

INSTRUCTION MANUAL

Type MS26 *q*
FM-AM STANDARD
SIGNAL GENERATOR



RADIOMETER

ELECTRONIC MEASURING INSTRUMENTS
FOR SCIENTIFIC AND INDUSTRIAL USE

INSTRUCTION AND OPERATING MANUAL
FOR

Type MS264
FM-AM STANDARD
SIGNAL GENERATOR

s/n 44389.

These instructions apply to
model MS26 only

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INTRODUCTION

GENERAL

The type MS26 FM-AM STANDARD-SIGNAL GENERATOR is designed as a laboratory standard which generates radio frequency signals of accurately known frequency and amplitude.

The generator has all the qualities necessary to measure FM broadcasting, television, mobile service, and other systems operating on the frequency range from 54 to 216 Mc.

DESCRIPTION

The principle of the type MS26 Standard Signal Generator is shown in the block diagram at the back of the manual. The RF signal is generated by an oscillator, which covers the range from 27 to 54 Mc. The signal is fed to a buffer and frequency doubler stage from which a 54-108 Mc signal drives the output stage. With a switchable tank circuit, the output stage operates either as an amplifier (on the 54-108 Mc range) or as a frequency doubler (on the 108-216 Mc range). A piston-type (waveguide-below-cut-off-type) attenuator is inductively coupled to the tank coil of the output stage. The position of the attenuator pick-up loop is accurately controlled through a rack-and-pinion drive which is coupled to the attenuator dial. The piston attenuator controls continuously the output voltage over a range of 120 dB. The RF signal is drawn from 50 or 75 ohm output terminals on the front panel.

The three RF stages are simultaneously tuned by a special variable capacitor whose sections are adjusted to accurate ganging. The carrier frequency is read directly in Mc on the individually calibrated dial with two scales.

Frequency modulation is produced by a reactance tube connected across the RF oscillator. Up to ± 300 kc are available in 4 ranges modulated by either an internal 400 or 1000 cps oscillator or by an external source. The actual frequency deviation is read on the scale of the modulation meter.

The reactance tube circuit incorporates an incremental frequency control, Δf , and a fine tuning control.

The incremental frequency control is calibrated from 0 to ± 60 kc on the upper range and from 0 to ± 30 kc on the lower. The voltage for this circuit is derived from the internal supply through a zener-diode stabilizer; no batteries are involved. With the fine tuning control a convenient, backlash-free setting

of the carrier frequency is achieved.

Amplitude modulation is introduced in the output stage by screen-grid modulation. The buffer stage ensures a minimum of reaction on the RF oscillator. The modulation is either internal from a 400 or 1000 cps oscillator or from an external source. With a diode-detector, connected across the tank circuit of the output stage, the RF level and the percentage of modulation is measured.

The detected audio signal is amplified, rectified, and fed to the modulation meter which has a 0 to 50% AM scale. This direct measurement of amplitude modulation ensures a high accuracy and stability. The detected d-c signal, a measure of the RF level, is fed to the carrier level meter, which has a scale calibrated from -6 dB to +6 dB. When the level is set to 0 dB, the attenuator dial reads the output voltage directly in volts (0.1 μ volt to 0.1 volt) and in dB above 1 μ volt (-20 to +100 dB), across a matched load. The corresponding range of open circuit voltage is 0.2 μ volt to 0.2 volt. When the meter level is increased to +6 dB, the maximum output level is 0.2 volt across a matched load (0.4 volt open-circuit).

Levels below 0.1 μ volt can be produced by inserting a 20 dB pad (type FDL2 or 3) in the output.

All RF circuits are enclosed in a shielded box from which leads are carefully filtered to avoid stray radiation, which could interfere with measurements at low levels.

When you have external modulation AM or FM, the actual modulation is measured with the internal metering circuits.

Provisions are included for simultaneous AM and FM, one from the internal modulation generator, the other from an external source, or vice versa.

An electronically regulated power supply is included for increased stability and for low residual modulation.

SPECIFICATIONS

CARRIER FREQUENCY

Range:

54 to 216 Mc in two ranges, 54-108 and 108-216 Mc.

Calibration:

The frequency dial is calibrated directly in Mc.

The accuracy is better than 0.5%.

Incremental Frequency:

Continuous from 0 to ± 60 kc on the higher range, and from 0 to ± 30 kc on the lower.

The dial calibration is independent of the frequency setting on both ranges.

Fine Tuning

Backlash-free control of the frequency over approx. ± 15 kc on the higher and ± 7.5 on the lower range.

Interpolation Dial:

Divided from 0 to 100 and coupled to the main frequency dial through a 1:15 reduction gear.

CARRIER OUTPUT

Output Level:

0.05 μ volt to 0.2 volt across a matched load. (0.1 μ volt to 0.4 volt open circuit). The level is continuously variable through a piston-type attenuator.

The attenuator dial is calibrated in volts and dB over 1 μ volt, both referred to voltage across a matched load.

Output Impedance:

Two outputs with nominal impedances of 50 and 75 ohms.
VSWR less than 1.4 (typically 1.25).

Accuracy of Output Voltage:

1 dB + 0.1 μ volt.

Spurious Frequencies

All spurious signals (harmonics and sub-harmonics) are typically more than 40 dB below the output signal level.

Stray Radiation:

Negligible. Cannot be detected by high-sensitivity commercial FM-receivers.

Terminals:

Both RF terminals are BNC type UG-290/U connectors.

FREQUENCY MODULATION

Deviation Ranges:

0 to ± 300 kc in 4 ranges.

Full scale readings of ± 10 , ± 30 , ± 100 and ± 300 kc.

Distortion:

Less than 3% distortion at ± 100 kc.
 Less than 10% distortion at ± 280 kc.

Accuracy:

5% of full scale up to ± 200 kc at a modulation frequency of 400 or 1000 cps.

AM on FM:

At ± 280 kc deviation the AM is typically below 6%.

Incidental FM:

With the generator operating CW the incidental FM, because of hum and noise is typically 0.3 parts per million, i.e., 64 dB below a ± 75 kc modulation level, at 150 Mc.

External FM:

The deviation is measured by the internal metering circuit. The frequency response is within ± 1 dB from 20 cps to 30 kc, referred to 400 cps. Approximately 60 volts into a min. 14 kilohm load is necessary for full scale FM.

AMPLITUDE MODULATION

Range:

0 to 50% AM. The meter scale is calibrated in % AM from 0 to 50.

Distortion:

The envelope distortion is less than 5% at 50% AM.

Accuracy:

5% of the reading +3% AM at 400 cps.

FM on AM:

At 30% AM, 400 or 1000 cps, the FM produced is typically 2 parts per million.

Residual AM:

With the generator operating in CW the residual AM, because of hum and noise, is below 0.1% AM.

External AM:

The modulation depth is measured by the internal metering circuit, and the frequency response is within ± 1 dB from 30 cps to 9 kc, referred to 400 cps. Approximately 65 volts into a min. 9 kilohm load is necessary for full scale AM.

MODULATING OSCILLATOR

Frequency: 400 or 1000 cps $\pm 5\%$
Distortion: below 0.3%
Synchronization voltage: 400 or 1000 cps voltage of about 70 volts can be drawn from the terminals on the front panel.

POWER SUPPLY

Voltages: 110, 115, 127, 200, 220, 240 volts
Line frequency: 50 to 60 cps
Consumption: 45 watts

TUBES

1 E180F
1 EC81 (6R4)
1 ECF80 (6BL8)
3 EF80 (6BX6)
1 PL81 (21A6)
1 PL83 (15A6)
1 85A2 (5651)

OVER-ALL DIMENSIONS

Height	Width	Depth
380	565	290 mm
15	22 1/4	11 1/2 inches

The front panel has 19" standard rack dimensions.

WEIGHT

27 kilos net (60 lbs).

ACCESSORIES FURNISHED

1 type 6E6 coaxial cable (50 ohms) with BNC type UG-88/U plugs.
1 type 6D6 coaxial cable (75 ohms) with BNC type UG-88/U plugs.
1 type 12G19-1.5 power cord.

EXTRA ACCESSORIES

TERMINATING UNIT type TPL2. Supplies correct matching to a 75 ohm generator output. The output impedance at the point is 37.5 ohms. The unit is furnished with a female BNC type UG-290/U connector.

20 dB PADS type FDL2/3

Small 20 dB attenuator terminated in male and female type BNC connectors.

The impedances are:

Type FDL2: 75 ohms

Type FDL3: 50 ohms

CABLE, type 3D6 coaxial cable (75 ohms) with one BNC type UG-88/U and one UHF type PL-259 plug.

BALANCING TRANSFORMER, type UBT3, gives a balanced output voltage. The frequency range is from 40 to 250 Mc.

Impedance ratio: 75 to 300 ohms

Voltage ratio: 1:1

VIDEO MODULATOR, type MOD1, provides for video and pulse modulation of signal generators. In addition it can be used for high-quality AM. The frequency range is from 30 to 240 Mc.

Modulation frequency: d-c to 10 Mc (3 dB)

Amplitude modulation: 0 to above 95% AM with distortion less than 1%.

Pulse modulation: On-off ratio at least 40 dB with a rise-time of approx. 0.04 μ sec.

SECTION 1

OPERATING PRINCIPLE

The drawing appended to the manual shows the complete circuit diagram of the Signal Generator.

1.1 THE RF UNIT

The RF-unit is contained in a shielded box whose cover can be removed for inspection or repair.

The RF-oscillator (tube V2) is operated as a tuned plate oscillator covering the frequency range from 27 to 54 Mc. The tuning is accomplished with the variable capacitor, C1C whose shaft is connected to the main frequency dial via a spring-loaded gear. The tuning knob with the interpolation dial is coupled to the main dial through a friction drive. The gearing ratio between the tuning knob and the main frequency dial is approx. 1:18.

From the RF-oscillator tank circuit, voltage is applied to the grid of the tube V3, which operates as a class-C amplifier and buffer stage. In class-C operation the harmonic content of the anode current is high. The frequency range 54-108 Mc is produced by tuning the anode tank circuit to the second harmonic. The tuning is done with the capacitor C1E, which is ganged to the oscillator capacitor.

The output from this stage is fed to the output stage (V4). On the low frequency range (54-108 Mc) this stage operates as a class-C amplifier. On the high range (108-216 Mc) 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 two spring contact fingers. One is pressed against contact points on the coil L7 by rotating a cam shaft, which is coupled to the range switch.

The output from the output stage is coupled inductively to a piston type attenuator. At the input end of the attenuator is a mode suppressor to reject unwanted modes, so that only $TE_{1,1}$ mode is present in the waveguide.

The pick-up loop is mounted on a plunger which is moved axially in the attenuator tube by a rack and pinion drive. To match the cable to the

50 ohm connector, a 50 ohm resistor is mounted in series with the pick-up loop. An additional 25 ohm resistor from the 50 ohm terminal furnishes the 75 ohm output impedance.

The RF monitoring system consists of the two germanium diodes CR1 and CR2, which are coupled to the output tank circuit. The d-c output from the diodes is fed to the carrier level meter through suitable resistors and via a section of the range switch. In the low range (54-108 Mc) the current is led through R50 and P6 and in the high range through R49 and P7. The two potentiometers adjust the sensitivity of the monitoring system.

The variation of the output from the detector during the warm-up period of the instrument is compensated for by the thermistors RT2 and RT3. The coil L6 together with the capacitance of the diodes provides for proper frequency response in the highest frequency range.

To prevent stray radiations from the RF circuits all connections to the RF-unit are taken through a system of screened two-section low-pass filters.

1.2 MODULATION CIRCUITS: GENERAL

The sine-wave modulation oscillator (V5 and V6) operates as a conventional Wien-bridge RC-oscillator. The oscillator can be set to 400 cps or 1000 cps with the switch S5. The regeneration is controlled by the frequency selective network C60-61, R71-72, C62, and R70. These components give a frequency of 400 cps. With the switch S5 in "1000 cps" position R70 and R71-72 are shunted with R75 and R73-74.

Another network, which comprises C56 and R69, applies a degenerative voltage across the ballast lamp RT4. The rapid increase of the resistance of the lamp with respect to increases in feedback voltage tends to limit the oscillation to the linear portion of the tube characteristic.

The oscillator has a very low distortion (less than 0.3%). Approximately 70 volts are present from the plate of the tube V6 for modulation purposes. The modulation voltage is coupled to the modulation systems (FM and AM) via the modulation selector S4.

1.3 INTERNAL AM

AM is produced by modulating the screen grid voltage of the RF output tube (V4). The modulation voltage is fed to the top of the screen-grid potentiometer, P11. This point is isolated from the d-c supply by a 50 Henry choke (L20). The AM is monitored by the RF detector circuit (CR1, CR2). The detected AF output across the carrier level meter M2 and the resistor R51 is proportional to the modulation depth, if the d-c current is constant. The AF-output is fed into a feedback amplifier (left section of V9) and further to a cathode-follower (right section of V9). Via the modulation selector (S4) and C53 the signal is fed to the AM meter circuit. The sensitivity of this circuit is determined by R39 and P2. The AM meter reading is valid only when the d-c reference (carrier level meter) is set to 0 dB.

1.4 INTERNAL FM

The frequency modulation is produced by a reactance tube V1, which operates across the tank coil of the RF-oscillator. One of the elements in the phase shift network, C1A, is a section of the variable condenser. The capacity of this section is adjusted to keep the frequency modulation constant over the entire frequency range.

The modulation voltage is taken from the RC-oscillator (V5 and V6) and fed to the top of the FM-potentiometer (P10). Through the FM range switch the signal is fed into a divider network with constant input impedance. In this network the modulation voltage is divided according to the FM ranges ± 300 , ± 100 , ± 30 and ± 10 kc. In the lower frequency range the signal is fed through the capacitor C46 to the grid of the reactance tube. In the higher range the modulation voltage is divided by two (R40A and B) to make the deviation independent of the setting of the range switch.

The meter circuit is connected to the FM system in front of the divider network. The sensitivity of the FM meter circuit is determined by R45 and P1.

The drift in the detector output during the warm-up period of the instrument is compensated for by the thermistor RT 1.

To reduce the unwanted AM on FM, the AM detector and amplifier circuits are used as a feedback path to the screen grid of the RF out-

put (and modulating) tube by which the amplitude modulation is reduced. The feedback path runs through the detector, the detector amplifier, and the cathode-follower (V9) to the RF output tube. To get a high degree of suppression the feedback of the AM-detector-amplifier (V9) is disconnected. All the necessary connections are made automatically when the modulation selector is set to internal or external FM. In the case of simultaneous FM and AM, the AM suppression system is disconnected.

1.5 EXTERNAL MODULATION

When the modulation switch is set to external modulation, the internal modulation system is connected to the external modulation terminals. The external modulation is measured with the internal metering systems. For further information see Section 2.

1.6 INCREMENTAL FREQUENCY

A d-c voltage produces calibrated static deviation (Δf) in the same way as an a-c voltage applied to the reactance tube grid produces a dynamic deviation (FM).

The d-c voltage is drawn from a zener-diode stabilizer. The zener-diode (CR3) is fed through the resistor R38. The stabilized voltage is fed to the top of the Δf potentiometer (P8) via the resistor R37. To avoid influence on the dynamic FM systems, the impedance of the stabilizer circuit is made high with the resistor R36. The d-c voltage is fed to the grid of the reactance tube.

1.7 FINE TUNING

The fine tuning circuit consists of the potentiometer P5 and the resistor R5. With the potentiometer the cathode bleeder current of the reactance-tube can be changed a small amount. This produces a change in the tube bias and the acting of the circuit is similar to the incremental frequency control.

1.8 POWER SUPPLY

The instrument operates from a 50 to 60 cps power line. The voltage selector, S7, can be set to 110, 115, 127, 200, 220, or 240 volts.

The full-wave rectifier and filter circuits (V11, L19, and C43A-B)

supply an anode voltage of approx. 280 volts for the internal modulation oscillator. The anode current to the other circuits of the instrument is drawn from a conventional electronic regulator, which consists of the series-regulator tube (V7), the regulator amplifier tube (V8), and the reference tube (V10).

The filament current is drawn directly from the transformer.

SECTION 2

OPERATING INSTRUCTIONS

2.1 CONNECTION

Before connecting the instrument to the power line, make sure that the line voltage selector, S7, is set to the voltage of the power line. The voltage selector is always set at 220 volts when the instrument leaves the factory.

When changing to another voltage, loosen the center screw on the voltage selector and set the selector to the desired voltage. The selector is accessible at the back of the cabinet. When changing to another voltage it may be necessary to change the fuse (located in the selector).

The correct value is stated in item 2.40 of this section.

2.2 CONTROLS, DIALS, METERS, AND TERMINALS

All controls are located on the front panel.

2.21 Main frequency dial

Calibrated in megacycles. Only a single scale is used, because the high range is obtained by the frequency doubling of the range 54-108 Mc.

The scale has two sets of figures, one for each range.

2.22 Frequency tuning knob

Located to the left below the main frequency dial and supplied with a crank handle for fast operation and a 0-100 vernier dial for interpolation purposes.

2.23 Δf kc

Permits small deviations from the main frequency. Gives a ± 30 kc deviation on the low range (54-108 Mc). The reading should be multiplied by 2 in the high range (108-216 Mc).

2.24 Fine tuning

Uncalibrated frequency control as a supplement to the Δf dial. Gives a frequency deviation of approx. ± 7.5 on the low range and approx. ± 15 kc on the high range. When the white dot on the knob points upwards, the control is in its neutral position.

- 2.25 Range (switch)
Selects the desired frequency range.
- 2.26 Carrier (potentiometer)
Standardizes the attenuator calibration when the carrier level meter is set to the 0 dB mark.
- 2.27 Attenuator (dial)
Indicates the output voltage when the carrier level meter reading is set to 0 dB. Calibrated in μ volts and in dB above 1 μ volt across 50 or 75 ohms. Can be set to values from 100 mV (100 dB) down to 0.1 μ V (-20 dB). Open circuit voltage is 6 dB higher.
- 2.28 Modulation (switch)
Switches 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:
- (1) INT. FM and EXT. AM simultaneously
 - (2) EXT. FM
 - (3) INT. FM
 - (4) CW
 - (5) INT. AM
 - (6) EXT. AM
 - (7) INT. AM and EXT. FM simultaneously
- 2.29 Modulation AM (potentiometer)
Controls the amplitude modulation depth.
- 2.30 Modulation FM (potentiometer)
Controls the frequency deviation according to the setting of the FM RANGE switch.
- 2.31 FM range (switch)
Selects the desired deviation range. The switch has 4 positions ± 10 , ± 30 , ± 100 , and ± 300 kc. The figures refer to full scale readings on the modulation meter.
- 2.32 Meter
Connects the modulation meter either to the FM or to the AM measuring system.
- 2.33 Modulation frequency switch
Selects the desired internal modulation frequency. The switch

has two positions, 400 and 1000 cps.

2.34 Power input terminals

Located to the lower left on the front panel. Should be connected to the power line with the type 12G19-1.5 power cord which is supplied with the instrument.

2.35 RF output terminals

The output may be drawn from either the 50 or the 75 ohm type UG-290/U BNC connectors. The instrument is supplied with 50 and 75 ohm coaxial cables, type 6E6 and 6D6.

2.36 EXT. MOD. terminals

AM: The modulation system is flat within 1 dB between 30 cps and 9 kc, referred to 400 cps. The sensitivity of the AM system is approx. 1.3 volts per % AM. The input impedance is higher than 9 kilohms.

FM: The modulation system is flat within 1 dB between 20 cps and 30 kc, referred to 400 cps. The sensitivity of the FM system is approx. 60 volts for full scale FM. The input impedance is higher than 14 kilohms.

2.37 SYNC. terminals

Furnish approx. 70 volts (400 or 1000 cps) for oscilloscope synchronization.

Source impedance higher than 100 kilohms. When the internal modulation generator is not in use, there is not any voltage present across the terminals.

2.38 Carrier level meter

Monitors the RF voltage at the attenuator input. When the meter reads 0 dB, the output voltage can be read directly from the attenuator dial. The meter is calibrated from -6 dB through zero to +6 dB for extending the output voltage range.

2.39 Modulation Meter

Indicates the actual modulation depth or frequency deviation internal or external. The meter has a 0-50% AM scale and a 0- \pm 10 kc and a 0- \pm 30 kc FM scales to be used according to the FM range switch setting position. The AM reading applies only when the carrier level meter reads 0 dB.

The FM reading, however, is independent of the carrier level.

2.40 Power Line Fuse

Protects the instrument against overload. At the back of the instrument the power fuse is accessible. At 200, 220, and 240 volts a 0.4 amp, and at 110, 115, and 127 a 0.8 amp slow-blow fuse should be used.

2.41 Pilot Lamp

6.3 V, 0.3 amp.

2.5 STEP-BY-STEP OPERATION

- (1) Make sure that the line voltage selector is set at the correct voltage.
- (2) Connect the instrument to the power-line, switch it on, and allow it to warm up for a few minutes.
- (3) Set the RANGE switch to the desired frequency range.
- (4) Set the frequency tuning dial to the desired frequency.
- (5) Turn the CARRIER control until the meter reads 0 dB.
- (6) Select the desired type of modulation with the MODULATION switch. In the case of FM, set the FM RANGE switch to the desired position.
- (7) Set the desired modulation depth or frequency deviation with the METER switch and one of the two modulation controls AM or FM.
- (8) Adjust the RF output level with the ATTENUATOR.

SECTION 3 MAINTENANCE

3.1 GENERAL

The type MS26 FM-AM STANDARD-SIGNAL GENERATOR is designed to withstand a certain amount of rough treatment, but careful handling and proper operation results in a long life and high reliability.

Such repairs as are necessary, should only be made by skilled personnel provided with the proper equipment to ensure that the repair is correctly made.

3.2 REMOVING THE INSTRUMENT FROM THE CABINET

The instrument can be removed from the cabinet when the six fixing screws along the edge of the front panel have been removed.

3.3 TUBE REPLACEMENTS

In general the tubes of the instrument do not require any replacement until they cause some kind of trouble.

3.31 V7, V8, and V10

Replacement of any tube of the voltage regulator (V7, V8, and V10) may cause a change in the magnitude of the regulated voltage. Therefore, when changing a tube of the regulated circuit, it is advisable to measure the value of the regulated voltage (from the cathode of V7 to chassis). This voltage should be 160 volts, and can be adjusted with the potentiometer P3.

3.32 V5 and V6

When a tube is replaced in the modulation oscillator, the distortion in the output voltage should be checked. In general the total harmonic content is less than 0.3%. The output voltage is approximately 70 volts.

The lamp RT4 has an extremely long life and should not be replaced indiscriminately. Should the lamp fail, however, the output should be checked after replacement.

Replacement of a tube in the RF-unit may necessitate readjustments for which special testing equipment and procedures may be necessary. Therefore, replacement should only be made if ab-

solutely necessary.

3.33 V 4

Replacement of the tube (V4) in the output stage may cause a mis-tuning 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 +6 dB with the CARRIER potentiometer turned to the extreme right-hand.

If an adequate tube is not available, the tuning may be adjusted with the trimming screw capacitor C1F.

3.34 V 3

Replacement of the tube V3 in the doubler stage can be made in a similar way. To determine whether the doubler stage tank circuit is properly tuned, that stage can be checked by measuring the d-c voltage across the grid leak resistor (R16) of the output tube. This measurement may be made with a d-c vacuum-tube voltmeter, such as the RADIOMETER type RV23. To avoid heavy capacitive loading of the circuit, the voltmeter must be connected to the grid through a low capacitance probe. The d-c voltage is normally between 5 and 10 volts and should be fairly constant over the entire tuning range.

3.35 V 2

Replacement of the oscillator tube (V2) generally affects the calibration of the main frequency dial. This error may, however, be diminished by selecting the tube. The d-c voltage developed across the grid leak resistor (R11) of the doubler tube (V3) 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 10 volts.

3.36 V 1

Replacement of the reactance tube (V1) generally affects both the calibration of the main frequency dial and the frequency modulation properties. After replacement it is necessary to check the frequency calibration of the instrument and the fre-

quency modulation properties. A method of checking the FM is given in item 3.4. The FM characteristics are adjusted with the potentiometers P1, P4, and P5. (See item 3.5).

3.4 MEASURING FM, AM, AND CW

3.41 FM:

If it is desirable to check the frequency modulation, this may be done either with special instruments (Radiometer type AFM1 MODULATION METER) or by the "Vanishing Carrier Method" outlined below. This method is based on the fact that the carrier frequency disappears at discrete values of the modulation index.

The modulation index B is defined as the ratio of the frequency deviation ΔF to the modulating frequency f, thus,

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

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
19.071
21.212 etc.

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

The FM meter reading can be adjusted with the potentiometer P1.

3.42 AM:

The AM reading can be checked either with a selective modulation meter (RADIOMETER type AFM1), which is preferable, or by displaying the output on an oscilloscope screen. When using the second method, the output frequency has to be converted to

a lower frequency. The AM meter reading can be adjusted with the potentiometer P2.

3.43 CW:

The carrier level reading can be checked with a VHF voltmeter with the attenuator set to maximum. The CW-meter reading can be set by the potentiometer P6 in the low frequency range and with P7 on the high range.

3.5 SCREW DRIVER ADJUSTMENTS AND THEIR FUNCTIONS

P1: Adjusts the FM meter sensitivity.

P2: Adjusts the AM meter sensitivity.

P3: Adjusts the output voltage of the regulated power supply. Should be set to +160 volts.

P4: Adjusts the linearity of the frequency modulation. Set the Signal Generator to about 80 Mc and set the deviation to about 280 kc. Use a modulation meter (RADIOMETER type AFM1) or a low distortion FM detector in connection with a distortion meter (RADIOMETER type BKF5 or FRA2) as an indicator. Turn the potentiometer to minimum distortion.

P5: Adjusts the linearity of the frequency modulation. Use the same test set-up as for P4, but with a smaller deviation (approx. 80 kc). Set the potentiometer to minimum FM distortion.

P6: Adjusts the carrier level reading on the low frequency range (54-108 Mc).

P7: Adjusts the carrier level reading on the high frequency range (108-216 Mc).

3.6 OPERATING VOLTAGES

The voltages listed on the following page can be used 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 which is used should have a negligible consumption (vacuum-tube voltmeter) and for all the measurements should be equipped with a low capacitance probe (RADIOMETER type RV23).

D-C VOLTAGE MEASUREMENTS

all voltages measured to chassis

tube V1	pin 1 and 3	364 V
	7	160 V
	8	160 V
tube V2	pin 1-8	85 to 95 V
	8 1	-3.5 to 6 V
tube V3	2	-5 to -10 V
	7	155 V
	8	110 V
tube V4	pin 2	-5 to -10 V
	7	155 V
	9	0 to 160 V
tube V5	pin 1	115 V
	3 and 6	2 V
	7	270 V
tube V6	pin 1 and 3	4.5 V
	7	280 V
	8	230 V
tube V7	pin 2 to pin 3 and 9	-8 to -20 V
tube V8	pin 1 and 3	85 V
	2	approx. 1.3 V
	7	140-150 V
tube V9	pin 1	160 V
	3	87 V
	6	110 V
	7	2.2/5.5 V
	8	90 V
	9 to pin 8	-2 V
tube V10	pin 1 and 5	85 V
tube V11	pin 8	300 V
	4 and 6	250 V a-c

Total primary consumption at 220 V line voltage : 400 mA.

PARTS LIST

When ordering parts please include:

- (1) Complete description of the part, inclusive of circuit reference.
- (2) Complete type-designation and factory number of the instrument.
- (3) If the component is not listed below, give a description of the function and the location of it.

CIRCUIT REF.

DESCRIPTION

CAPACITORS

C1 A-G	variable	incl. trimmers					
C2	ceramic	50 pF	5%	500 V	T.C.	approx. 0	
C3	ceramic	200 pF	5%	500 V	T.C.	$-750 \cdot 10^{-6}/^{\circ}\text{C}$	
C4	ceramic	50 pF	5%	500 V	T.C.	$-750 \cdot 10^{-6}/^{\circ}\text{C}$	
C5	ceramic	3 pF	10%	500 V	T.C.	$-750 \cdot 10^{-6}/^{\circ}\text{C}$	
C6	ceramic	50 pF	5%	500 V	T.C.	$-750 \cdot 10^{-6}/^{\circ}\text{C}$	
C7	ceramic	50 pF	5%	500 V			
C8	ceramic	2 nF	+50 - 30%	500 V			
C9-C10	ceramic	50 pF	5%	500 V			
C11	ceramic	100 pF	5%	500 V			
C12	ceramic	30 pF	5%	500 V			
C13	ceramic	2 pF	± 0.2 pF	500 V			
C14	ceramic	3 pF	$\pm 10\%$	500 V			
C15-C20	ceramic	feed-through	2.5 n	500 V			
C21	ceramic	feed-through	250 pF	500 V			
C22	ceramic	feed-through	2.5 n	500 V			
C23	electrolytic	16 μF		320/350 V			
C24-C26	ceramic	feed-through	100 pF	500 V			
C27	ceramic	feed-through	2.5 nF	500 V			
C36-C38	ceramic	feed-through	100 pF	500 V			
C39-C41	ceramic	feed-through	50 pF	500 V			
C42	polyester	0.1 μF	10%	400 V			
C43A-B	electrolytic	2 x 24 μF		320/350 V			
C44-C45	paper	5 nF		5000 V			
C46	polyester	0.47 μF	10%	400 V			
C47	polyester	10 nF	10%	400 V			
C48	electrolytic	16 μF		320/350 V			
C49	electrolytic	16 μF		320/350 V			
C50	polyester	0.1 μF	10%	400 V			
C51	electrolytic	50 μF		6/8 V			
C52	polyester	0.1 μF	10%	400 V			
C53	polyester	0.47 μF	10%	400 V			
C54-C56	metallized	1 μF		250/375 V			
	paper						
C57	polyester	10 nF	10%	400 V			
C58-C59	electrolytic	16 μF		320/350 V			
C60-C61	ceramic	200 pF	5%	500 V	T.C.	approx. 0	
C62	ceramic	100 pF	5%	500 V	T.C.	approx. 0	
C63	ceramic	feed-through	2.5 nF	500 V			

RADIOMETER

CIRCUIT REF.		DESCRIPTION			
CR1-CR2	diode germanium	0A85	Philips		
CR3	zener diode	0AZ 203	Philips		
CR4-CR7	diode germanium	0A81	Philips		
F1	fuse, slow blow	0.4 amp	250 V	(at 200, 220, and 240 V)	
	fuse, slow blow	0.8 amp	250 V	(at 110, 115, and 127 V)	
I1	pilot lamp	0.3 amp	6.3 V		
J1-J2	connector	BNC type UG-290/U			
J3-J5	banana jack	4 mm insulated, black			
J6	banana jack	4 mm non-insulated			
J7	power line socket	SBI 145-J			

INDUCTORS

L1	RF	40 μ H				drawing number 1771-A4
L2	oscillator					drawing number 1771-A4
L3	RF	2.6 μ H				drawing number 1771-A4 (wound on R14)
L4	1. doubler					drawing number 1771-A4
L5	RF	2.6 μ H				drawing number 1771-A4 (wound on R18)
L6	RF					drawing number 1771-A4 (wound on R20)
L7	2. doubler					drawing number 1771-A4
L8	attenuator pick-up loop					drawing number 840-A1
L9-L14	coil	powder core	50 μ H			
L15-L16	ferrite tube	2/4.1 ϕ x 15 mm				
L17-L18	coil	powder core	50 μ H			
L19	choke	filter	10 H	0.12 amp	175 ohms type 31.5 H	J.S. No. 971
L20	choke	anode	50 H	15 mA	400 ohms type 31.5 H	J.S. No. 973/2
L21	choke	anode	6 H	60 mA	230 ohms type 3.15 H	J.S. No. 4218
L22	ferrite	tube	2/4.1 ϕ x 30 mm			
M1	meter	"MODULATION"	0.1 mA	800 ohms		IBS No. 224
M2	meter	"CARRIER LEVEL"	0.1 mA	800 ohms		IBS No. 223

POTENTIOMETERS

P1	carbon	50 k	0.2 W
P2	carbon	25 k	0.2 W
P3	carbon	10 k	0.2 W
P4	wirew.	500 Ω	1 W
P5	carbon	200 k	0.4 W
P6	carbon	50 k	0.2 W
P7	carbon	50 k	0.2 W
P8	wirew.	10 k	4 W
P9	carbon	50 k	0.4 W
P10-P12	wirew.	20 k	4 W

CIRCUIT REF.

DESCRIPTION

RESISTORS

R1	carbon film	33 k Ω	5%	0.5 W
R2	carbon film	2.2 k	5%	0.5 W
R3	carbon film	100 Ω	5%	0.5 W
R4	carbon film	180 Ω	5%	0.5 W
R5	carbon film	33 k	5%	1 W
R6-R7	carbon film	47 k	5%	1 W
R8	carbon film	10 k	5%	1 W
R9	wirew.	3 Ω	5%	0.5 W
R10	carbon film	47 k	5%	0.5 W
R11	carbon film	100 k	5%	0.5 W
R12	carbon film	22 Ω	5%	0.5 W
R13	carbon film	33 k	5%	0.5 W
R14	carbon film	6.8 k	5%	0.5 W
R15	carbon film	1 k	5%	0.5 W
R16	carbon film	100 k	5%	0.5 W
R17	carbon film	220 Ω	5%	0.5 W
R18	carbon film	6.8 k	5%	0.5 W
R19-R20	carbon film	1 k	5%	0.5 W
R21	carbon film	15 k	5%	0.5 W
R22	carbon film	220 k	5%	0.5 W
R23-R24	carbon film	4.7 k	5%	0.5 W
R25	carbon film	50 Ω	1%	0.1 W
R26	carbon film	25 Ω	1%	0.1 W
R27	carbon film	1 k	5%	0.5 W
R28-R29	carbon film	100 k	5%	0.5 W
R30	carbon film	1 k	5%	0.5 W
R31	carbon film	82 k	5%	0.5 W
R32	carbon film	4.7 M	5%	0.5 W
R33	carbon film	5.6 M	5%	0.5 W
R34	carbon film	10 M	5%	0.5 W
R35	wirew.	10 Ω	5%	0.5 W
R36	carbon film	220 k	5%	0.5 W
R37	carbon film	100 k	5%	0.5 W
R38	carbon film	39 k	5%	0.5 W
R39	carbon film	100 k	5%	0.5 W
R40A-B	wirew.	750 + 750 Ω	0.5%	
R41A-B	wirew.	1200 + 1375 Ω	0.5%	
R42A-B	wirew.	964 + 1505 Ω	0.5%	
R43A-C	wirew.	964 + 1375 + 667 Ω	0.5%	
R44	carbon film	6.8 k	5%	0.5 W
R45	carbon film	150 k	5%	0.5 W
R46	carbon film	39 k	5%	0.5 W
R47	carbon film	180 k	5%	0.5 W
R48	carbon film	4.7 k	5%	0.5 W
R49	carbon film	56 k	5%	0.5 W
R50	carbon film	82 k	5%	0.5 W
R51	carbon film	18 k	5%	0.5 W
R52	carbon film	120 k	5%	0.5 W
R53	carbon film	470 k	5%	0.5 W
R54	carbon film	3.3 k	5%	0.5 W
R55	carbon film	470 k	5%	0.5 W
R56	carbon film	3.3 k	5%	0.5 W
R57	carbon film	4.7 k	5%	0.5 W
R58	carbon film	18 k	5%	0.5 W

drawing no. 1775-A4
drawing no. 1775-A4
drawing no. 1775-A4
drawing no. 1775-A4

CIRCUIT REF.

DESCRIPTION

RESISTORS

R59	carbon film	390 Ω	5%	0.5 W
R60	carbon film	470 k	5%	0.5 W
R61	wirew.	2.5 k		3 W
R62	carbon film	100 k	5%	0.5 W
R63	carbon film	100 Ω	5%	0.5 W
R64	carbon film	12 k	5%	0.5 W
R65	carbon film	1 k	5%	0.5 W
R66	carbon film	470 k	5%	0.5 W
R67	carbon film	10 k	5%	0.5 W
R68	carbon film	330 k	5%	0.5 W
R69	carbon film	6.8 k	5%	0.5 W
R70	carbon film	3.9 M	5%	0.5 W
R71	carbon film	820 k	5%	0.5 W
R72	carbon film	270 k	5%	0.5 W
R73	carbon film	390 k	5%	0.5 W
R74	carbon film	560 k	5%	0.5 W
R75	carbon film	3.3 M	5%	0.5 W

RT1	thermistor	type B8.320.03 P/22 k	Philips
RT2	thermistor	type B8.320.03 P/47 k	Philips
RT3	thermistor	type B8.320.03 P/100 k	Philips
RT4	ballast lamp	220 S 06	Philips

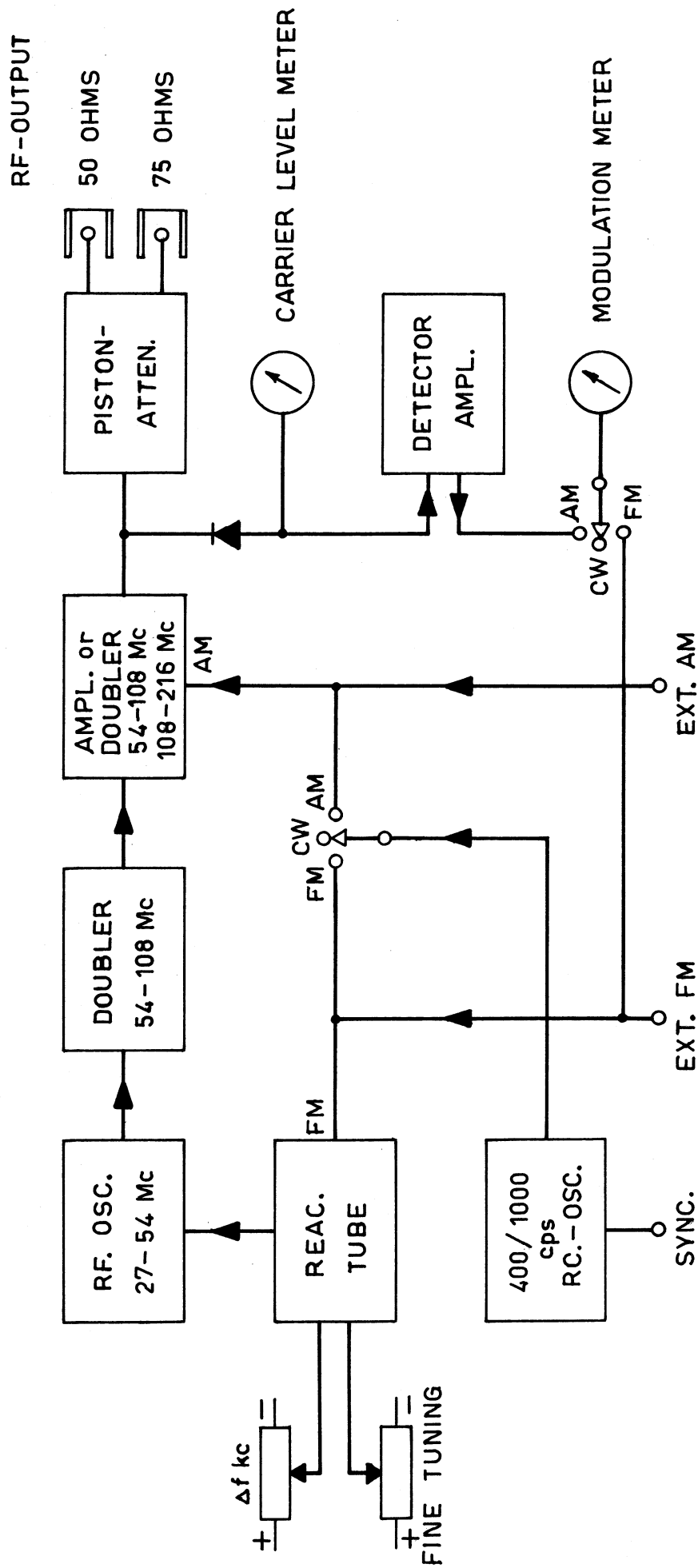
SWITCHES

S1	RANGE	drawing number 782-1
S2	FM RANGE	drawing number 781-1
S3	METER	drawing number 784-1
S4	MODULATION	drawing number 783-1
S5	400/1000 cps	type S-II
S6	toggle 6 A	type RP1915
S7	selector line voltage	type 2040/115 V

T1	transformer	type 125 J.S. no. 974/1
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TUBES

V1	EF80	(6Bx6)	Philips
V2	EC81	(6R4)	Philips
V3	EF80	(6Bx6)	Philips
V4	E180F	(6688)	Philips
V5	PL83	(15A6)	Philips
V6	EF80	(6Bx6)	Philips
V7	PL81	(21A6)	Philips
V8	EF80	(6Bx6)	Philips
V9	ECF80	(6BL8)	Philips
V10	85A2	(5651)	Philips
V11	GZ 34	(5AR4)	Philips



MS 26. BLOCK DIAGRAM

