

INSTRUCTION MANUAL

Type MS24

FM-AM STANDARD-SIGNAL GENERATOR



RADIOMETER

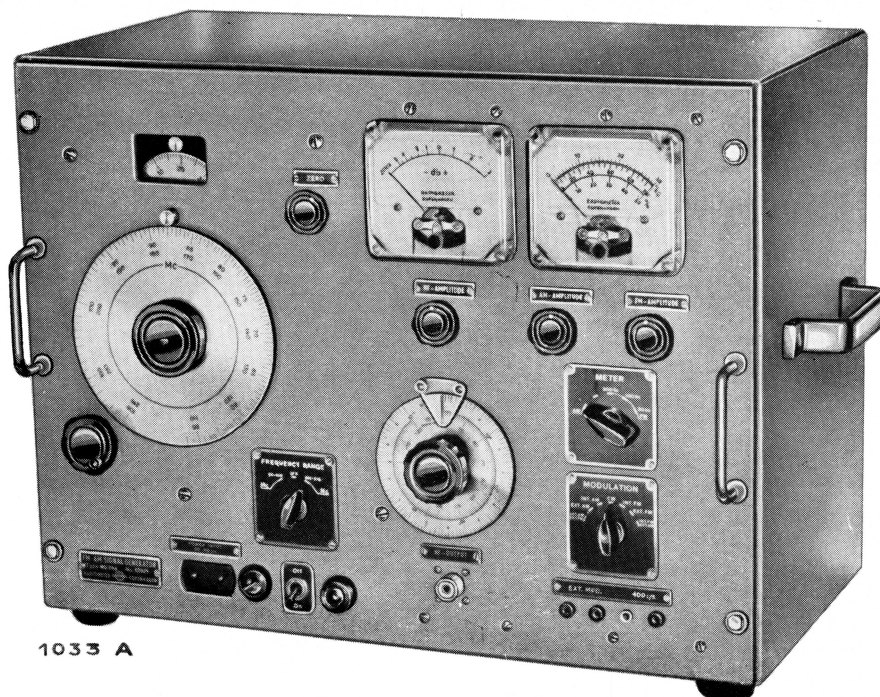
ELECTRONIC MEASURING INSTRUMENTS
FOR SCIENTIFIC AND INDUSTRIAL USE

INSTRUCTION AND OPERATING MANUAL
FOR

Type MS24

FM-AM STANDARD-SIGNAL GENERATOR

These instructions apply
to model MS24 only



FM-AM Standard-Signal Generator type MS 24

54-216 Mc

Introduction

The type MS24 Signal Generator is designed as a laboratory standard which meets all the requirements for evaluating and testing receiving equipment for FM broadcasting, television, mobile service, and other systems operating within the frequency range 54—216 Mc/s.

Description

The RF unit of the Signal Generator incorporates a reactance-tube modulated oscillator which covers the frequency range 27—54 Mc/s. The oscillator is followed by a doubler stage from which the second harmonic of the oscillator frequency is drawn and fed to an output stage.

This stage is operated either as an amplifier or as a second doubler. The tuning condensers of all three stages are ganged. By this means the output frequency can be varied from 54 to 216 Mc/s in two bands.

The doubler stage following the oscillator serves several purposes. It isolates the oscillator from the output stage to improve the frequency stabil-

ity, and makes possible the use of a conveniently low oscillator frequency. Furthermore it ensures sufficient voltage to saturate the output stage and thus remove any undesired amplitude modulation up to this point.

Amplitude modulation is produced by applying the modulation voltage to the screen grid of the output tube.

All RF parts of the Signal Generator are enclosed in a shield, and to prevent leakage all supply leads are furnished with RF filters inside the shield.

At the coaxial connector on the front panel output voltages between $0.1 \mu\text{V}$ and 0.1 V are available at an internal impedance of 75 ohms. This output is obtained through a wave-guide-below-cut-off type attenuator.

The attenuator is magnetically coupled to the tank coil of the output stage. A monitoring loop placed across the attenuator mouth samples the magnetic field at that point, and the induced voltage actuates the output monitoring system and consequently the output meter on the front panel. At the input end of the attenuator is also mounted a mode suppressor to reject undesired modes in the attenuator tube.

A pickup loop is mounted on a plunger which is moved inside the attenuator tube by means of a rack-and-pinion drive.

The output cable is terminated by the pickup coil in series with a 75 ohm miniature carbon resistor. By proper designing it has been possible to obtain a very smooth termination of the output cable over the entire operation frequency range. In principle the output monitoring system is a Wheatstone bridge in which a bead thermistor is used as one of the arms. The bridge is balanced for d-c conditions, and when RF voltage from the monitoring loop is applied to the bead thermistor, the bridge becomes unbalanced. The amount of unbalance, which is a measure of output level, is indicated by a d-c microammeter connected across the bridge. The tendency to drift according to variations in ambient temperature is compensated for by means of a second thermistor of the disk type.

The Signal Generator incorporates a 400 c/s sine wave oscillator for modulation purposes.

This oscillator operates on the conventional Wien bridge RC oscillator principle and is practically free from distortion. Generally it has a total harmonic content of less than 0.3%.

The modulation oscillator may be used for either FM or AM, or it may be switched off.

Terminals provide for using an external AF source. A modulation switch provides for switching between internal and external source as well as between AM or FM in different combinations including simultaneous FM and AM.

FM deviation and AM percentage are read on the modulation meter on the front panel.

The power supply incorporated in the Signal Generator supplies an electronically regulated voltage for the RF unit and the thermistor bridge. The Signal Generator operates from a 50-60 cycle power line.

SPECIFICATIONS

Carrier frequency range:

54—216 Mc/s covered in two ranges:

54—108 Mc/s

108—216 Mc/s

Frequency calibration:

Dial calibrated directly in Mc/s. The frequency is correct within 0.5% of the dial reading.

Vernier frequency dial:

Divided from 0 to 100 and coupled to main frequency dial at a gear ratio of 1:20

Output voltage:

0.1 μ V to 0.1 volt open circuit voltage at nominal internal impedance of 75 ohms.

Attenuator dial:

Calibrated in μ V and dB above 1 μ V.

Output level meter:

Calibrated in dB above reference level from —6 to +3 dB.

Accuracy of output voltage:

10% \pm 0.1 μ V when zero is correctly set.

Stray radiation:

Cannot be detected on high-sensitivity commercial FM-receivers.

Frequency modulation:

0—300 kc deviation.

Amplitude modulation:

0—50%.

Modulation possibilities:

Internal FM and external AM simultaneously
External FM
Internal FM
C. W.
Internal AM
External AM
Internal AM and external FM simultaneously

Internal modulation source:

400 c/s within 4%. Distortion less than 0.3%.

External modulation source:

Approximately 0.15 V/kc or 1 V/% (50 volts max.)
Input impedance of external modulation terminals about 8 kilohms.

Modulation meter:

Calibrated in three FM ranges:

0 — \pm 30 kc

0 — \pm 100 kc

0 — \pm 300 kc

and an AM range:

0—50%

FM distortion:

With internal modulation, less than 3% at 100 kc deviation; less than 10% at 280 kc deviation.

AM distortion:

With internal modulation, less than 5% at 50% modulation.

Accuracy of modulation meter indications:

Frequency deviation within 5% of meter reading on entire carrier frequency range up to 200 kc deviation. Variation with modulating frequency 2% from 20 c/s to 20 kc/s.

AM indication within 10% AM.

Fidelity characteristics:

FM modulation system flat from 0 c/s. Less than 1 dB down at 25 kc/s.

AM modulation system flat from 30 c/s to 9 kc/s. Less than 1 dB down at limits.

Power supply:

110—127—150—200—220—240 volts, 50—60 c/s.

Tubes:

1 — EC81 (6R4) 1 — PL83 (15A6)

5 — EF80 (6BX6) 1 — 85A2 (5651)

1 — PL81 (21A6) 1 — GZ34 (5V4)

Accessories supplied:

Power cord, type C12H13, 1.5 m long.

Output cable, type C3A3, 1 m long and provided with a UHF connector No. PL259 at both ends. 75 ohm characteristic impedance.

Extra accessories available:

UHF connector No. PL259

Converter type MSK1 providing an extension of the frequency range down to 0.1 Mc/s.

Transformers for balanced output:

UBT1 for 300 ohms

Over-all dimensions:

Height: 380 mm

Width: 565 mm

Depth: 290 mm

Net weight:

26.5 kilos

Data subject to change without notice.



I N D E X

page

Introduction	1
--------------------	---

Section I - GENERAL DESCRIPTION

(1) Operating principle	1
(2) RF unit	2
(3) Output system	3
(4) Modulation oscillator	5
(5) Modulation system	5
(6) Power supply	7

Section II - OPERATING INSTRUCTIONS

(1) Connection	8
(2) Operating controls, dials, and terminals	8
(a) Frequency controls	8
(b) Output controls	8
(c) Modulation controls	9
(d) Terminals	9
(3) Step-by-step operation	10

Section III - MAINTENANCE

(1) General	11
(2) Removing the instrument from the cabinet	11
(3) Tube replacement	11
(4) Amplitude modulation adjustment	14
(5) Frequency modulation adjustment	14
(6) Operating voltages and currents of the signal generator	15
(7) Fuses	17

Section IV - SPECIFICATIONS

18

APPENDIX: Simplified diagram and
Complete diagram

Type MS24 STANDARD SIGNAL GENERATOR

Introduction:

The type MS24 Signal Generator is designed as a laboratory standard providing radio frequency signals of accurately known frequency and amplitude.

The generator meets all the requirements in evaluating and testing receiving equipments for FM broadcasting, television, mobile service, and other systems operating within the frequency range from 54 to 216 Mc/s.

Section I

GENERAL DESCRIPTION

(1) Operating principle

The basic operating principle of the Signal Generator is indicated in the block diagram of fig. 1. The reactance-modulated oscillator operates in the frequency range from 27 to 54 Mc/s.

This oscillator is followed by a doubler stage from which the second harmonics of the oscillator frequency is drawn and fed to the output stage, which is operated either as an amplifier or as a second doubler. The tuning condensers of all three stages are ganged. By this means the output frequency can be varied from 54 to 216 Mc/s.

The output system consists of a waveguide attenuator which is coupled to the output stage. A monitoring device is placed at the input side of the attenuator.

Amplitude modulation is produced in the output stage. The undesired frequency modulation of the oscillator produced during amplitude modulation is negligible because of the buffer action of the doubler stage.

A 400 c/s modulation oscillator provides for either amplitude or frequency modulation. External terminals permit the use of

an external AF source. By means of a switching arrangement both the internal and the external AF source may be used for either FM, AM, or FM and AM simultaneously.

(2) RF unit

The oscillator tube (type EC81, tube No. 2) is operated as a tuned plate RF oscillator covering the frequency range from 27 to 54 Mc/s. The tuning is accomplished by means of the capacitor C_2 (location B4 of the complete circuit diagram).

A type EF80 tube which operates across the tank circuit of the oscillator tube as an inductive element provides for frequency modulation.

In the phase shift network connecting the tank circuit with the grid of the reactance tube, one of the elements, the C_1 condenser, is made variable in order to provide for constant frequency deviation sensitivity over the entire tuning range. The condenser C_1 , which is ganged with the oscillator tuning capacitor, is furnished with a slotted rotor. By bending the sections of this rotor the deviation can be made as constant as desired over the entire frequency range.

The resistor 0.2 M Ω (location D2) controls the cathode bias of the reactance tube by bleeding current through the cathode resistor, and thus it serves to adjust the operating point of the tube to the most suitable portion of its characteristics. The cathode resistors 500 Ω (location C1) and 100 Ω (location C2) in series are bypassed by 2.2 nF (location C2). This bypassing applies to RF only, and degeneration takes place at audio frequencies. By adjusting resistor 500 Ω (location C1) the amount of degeneration is changed so as to provide the deviation sensitivity required.

The frequency doubling stage (tube No. 3, type EF80) serves several purposes. It provides an isolation between oscillator and output stage to improve the frequency stability, and permits the oscillator to be operated at a lower frequency. Furthermore it provides sufficient voltage to saturate the output stage and thus remove any undesired amplitude modulation up to this point.

The doubler tube is operated as a class-C amplifier, and the tuning capacitor C_3 (location B6) in the anode circuit is ganged with the oscillator tuning capacitor to make the resonance frequency track with the oscillator frequency.

The design of the output stage (tube No. 4, type EF80) is similar to that of the doubler stage. In the low frequency range this stage functions as an amplifier. In the high range the inductance of the tank coil is changed in order to double the resonant frequency of the tank circuit. By this means the stage becomes a frequency doubler. The coil inductance is changed by means of two spring contact fingers, one of which is pressed against contact points on the coil L_6 (location B9) by rotating a sort of cam shaft which is coupled to the FREQUENCY RANGE switch.

Amplitude modulation is obtained by applying the modulation voltage to the screen grid of the output tube.

All RF parts of the signal generator are enclosed in a shield thus forming an RF assembly.

To prevent leakage all supply leads are carefully filtered for RF before they are brought out through the shield.

(3) Output system

Output between 0.1 μ V and 0.1 V, at an internal output impedance of 75 ohms, is available at a coaxial connector on the front panel. This output is obtained through a mutual inductance or waveguide-below-cut-off type attenuator.

The attenuator is magnetically coupled to the tank coil of the output stage. A monitoring loop, placed directly across the attenuator mouth, samples the magnetic field at that point and the induced voltage actuates the output measuring system and consequently the outputmeter on the panel. At the input end of the attenuator is also a mode suppressor to reject unwanted modes so that only the $TE_{1,1}$ mode is attenuated down the wave guide.

The pickup loop is mounted on the plunger which is moved backwards and forwards in the attenuator tube by means of a rack

and pinion device. The plunger incorporates a well in which a 75 ohm resistor is mounted. The series connection of resistor and pickup coil terminates the output cable. The pickup loop is so designed that the self-inductance in connection with the stray capacitances between coil ends and ground form a symmetrical four-pole network with an image impedance of 75 ohms.

The result of this design is a very smooth termination of the output cable over the entire operation frequency range.

The output measuring system incorporates a bead thermistor E2301/20 (location C9) which forms part of a bridge circuit. The bridge is balanced for d-c conditions, and when RF voltage from the monitoring loop is applied to the bead thermistor, the bridge becomes unbalanced. The amount of unbalance (which is a measure of output level) is indicated by a d-c microammeter connected across the bridge. The thermistor is connected to the monitoring loop by means of a coaxial cable with a characteristic impedance equal to the operating resistance of the thermistor. In this way the cable is correctly terminated by the thermistor.

In principle the thermistor bridge is a Wheatstone type in which the bead thermistor is used as one of the arms. A second thermistor KB1391 (location D3) is shunted across the entire bridge as a balance-regulating device. As the bead thermistor is sensitive to temperature, the bridge tends to drift appreciably from its zero setting according as the temperature inside the instrument increases or decreases. However, the thermistor shunted across the bridge compensates for this tendency by changing its d-c resistance so that the d-c voltage across the bridge is changed in such a manner that the bridge remains in balance when the temperature changes.

The compensating thermistor, which is of the disk type, is mounted in a good thermal contact with the bead thermistor mount. By changing the voltage across the bridge the current flowing through the bead thermistor is changed. Owing to a selective design the d-c voltage across the bridge can be varied so as to keep the resistance of the

bead thermistor almost constant over the range of ambient temperatures to be considered. Therefore the bridge can be zero set, and it will remain practically in balance after the warm-up period.

(4) Modulation oscillator

The sine-wave oscillator incorporated in the type MS24 Signal Generator operates on the conventional Wien bridge RC oscillator principle.

Regeneration between the tubes No. 5 and 6 is controlled by the frequency selective network comprising 100 pF (location E14), 4 MΩ (location E15), 400 pF (location F14), and 1 MΩ (location F15). At 400 c/s this regenerative network has a peak response which causes the circuit to oscillate at that frequency. Another network comprising 1 μF (location E13) and 6.3 kΩ (location E14) applies a degenerative voltage across the ballast lamp type 220 S06 (location F13). The rapid increase in resistance of this lamp with respect to increases in feedback voltage tends to limit the oscillation to the linear portion of the tube characteristic. The oscillator is practically free from distortion. In general it has a total harmonic content of less than 0.3%. Approximately 70 volts are obtained from the plate of the type PL83 tube (No. 6) for modulation purposes.

(5) Modulation system

The internal 400 c/s modulation oscillator may be used for either frequency or amplitude modulation, or it may be switched off. The terminals EXT. MOD. permit the use of an external AF source. The MODULATION switch (type MEC 568-2) provides for switching between internal and external source as well as between AM and FM in different combinations including simultaneous FM and AM. The modulation possibilities are as follows:

- INT. FM and EXT. AM simultaneously
- EXT. FM
- INT. FM
- C.W.
- INT. AM
- EXT. AM
- INT. AM and EXT. FM simultaneously

The FM-AMPLITUDE potentiometer 20 k Ω (location F7) controls the FM deviation, and the AM-AMPLITUDE potentiometer 20 k Ω (location G8) controls the AM percentage.

The meter is calibrated in three FM ranges:

- 1) 0 - \pm 30 kc
- 2) 0 - \pm 100 kc
- 3) 0 - \pm 300 kc

and is also provided with an AM scale 0-50%.

AM is obtained by modulating the screen grid voltage of the RF output tube. The modulation voltage is fed to the top of the screen grid potentiometer 20 k Ω (location G7). This point is insulated from the d-c supply by means of a 50 henry choke (location F8). With the METER switch in AM position the modulation meter indicates the modulation voltage. Adjustment of the resistor 100 k Ω (location G6) will change the AM sensitivity of the modulation meter to agree with the true modulation percentage.

At FM the audio modulating voltage is applied to the grid of the reactance tube No. 1. On the high RF range the modulating voltage is reduced to one half in order to maintain the same frequency deviation. This is accomplished by means of the resistors 1 k Ω (location F1) and 1 k Ω (location G1).

The measuring circuit for indicating FM deviation is so arranged that the modulating voltage applied to the grid of the reactance tube is practically unaffected by switching the meter off and on, and by switching from one deviation range to another.

The FM deviation indicated on the modulation meter is controlled by the setting of the resistor 10 k Ω (location F5).

(6) Power supply

The instrument operates from a 50-60 cycle power line. The voltage selector can be set to the following voltages: 110, 127, 150, 200, 220, or 240 volts, a-c.

The full-wave rectifier circuit associated with tube No. 10 (type GZ32) supplies a d-c voltage of approximately 280 volts for the internal modulation oscillator. From this rectifier is also furnished an electronically regulated supply of 160 volts for the RF unit and the thermistor bridge.

The regulating circuit includes the tubes No. 7 (PL81), No. 8 (EF80), and No. 9 (85-A2).

The power supply also provides filament power for all the tubes.

Section II
OPERATING INSTRUCTIONS

(1) Connection

Before connecting to the power line make sure that the line voltage selector is set to the correct voltage. The voltage selector is accessible when the cover plate at the back of the cabinet is removed. Before the instrument leaves the factory the voltage selector is always set to 220 volts.

The instrument is switched on with the power switch ON-OFF and is allowed to warm up for a few minutes.

(2) Operating controls, dials, and terminals

All the controls required for the operation of the instrument are located on the front panel.

(a) Frequency controls

The main tuning dial is calibrated directly in megacycles. As the high frequency range is obtained by frequency doubling of the range 54-108 Mc/s only a single scale is used, which is provided with two sets of figures, one for each range.

The setting of the main tuning dial is adjusted by means of a friction drive knob which is provided with a small handle for fast rotation.

Small increments in carrier frequency can be obtained by means of a 0-100 vernier dial which is coupled to the main dial at a gear ratio of 1:20.

The FREQUENCY RANGE switch which selects the carrier frequency range is provided with an OFF position. In this position no RF output is present.

(b) Output controls

The output level is set with the output attenuator dial which is directly calibrated in μV from 0.1 to 10^5 , and in db from -20 to 100 decibels above 1 μV . The attenu-

ator dial calibration is standardized by adjusting the HF-AMPLITUDE control until the RF output meter reads 0 db. Before setting the HF-AMPLITUDE control, the FREQUENCY RANGE switch should be set to position OFF and the output meter to ZERO mark by means of the ZERO control. This procedure balances the thermistor bridge for zero RF conditions.

(c) Modulation controls

The modulation selector switch named MODULATION allows the signal generator to be modulated in different ways: FM or AM from internal 400 c/s generator, FM or AM from external audio frequency generator, and simultaneous FM and AM using both internal and external modulation source.

The METER switch provides for switching the meter to indicate either FM or AM.

The potentiometers AM-AMPLITUDE and FM-AMPLITUDE provide for continuous control of AM and FM levels.

(d) Terminals

The POWER INPUT terminal provides for connecting to the power line by means of a type C12H13-1.5 power cord which is supplied with the instrument.

RF output can be drawn from the instrument at the HF-OUTPUT terminal, which fits an American type UHF connector No. PL259. A 1 m long type C3A3 output cable provided with a UHF connector in both ends and with a characteristic impedance of 75 ohms is supplied with the instrument.

The EXT. MOD. terminal provides for external modulation. The external voltage must have an amplitude between 0 and 50 volts. The input impedance is about 8 k Ω .

The output voltage of the internal modulation oscillator is available at the terminal "400 c/s" for synchronizing or other purposes.

(3) Step-by-step operation

- (1) Determine the line voltage on which the instrument is to be operated. Adjust the line voltage selector to the proper value.
- (2) Connect the instrument to the line, switch it on, and allow it to warm up for five minutes or more.
- (3) Set the FREQUENCY-RANGE switch to position OFF, and the output level meter to the ZERO mark by means of the ZERO control.
- (4) Using the FREQUENCY RANGE switch and the main frequency dial knob, select the desired output frequency.
- (5) Using the HF-AMPLITUDE control, set the output meter to 0 db.

The setting of the attenuator dial depends on the conditions of the test.

- (6) Using the MODULATION switch, select the type of modulation. If external modulation is wanted, connect the external AF generator to the EXT. MOD. terminal. Set METER switch to the range required and adjust the modulation level by means of AM-AMPLITUDE and/or FM-AMPLITUDE.

Section III
M A I N T E N A N C E

(1) General

The type MS24 Signal Generator is a delicate instrument, so unnecessary repair or attempts to improve the accuracy should not be made.

Such repairs as may become necessary should be made by skilled persons only, 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. When the instrument is not in use the power switch should be turned off.

The Signal Generator should be protected from dust, moisture, and extreme temperatures. It is advisable daily to inspect the exterior for dust, dirt, and corrosion.

(2) Removing the instrument from the cabinet

The Signal Generator can be removed from the cabinet when the four fixing screws along the edge of the front panel have been removed.

(3) Tube replacement

In general the tubes of the type MS24 Signal Generator require no replacement until they cause some kind of trouble. The troubles which are generally due to faulty tubes are: insufficient power output, faulty internal modulation, etc.

All tubes, except those inside the RF unit, can be readily replaced.

Replacement of any tube of the voltage regulator (tubes No. 7, 8, and 9) may cause a change in the magnitude of the regulated voltage. Therefore, when changing a tube of the regulator circuit it is advisable to measure the value of the regulated voltage (from the cathode of the No. 7 tube (type PL81) to the chas-

sis). This voltage should be approximately 160 volts, and it can be adjusted to proper value by means of the potentiometer 10 k Ω (location C11). The proper value is that causing the output meter to read ZERO when the ZERO control is rotated clockwise a third of its travel.

When a tube is replaced in the modulation oscillator it is desirable to measure the distortion in the output voltage. A tube which departs from the average type characteristic may cause an increase in distortion without any other evidences of trouble. In general the total harmonic content is less than 0.3%. The output voltage is approximately 70 volts.

The type 220 S06 lamp has an extremely long life and should not be replaced indiscriminately. Should the lamp fail, however, the output voltage should be checked after replacement.

It is no easy job to replace a tube in the RF assembly because readjustment of the unit requires specialized testing equipment and procedures. Therefore, replacement of these tubes should be avoided, and if the RF unit is found to be unsatisfactory in operation the instrument should be returned to the factory for repair.

If absolutely necessary, however, the tubes of the RF unit can be replaced when observing the following precautions:

Replacement of tube No. 4 in the output stage may cause a mistuning of the output tank circuit. In general it is desirable to select the tube so that the resonance frequency of the circuit remains unaffected. Proper tuning of the tank circuit will cause an RF output well above 0 db with the HF-AMPLITUDE control at maximum setting, and a few db variation in this output when the carrier frequency is varied over the entire frequency range.

If no suitable tube is available the tuning may be adjusted by means of the trimming screw associated with the capacitor C₄.

Replacement of tube No. 3 in the doubler stage can be made in a similar way. Whether or not the doubler stage tank circuit is properly tuned can be established by measuring the d-c volt-

age across the grid leak resistor of the output tube. This measurement may be made by means of a d-c vacuum-tube voltmeter with a high input resistance, such as the RADIOMETER type RV21 Vacuum-Tube Voltmeter (polymeter). To avoid heavy capacitive loading of the circuit the voltmeter must be connected to the grid through a miniature type carbon resistor of high resistance (2 megohms). The resistor must be placed so close to the grid as possible. The d-c voltage across the grid leak is normally between 10 and 15 volts and must be fairly constant over the entire tuning range.

Replacement of the oscillator tube (No. 2) will generally affect the calibration of the main frequency dial. This error may, however, be diminished by selecting the tube with the greatest care. The d-c voltage developed across the grid leak resistor of the doubler tube may be taken as a measure of the oscillator output voltage. This voltage may be measured as described above, and it will generally be between 5 and 8 volts.

Replacement of the reactance tube (No. 1) will generally affect both the calibration of the main frequency dial and the frequency modulation properties of the instrument. Therefore, it is most difficult to find a suitable tube replacement.

After replacement it is necessary to check the frequency calibration of the instrument and the frequency modulation properties. A method of checking the frequency deviation is described in paragraph No. 5 of this section.

The deviation sensitivity can be reset by adjusting the resistor 500Ω (location C1) which controls the amount of degeneration at audio frequencies.

The linearity of the reactance tube can be adjusted by means of the resistor 0.2 MΩ (location D2) which controls the cathode bias.

The linearity of the modulation can be checked by means of an FM demodulator with low self-distortion. If no such demodulator is available the d-c modulation characteristic can be determined by setting the MODULATION switch to the CW position and applying a d-c voltage to point No. 11 of the METER switch

type MEC 567 (location F1). The linearity may be determined from the characteristic.

(4) Amplitude modulation adjustment

If desired, the degree of amplitude modulation read on the modulation meter can be checked by converting the output frequency of the signal generator to a low frequency of a few hundred kc/s.

This frequency can be observed on a cathode-ray oscilloscope and be used for adjustment purposes. Adjustment of the resistor 100 k Ω (location G6) will change the modulation meter sensitivity to agree with the modulation percentage.

(5) Frequency modulation adjustment

If it is desired to check the carrier deviation this may be accomplished by means of the carrier zero method.

This method is based on the fact that the carrier frequency disappears at discrete values of modulation index.

The modulating index B is defined as the ratio of the frequency deviation ΔF to the modulating frequency f, i.e.

$$B = \frac{\Delta F}{f}$$

and consequently the frequency deviation

$$\Delta F = B \cdot f$$

The carrier will be zero at the following modulation indices:

2.404
5.520
8.653
11.791
14.930
18.071
21.212 etc.

A selective communications receiver tuned to the output frequency of the signal generator can be used as an indicator to determine the point at which the carrier disappears.

The FM deviation read on the modulation meter can be adjusted by means of the resistor 10 k Ω (location F5). However, the actual deviation sensitivity of the reactance tube is adjusted by means of the resistor 500 Ω (location C1) in the RF unit. In general the setting of this resistor should not be disturbed.

(6) Operating voltages and currents of the signal generator

The voltages and currents listed on page 16 can be used as references when servicing the signal generator. 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).

Voltage measurements

(all voltages measured to chassis)

	from	d-c volts	a-c volts
tube No. 10	pin No. 4		270
	6		270
	8	297	10.5
	"280 V"	280	0.36
	"160 V"	160	0.06
tube No. 8	pin No. 1	85	
	7	145	
tube No. 6	pin No. 7	280	70
	1	270	
	3	4.2	
tube No. 5	pin No. 7	270	} MODULATION switch in position INT. FM or INT. AM
	8	105	
	1	2.6	
tube No. 1	pin No. 1	2.9	
tube No. 2	pin No. 8	70	} see page 13 for special precautions
tube No. 3	pin No. 2	6	
tube No. 4	pin No. 2	12	

Current measurements

Total primary consumption at 220 volt line voltage.....400 mA~

Current at contact No. 2 of "Tuchel" connector

(total consumption of thermistor bridge + RF unit).....52 mA

(7) Fuses

The fuse mounted on the front panel is the power line fuse. A 2-amp fuse should be used in case of line voltages higher than 200 volts. For lower line voltages the fuse should be able to carry a correspondingly higher current.

The center-tap fuse for the power supply is accessible when the cover plate at the back of the instrument is removed. This fuse is mounted on the line voltage selector and should be 0.2 to 0.5 amp.

Section IV
SPECIFICATIONS

Carrier frequency range

54-216 Mc/s covered in two ranges:

54-108 Mc/s

108-216 Mc/s

Frequency calibration

Dial calibrated directly in Mc/s. The frequency is correct within 0.5% of the dial reading.

Vernier frequency dial

Divided from 0-100 and coupled to main frequency dial at a gear ratio of 1:20.

Output voltage

0.1 μ V to 0.1 volt open circuit voltage at a nominal internal impedance of 75 ohms. VSWR less than 1.4.

Attenuator dial

Calibrated in μ V and db above 1 μ V.

Output level meter

Calibrated in db above reference level from -6 to +3 db

Accuracy of output voltage

10% \pm 0.1 μ V when zero is correctly set.

Stray radiation

Cannot be detected on high-sensitivity commercial FM-receivers.

Frequency modulation

0-300 kc deviation

Amplitude modulation

0-50%

Modulation possibilities

Internal FM and external AM simultaneously

External FM

Internal FM

C.W.

Internal AM

External AM

Internal AM and external FM simultaneously

Internal modulation source

400 c/s within 4%. Distortion less than 0.3%

External modulation source

Approximately 0.15 V/kc or 1 V/% (50 volts max.).

Input impedance of external modulation terminals
about 8 kilohms.

Modulation meter

calibrated in three FM ranges:

0 - \pm 30 kc

0 - \pm 100 kc

0 - \pm 300 kc

and an AM range:

0 - 50%

FM distortion

At internal modulation, less than 3% at 100 kc
deviation; less than 10% at 280 kc deviation.

AM distortion

At internal modulation, less than 5% at 50% modulation.

Accuracy of modulation meter indications

Frequency deviation within 5% of meter reading on entire carrier frequency range up to 200 kc deviation.

Variation with modulating frequency 2% from 20 c/s to 20 kc/s.

AM indication within 10% AM.

Fidelity characteristics

FM modulation system flat from 0 c/s. Less than 1 db down at 30 kc/s.

AM modulation system flat from 30 c/s to 9 kc/s. 1 db down at limits.

Power supply

110-127-150-200-220-250 volts, 50-60 c/s

Tubes

1 - EC81	1 - PL83
5 - EF80	1 - 85A2
1 - PL81	1 - GZ32

Accessories supplied

1 power cord type C12H13-1.5

1 m long type C3A3 output cable provided with a UHF connector No. PL259 at both ends. 75 ohm characteristic impedance.

Extra accessories available

Type MSK1 converter providing a continuous extension of the frequency range of the type MS24 Signal Generator down to 0.1 Mc/s without changing the signal level or the modulation characteristics.

Type UB1balun-transformer providing balanced output from the type MS24 Signal Generator.

Over-all dimensions

Height 380 mm

Width 565 mm

Depth 290 mm

Net weight

26.5 kilos

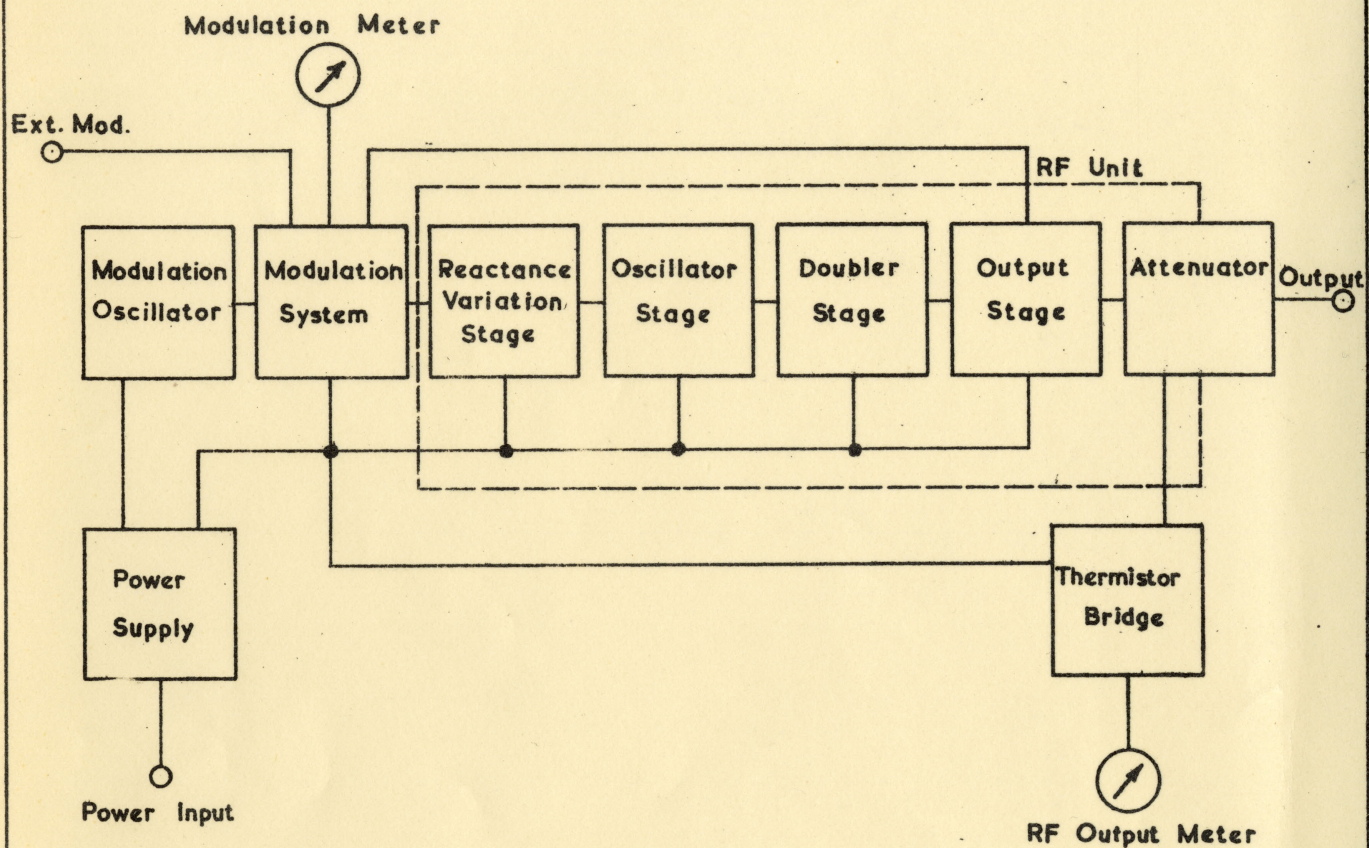


Fig. 1

SIMPLIFIED DIAGRAM

