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MEASURING EQUIPMENT TYPES BFM310 AND BFM320
FOR 4-MC COAXIAL CABLE TELEPHONE SYSTEMS

"Group Reference Pilot Checker" and
"Supergroup Reference Pilot Checker"

INTRODUCTION

Measuring Equipment type BFM310 and BFM320 is made to the specifications of Telefonaktiebolaget L M Ericsson, Stockholm, Sweden, for the supervision and maintenance of the group and supergroup translating bays of terminal stations in coaxial cable carrier telephone systems.

The Equipment is designed for level measurement on the group reference pilot at 84.080 kc/s and on the group reference pilots after group translation. Furthermore level measurements can be made on the supergroup reference pilot at 411.920 kc/s and on the supergroup reference pilots after supergroup frequency translation.

The measurements can be made without disturbing the traffic.

This manual contains information on the Measuring Instrument type BFM310 and the Power Supply Unit, type BFM030.

SECTION I

GENERAL DESCRIPTION

1.1 OPERATING PRINCIPLE

The Selective Measuring Instrument type BFM310 embodies a selective amplifier for 84.080 kc/s. A functional block diagram is shown in diagram No. 1225-A4. The instrument is connected to the measuring point by means of a shielded, balanced test lead which is connected to an input transformer in the instrument. The input transformer is loaded with a variable attenuator for sensitivity adjustment corresponding to the sending or receiving level. From the attenuator the signal is passed on to an amplifier with negative feedback and from there to a crystal filter. The crystal filter terminates in a variable attenuator by means of which the level can be changed by ± 1 Neper or ± 10 dB. After amplification in another negative feedback amplifier the output current is measured by means of a rectifier and an indicating meter. The meter deflection is proportional to the mean value of the current.

The Power Supply, type BFM030 supplies voltages for the operation of the instrument type BFM310 and is driven from an a-c source. The unit is shaped like a drawer which can be inserted in an opening in the front panel of the Selective Measuring Instrument, type BFM310.

SECTION II

DESCRIPTION OF SELECTIVE MEASURING INSTRUMENT

Type BFM310

This section comprises a description of the electrical function of the circuits in the measuring instrument type BFM310. The drawing No. 804-A2 appended to the operating instructions shows the complete circuit diagram of type BFM310 Measuring Instrument.

2.1 INPUT CIRCUIT

The measuring instrument is connected to the test point by means of a balanced twin plug. The test lead is connected to the input transformer T1/310. The input circuit is so designed that the input impedance measured directly across the end of the test lead is numerically greater than 6 kilohms in the frequency range 60-108 kc/s. As the capacitance of the test lead influences the input impedance, only the original test lead should be used. The input impedance as a function of the frequency is shown in drawing No. 1364-A4. The secondary winding of the input transformer is loaded with a variable attenuator which serves to adapt the sensitivity of the measuring instrument to the sending and receiving levels.

2.2 FIRST AMPLIFIER

From the attenuator the signals are passed on to a two-stage negative feedback amplifier consisting of the tubes No. 1 and 2. The plate circuit for tube No. 1 is tuned to 84.08 kc/s. Owing to the strong negative feedback (about 30 dB) the amplifier displays a great stability. From the transformer T2/310 in the plate of tube No. 2 the signals are passed on to the crystal filter ZGK10173.

2.3 CRYSTAL FILTER ZGK10173

The crystal filter which is supplied by Telefonaktiebolaget L M Ericsson ensures the required selectivity for the measurement of the group reference pilot 84.080 kc/s. In the circuit diagram No. 804-A2 the crystal filter has only been shown schematically. Further details on the design

and construction of the crystal filter are given in the diagrams No. 704280 and T1523-ZGK10173 appended to the instructions.

2.4 ATTENUATOR

The crystal filter is terminated in a 150 ohm attenuator, METER SENSITIVITY by means of which it is possible to change the deflection of the indicating meter by ± 1 Neper or ± 10 dB.

2.5 SECOND AMPLIFIER

From the attenuator the signals are passed on to a three-stage negative feedback amplifier consisting of the tubes No. 3, 4 and 5. The plate circuit for tube No. 3 is tuned to 84.08 kc/s. By means of the variable resistor AMPL. CAL. in the cathode of tube No. 5 the amount of feedback and consequently the sensitivity of the entire measuring instrument can be controlled. Owing to the strong negative feedback (approx. 34 dB) the amplifier is stable. From the plate in tube No. 5 the output current is fed to a rectifier and a meter whose deflection is proportional to the mean value of the current.

SECTION III

DESCRIPTION OF POWER-SUPPLY UNIT TYPE BFM030

This section contains a detailed description of the electrical function of the power-supply type BFM030. The circuit is shown in diagram No. 1218-A4 appended to the operating instructions.

3.1 GENERAL

By means of two voltage selector plugs the primary winding of the line transformer can be switched from 110 volts to 220 volts and the filament winding from 6.3 volts to 18 volts.

The pilot lamp is always operated from the 6.3 volt output of the line transformer and is therefore not to be replaced when changing the line voltage. The voltage selector plugs are engraved to indicate the selected voltage through windows in the front panel.

Fuses for primary current and plate current are accessible from the front panel.

The power-supply unit is designed for supplying both the selective measuring instruments type BFM310 and BFM320.

3.2 SUPPLYING POWER TO THE BFM310

Filament current and plate current are supplied via the contacts No. 5-8 and 2-1 in the multicontact-connector of the power supply unit. A 0.5 ohm resistor is inserted in the filament current circuit, and a 2500 ohm resistor is inserted in the plate current circuit. These resistors have the effect that when loaded with the BFM310 alone, the operating voltages adopt the nominal values.

Furthermore the power supply unit comprises decoupling filters in the filament and plate current circuits and in the latter furthermore a band-stop filter for ripple. These components are mounted outside the power supply unit on the chassis of the measuring instrument type BFM310. See diagram No. 804-A2.

3.3 SUPPLYING POWER TO THE BFM310 AND BFM320

The power supply unit type BFM310 is designed for supplying the filament current and anode current required for the operation of both measuring instrument type BFM310 and type BFM320.

The currents for BFM320 are drawn across a power connector mounted on the front panel of the BFM310. When the connecting cable between BFM310 and BFM320 is connected to the power connector, the two resistors of 0.5 and 2500 Ω mentioned in section 3.2 get short-circuited by two internal connections in the cable plug between contact No. 3 and 5 and between No. 2 and 6. See diagram No. 804-A2 and 1218-A4. By this means the operating voltages will adopt the nominal values when the power supply unit is loaded with BFM310 and BFM320.

SECTION IV

OPERATING PROCEDURE

4.1 CONNECTION

Before connecting the equipment to the power line, make sure that the line voltage and frequency are within the specified limits, and that the line voltage corresponds to the setting of the voltage selector plug in the Power Supply Unit.

The equipment is switched on with the power switch of the Power Supply Unit and should be allowed to warm up for a few minutes.

4.2 CONTROLS AND TERMINALS

All controls are located on the front panel of the instrument.

(A) SELECTIVE MEASURING INSTRUMENT TYPE BFM310

(a) Sensitivity controls:

The sensitivity of the instrument is selected by means of the SENSITIVITY switch.

The over-all amplification of the instrument can be adjusted by means of the AMPL. CAL. control.

By means of the METER SENSITIVITY switch the level can be changed by ± 1 Neper or ± 10 dB.

(b) Terminals:

The twin jack INPUT provides for connecting the test lead to the instrument.

A multicontact connector provides for connection of the measuring instrument type BFM320 to the Power Supply Unit.

(B) POWER SUPPLY UNIT TYPE BFM030

(a) Voltage selector plugs:

The voltage selector plug which is visible in the left-hand window of the front panel is used to switch the primary of the transformer from 110 volts a-c to 220 volts a-c. At the same time the plug indicates the voltage setting.

The voltage selector plug which is visible in the right-hand window of the front plate is used to switch the filament voltage from 6.3 volts a-c to 18 volts a-c according to the filament voltage of the tubes used. The plug indicates the voltage setting.

4.3 STEP-BY-STEP OPERATION

- (1) Prepare the Measuring Instrument by removing the cover of the case and connecting the test lead.
- (2) Connect the Power Supply Unit to an a-c power line and switch on. Allow for a warm-up period of at least 5 minutes.
- (3) Set the SENSITIVITY switch to the lowest position.
- (4) Connect the test lead to the test point.
- (5) Set the SENSITIVITY switch to secure a suitable deflection on the level meter.
- (6) If the needle goes off the scale, use the METER SENSITIVITY switch to bring it within the range.
- (7) Read the level meter and add the reading to the setting value of the SENSITIVITY switch and the METER SENSITIVITY switch.

SECTION V

MAINTENANCE

5.1 GENERAL

The Selective Measuring Instrument type BFM310 is a very delicate instrument, so unnecessary repair or attempts to improve the accuracy should not be made.

Such repairs as may become necessary should be made only by skilled personnel, provided with sufficient equipment to ensure that the repair is properly made.

When transporting, handling and operating the instrument with care, its useful life will be prolonged, and trouble will be reduced to a minimum.

The instruments should be protected from dust and moisture. It is advisable to keep the cover on the instrument case when the instrument is not in use, and from time to time to inspect the exterior of the instrument for dust, dirt and corrosion.

5.2 REMOVING THE INSTRUMENT FROM THE CASE

The Selective Measuring Instrument can be removed from the case when the four fixing screws along the edge of the front panel have been removed.

5.3 REMOVING THE POWER SUPPLY UNIT

The Power Supply Unit can be removed from the opening in the front panel of the Selective Measuring Instrument when the four **dome nuts** at the corners of the front panel of the unit have been removed.

5.4 TUBE REPLACEMENT

In general the tubes of the Selective Measuring Instrument require no replacement until they cause some kind of trouble.

All the tubes can be readily replaced when the instrument is removed from the case.

Tubes with average characteristics can be used for any replacement.

5.5 ALIGNMENT OF TUNED CIRCUITS

The resonant circuits C4 and C10 (see diagram No. 804-A2) are both tuned to 84.08 kc/s. The tuning of C4 and C10 should be carried out separately. The negative feedback must be neutralized by disconnecting the feedback resistors C4 or D12, respectively.

The total amplifications will increase by approx. 30 dB and 36 dB when the above mentioned resistors are disconnected.

A signal generator is connected to the input terminals of the instrument and tuned to maximum deflection on the level meter. On account of the crystal filter the frequency of the signal generator will be 84.08 kc/s. The deflection is set to a suitable value by means of the sensitivity switch and the attenuator of the signal generator.

The trimming screw of the coil is then turned until the level meter reads maximum.

5.6 CALIBRATION

The sensitivity can be adjusted by means of the AMPL. CAL. control. A signal generator is connected to the input terminals and tuned to 84.080 kc/s ± 2 c/s. The output level must within 0.5 per cent apply to the nominal level for zero deflection. The AMPL. CAL. control is then turned until the level meter reads zero.

5.7 SERVICING THE POWER SUPPLY UNIT

Provided that the instrument is not exposed to damage or is overloaded the life expectancy of the components of the Power Supply Unit approaches infinity. Therefore no special care and maintenance is required.

All fuses are mounted on the front panel of the Power Supply Unit and can readily be replaced. The fuse holders indicate the fuse value.

If a fuse blows, replace it. If the new fuse blows immediately, some defect has occurred in the Power Supply Unit or in the Selective Measuring Instrument. The defect must be traced and remedied before a new fuse is inserted. Never replace a fuse with a larger one.

5.8 OPERATING VOLTAGES AND CURRENTS

The voltages and currents listed below can be used as references when servicing the instrument. These values are mean values from a series of measurements, and deviations up to 20% may usually be neglected. The voltmeter should have a negligible consumption (vacuum-tube voltmeter).

B F M 3 1 0

VOLTAGE MEASUREMENTS

(all voltages measured to chassis)

		volts
tube No. 1	pin No. 2	3.0
	5	110
	6	110
tube No. 2	pin No. 2	2.0
	5	95
	6	95
tube No. 3	pin No. 2	2.0
	5	80
	6	80
tube No. 4	pin No. 2	1.2
	5	55
	6	55
tube No. 5	pin No. 2	1.5
	5	65
	6	65

SECTION VI

SPECIFICATIONS

6.1 COMPONENT PARTS

The Equipment consists of the following instruments:

- A) Selective Measuring Instrument, Type BFM310.
"Group Reference Pilot Checker".
- B) Power Supply Unit, Type BFM030.

6.2 SELECTIVE MEASURING INSTRUMENT, TYPE BFM310

a) Measuring frequency:

Group reference pilot 84.080 kc/s

b) Sensitivity:

-73 dB (-8.4 N) for deflection to zero mark. By means of the SENSITIVITY switch the sensitivity can be reduced to -55.6 dB (-6.4 N) and to -35.6 dB (-4.1 N) for deflection to zero mark.

By means of the METER SENSITIVITY the sensitivity can be changed by ± 10 dB or ± 1 N.

The indicating meter is calibrated from -1.0 N to +0.5 N or from -10 dB to +5 dB.

c) Input impedance:

$|Z| > 6 \text{ k}\Omega$ in the frequency range 60-108 kc/s

d) Selectivity:

The filter curve is flat within ± 0.1 dB (± 0.01 N) in the range 84.080 kc/s ± 5 c/s.

At 84.000 kc/s the attenuation relative to 84.080 kc/s is 17 dB (2 N)

At 84.140 kc/s the attenuation relative to 84.080 kc/s is 16 dB (1.8 N)

For all frequencies in the range 60-108 kc/s the relative attenuation outside the range 84.080 kc/s ± 250 c/s is greater than 46 dB (5.3 N).

e) Estimated distribution of measuring error:

1) Error due to variations in temperature:

± 0.05 dB (± 0.005 N) for the temperature interval 15°C to 35°C .

2) Error due to variations in supply voltage:

± 0.05 dB (± 0.005 N) for voltage variations of $\pm 10\%$.

3) Error due to crystal filter, indicating meter, attenuator, etc..

± 0.15 dB (± 0.015 N)

f) Total error:

± 0.2 dB (± 0.02 N)

g) Tubes:

5 type EF95, 6 AK5, 403B or 18AK5.
Minimum mutual conductance = 4.3 mA/V

h) Power supply:

The following voltages and currents are required for the operation of the instrument: 6.3 V/0.9 A or 18 V/0.3 A and 130 V d-c, 25 mA.

The measuring instrument is generally supplied from the Power Supply Unit type BFM030.

i) Construction:

The instrument is built into a heavy grey enamelled steel case with a detachable cover in which cables etc. are stored when not in use. The case is provided with two strong carrying handles and rubber feet on four sides, and with metal knobs on the fifth side (the top) on which the BFM320 Measuring Instrument can be mounted.

j) Over-all dimensions:

260 x 528 x 300 mm ($10 \frac{1}{4}$ x $1' 8 \frac{7}{8}$ x $11 \frac{7}{8}$)

k) Weight:

Max. 21 kilos (46 lbs.) inclusive of accessories.

l) Standard accessories:

- 1 Power Supply Unit, type BFM030 with connecting cable
- 1 Test lead provided with a switchboard plug
- 1 Test lead provided with a balanced twin plug
- 1 Manual for type BFM310 and BFM030

6.3 POWER SUPPLY UNIT, TYPE BFM030

This unit is intended for the supply of Selective Measuring Instrument type BFM310 and BFM320 from the a-c power line. It can be mounted in the compartment in the measuring instrument type BFM310.

a) Power supply:

220 V or 110 V, 50 or 60 c/s a-c.

b) Consumption:

When loaded with Selective Measuring Instrument type BFM310, the line current drawing is 150 mA when connected to 110 V a-c and 300 mA when connected to 110 V a-c.

When loaded with Selective Measuring Instruments type BFM310 and BFM320, the line current drawn is 250 mA when connected to 220 V a-c and 500 mA when connected to 110 V a-c.

c) Voltage supplied: :

130 V d-c for anode supply.

6.3 V a-c or 18 V a-c for filament supply.

The pilot lamp is always supplied from 6.3 V a-c

d) Construction:

The Power Supply Unit is mounted on a grey enamelled front panel of steel and is intended for mounting in the Selective Measuring Instrument type BFM310.

e) Over-all dimensions:

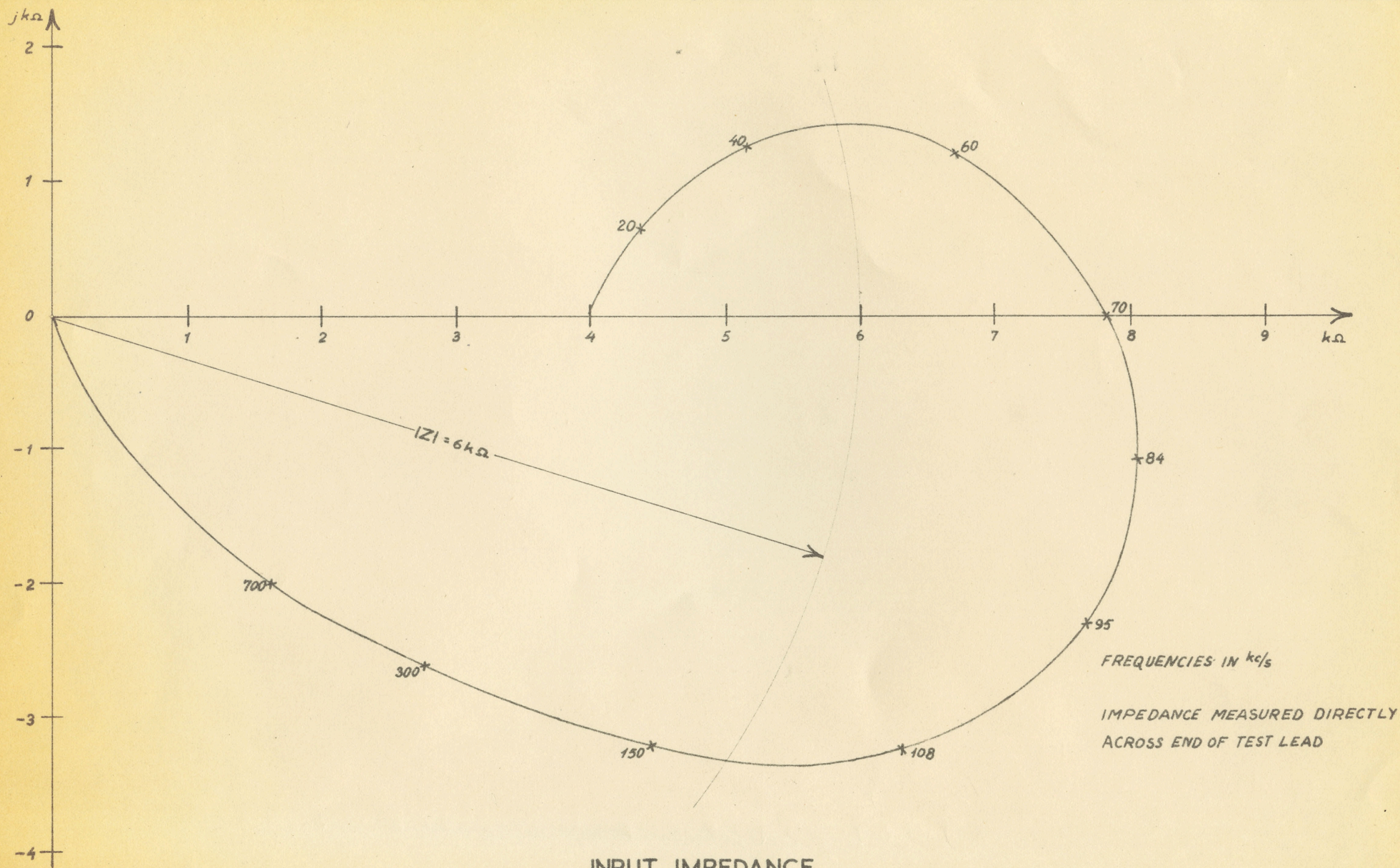
175 x 155 x 180 mm ($7'' \times 6 \frac{1}{8}'' \times 7 \frac{1}{8}''$)

f) Weight:

3.5 kilos (8 lbs) inclusive of connecting cable.

g) Accessory:

One 1.5 m (5') long connecting cable.



INPUT
TRANSFORMER

ATTENUATOR
 $2N + 2.3N$
 $17.4 \text{ dB} + 20 \text{ dB}$

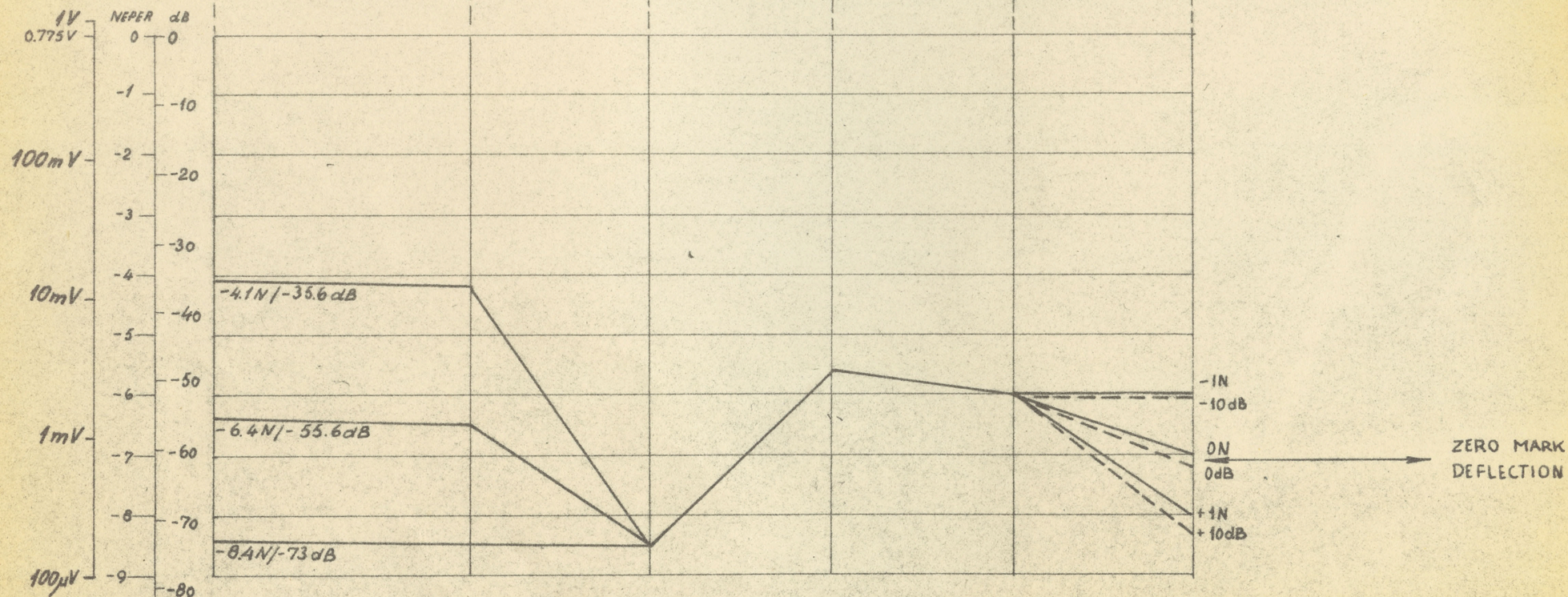
AMPLIFIER

CRYSTAL FILTER
 84.08 kc/s

ATTENUATOR
 $\pm 1N / \pm 10 \text{ dB}$

AMPLIFIER

INSTRUMENT



FUNCTIONAL DIAGRAM
FOR MEASUREMENT OF 84.08 kc/s PILOT.
SELECTIVE MEASURING INSTRUMENT
TYPE BFM 310.

RADIOMETER.

1225-A4.

rt. 1.

