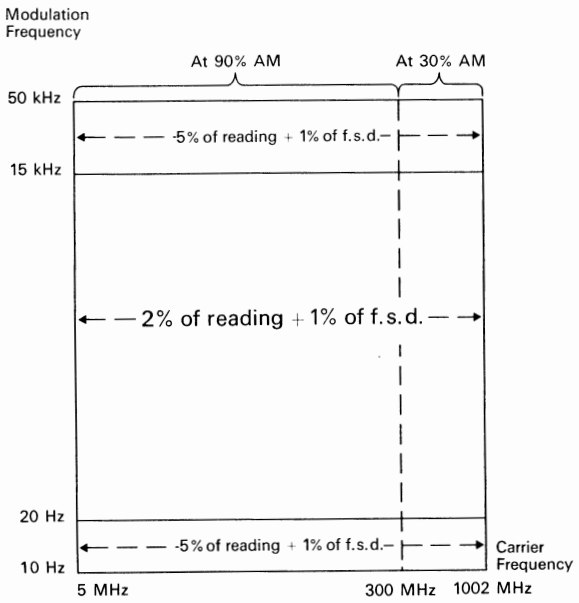


Fig. E1. Accuracy of modulation percentage measurements.

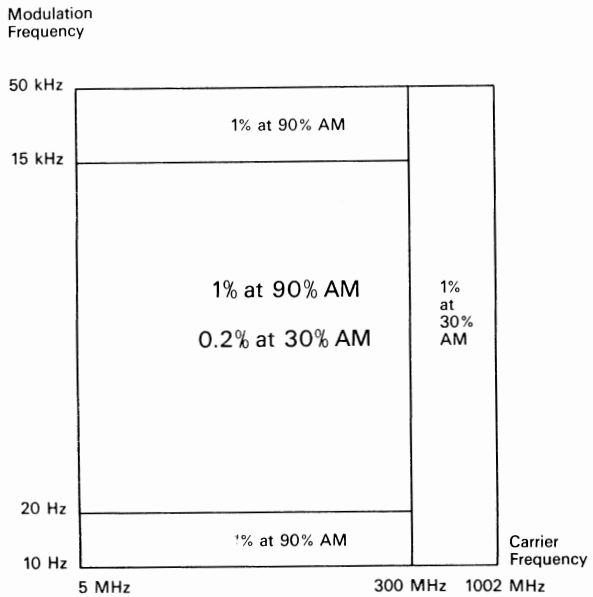


Fig. E2. Distortion for modulation percentage measurements.

13) Turn FUNCTION to AM + or AM - , depending on which peak of modulation is to be measured.

14) Rotate the selector METER RANGE until a proper deflection is obtained.

15) Read the modulation percentage. Check if the reading is the same for both peaks of modulation: a difference indicates distortion of the modulation envelope. See Fig. E2, and refer to SECTION B - SPECIFICATIONS under "AM MODULATION Distortion".

Residual AM on FM Signals

Proceed as described above. If resolution somewhat higher than that corresponding to the 3% AM range is wanted, an external meter, e.g., an electronic voltmeter, may be connected to the AF OUTPUT connector. The external meter will read 1 volt for full deflection of the internal meter, i.e., with the METER RANGE selector set to 3, the modulation percentage read on the voltmeter is 0.003% per mV.

The minimum residual AM reading for a given deviation caused by the instrument itself can be estimated as follows:

1) Apply a CW signal and set FUNCTION to LEVEL.

2) Rotate the TUNING knob back and forth so that the intermediate frequency is changed over the range 2 MHz - Δ f to 2 MHz + Δf, where Δf is the deviation of the frequency-modulated signal whose residual AM is to be measured. (Check the frequency change with the IF CHECK scale.)

3) Read the peak-to-peak value of the change in the LEVEL reading. The minimum residual AM is approx. half of this percentage change.

MEASURING FREQUENCY DEVIATION (FM kHz)

Frequency Deviation of FM signals

1) Feed the signal to be measured to the RF INPUT connector. Bear in mind that the max. applicable signal is 10 V and that the input impedance is 50 Ω.

2) Use the RF input attenuator according to the instructions printed on the front panel, or refer to Fig. D3 in SECTION D - GENERAL DESCRIPTION.

3) Set the switch IF BANDWIDTH to ±400 kHz when measuring on broadband equipment, or to ±25 kHz when measuring on narrow-band equipment.

4) Set the switch METER to SLOW if the modulation frequency of the signal is less than 160 Hz; otherwise set it to FAST.

5) Set the switch MAN.-AUTO. to MAN.

6) Set the drum scale to the desired frequency range by using the RANGE selector.

7) Set the selector FUNCTION to LEVEL.

8) Set the TUNING knob so that the cursor on the drum scale indicates the signal frequency ±2 MHz, and then tune so as to obtain maximum meter deflection.

9) Turn the selector FUNCTION to IF CHECK.

10) Make a fine adjustment with the TUNING knob so that the meter reads IF CHECK.

11) Set the selector FUNCTION to LEVEL. When using MAN.-AUTO. in position MAN., readjust to the LEVEL mark. When using MAN.-AUTO. in position AUTO., fine level-adjustment can be accomplished by means of LEVEL.

12) In order to obtain the best accuracy, select the low-pass filter corresponding to the modulation frequency of the signal under test. See Fig. E3, and refer to SECTION B - SPECIFICATIONS under "FM MODULATION - Accuracy".

13) Turn FUNCTION to FM + or FM -, depending on which peak of modulation is to be measured.

14) Rotate the selector METER RANGE until a proper deflection is obtained.

15) Read the modulation deviation. Check if the reading is the same for

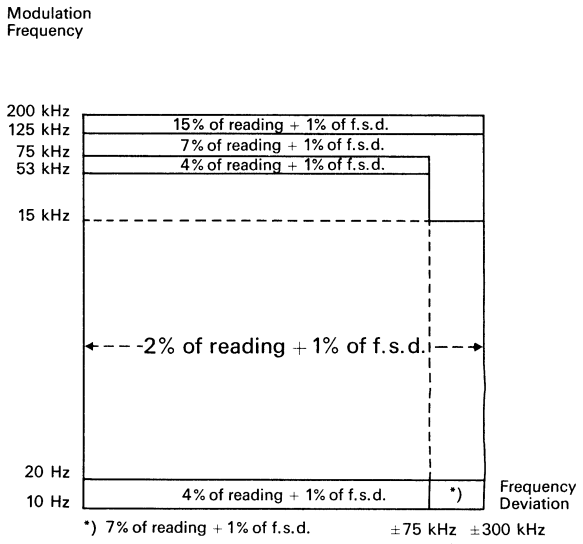


Fig. E3. Accuracy of frequency deviation measurements.

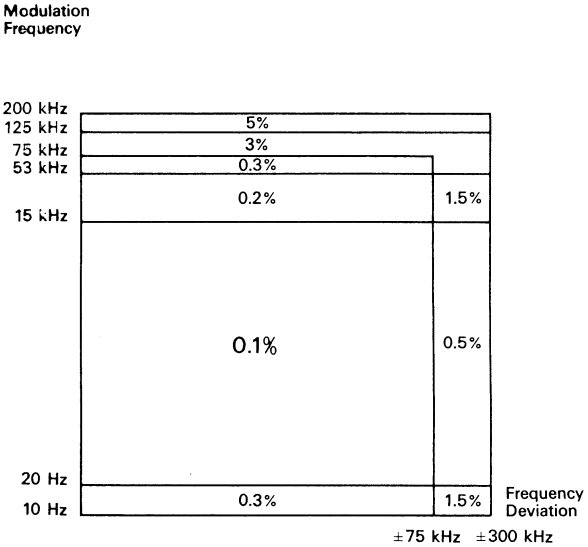


Fig. E4. Distortion for frequency deviation measurements.

both peaks of modulation: a difference indicates distortion of the modulating envelope. See Fig. E4, and refer to SECTION B - SPECIFICATIONS under "FM MODULATION - Distortion".

Residual FM on CW and AM signals

Proceed as described immediately above. Because of the very effective limiter stages in the FM detector, the residual FM caused by amplitude modulation is quite low, viz. 50 Hz (r.m.s.) at 50% AM when the band-pass filter (50 Hz - 15 kHz) is used. The residual FM at a carrier frequency within 15 - 250 MHz is less than 25 Hz FM (r.m.s.), and less than 100 Hz FM (r.m.s.) up to 1002 MHz, when measurements are performed in a room with an acoustical noise level lower than 60 dB (rel. 2 10^{-4} µbar) and the band-pass filter (50 Hz - 15 kHz) or one of the de-emphases (50 µs or 75 µs) is used. (See SECTION B - SPECIFICATIONS.)

If a resolution somewhat higher than that corresponding to the 3 kHz deviation range is wanted, an electronic voltmeter can be connected to the AF OUTPUT terminals. The external meter will read 1 volt for full deflection of the internal meter, i.e., with the METER switch set to 3, the deviation read on the electronic voltmeter will be 3 Hz per mV.

USING A CRYSTAL OSCILLATOR PLUG-IN UNIT, CODE 900-252

1) Remove the two screws and the plate covering the receptacle in which the

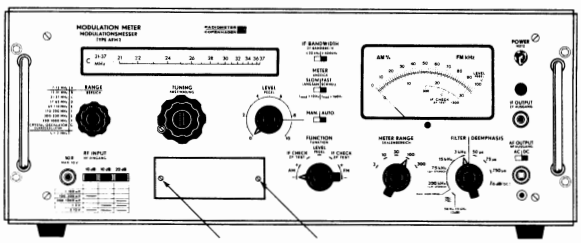


Fig. E5. The arrows show screws and plate to be removed when a plug-in unit is to be used.

Crystal Oscillator Unit is to be placed (see Fig. E5).

2) Supply the Crystal Oscillator Unit with Crystals. Bear in mind that the crystals must have the frequency f_{cr} defined below:

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

where f_s indicates the carrier frequency and n the odd harmonic of the crystal overtone frequency. The sensitivity specifications (see item INPUT LEVEL in SECTION C-ACCESSORIES or Fig. E6) are based on the combinations shown below of carrier frequency, order of harmonic, and range of crystal frequencies.

3) Position the Crystal Oscillator Unit in the Modulation Meter and fasten the two screws.

4) Switch the RANGE selector to position G - "CRYSTAL OSCILLATOR".

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

5) Tune the Modulation Meter to the desired carrier frequency.

6) Switch the function selector to IF CHECK.

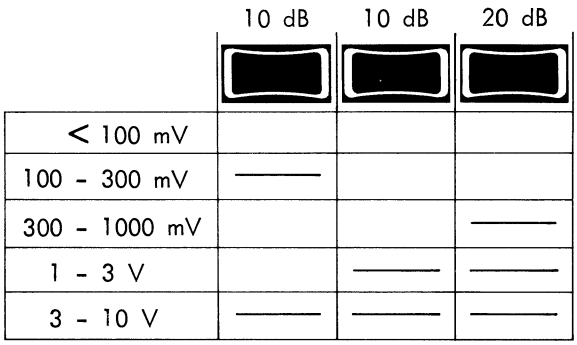
7) Switch the Crystal Oscillator Unit to the desired channel by means of the four-position selector.

8) Insert a screwdriver in the hole corresponding to the selected channel, and adjust the corresponding trimmer until the meter indicates IF CHECK.

9) If necessary, repeat steps 6 to 9 until all four channels are trimmed.

10) The Crystal Oscillator Unit, code 900-252, is now ready for use.

Proceed as described above for AM or FM measurements, but keep in mind that certain specifications of the Modulation Meter proper cannot apply, and refer to SECTION C under "Change in Specifications of AFM2 Caused by the Crystal Oscillator Unit", and see Fig. E6.



ATTENUATION	FREQUENCY RANGE	
	250 - 600 MHz	600 - 1000 MHz
0 dB	20 - 100 mV	30 - 100 mV
10 dB	100 - 300 mV	100 - 300 mV
20 dB	300 - 1000 mV	300 - 1000 mV
30 dB	1 - 3 V	1 - 3 V
40 dB	3 - 10 V	3 - 10 V

Fig. E6. Attenuation and sensitivity ranges when the Crystal Oscillator Unit, code 900-252, is in use.

USING AN EXTERNAL-OSCILLATOR AMPLIFIER, CODE 900-253

1) Remove the two screws and the plate covering the receptacle in which the External-Oscillator Amplifier is to be placed (see Fig. E5).

2) Position the External-Oscillator Amplifier in the Modulation Meter, and fasten the two screws.

3) Switch the RANGE selector to G - "CRYSTAL OSCILLATOR".

4) Feed the signal to be measured to the RF INPUT connector.

5) Feed the signal from the external oscillator to the INPUT connector.

6) Proceed as described above for AM or FM measurements.