RADIOMETER

TYPE TMS1
SWEEP GENERATOR

Electrical
measuring instruments for industrial and scientific work

RADIOMETER . 72 EMDRUPVEJ . COPENHAGEN NV . DENMARK

INSTRUCTION AND OPERATING MANUAL

FOR

TYPE TMS1

SWEEP GENERATOR

INDEX

SWEEP GENERATOR

TYPE TMS1

INTRODUCTION

The Sweep Generator type TMS1 has been designed as a test instrument for examining the characteristics of the RF and IF circuits of television receivers. Most facilities required by the service engineer are incorporated so that the need for additional test equipment is widely reduced.

DESCRIPTION

The instrument comprises a frequency modulated oscillator which oscillates on approximately 135 Mc/s, a buffer and limiter stage, and a converter stage consisting of a mixer tube and a variable frequency oscillator providing carrier output in the frequency ranges 5-50 Mc/s, 50-120 Mc/s, and 150-250 Mc/s.

The tank coil of the fixed frequency oscillator incorporates a core of ferrite. Frequency modulation is produced by changing the saturation degree of the ferrite and consequently the inductance of the coil. Nearly linear frequency sweep is produced over a frequency range of max. 20 Mc/s.

The instrument also incorporates a marker oscillator providing marker pips in the frequency ranges 5.1-5.9 Mc/s and 18-47 Mc/s on the fundamental, and at higher frequencies on the harmonics. The marker oscillator can also be switched between ten different fixed frequencies (standard TV channel pix-frequencies). The output of the sweep generator and the marker oscillator are added up inside the instrument. A separate marker attenuator provides for adjusting the relative marker output level.

The output voltage is controlled by means of a variable resistive attenuator. A wide range of output voltage is available from about 50 μV to 0.1 volt open circuit voltage.

The output impedance is 75Ω.

The tuned circuit in TV receivers can be aligned by using the instrument in conjunction with a cathode-ray oscilloscope.

The instrument gives off a voltage for the horizontal deflection of the oscilloscope.

The carrier is fed into any suitable point between the antenna input and the detector of the receiver.

When fed to the Y input of the oscilloscope, the output from the receiver will provide a picture of the response curve of the tuned circuits under test over a frequency range up to 20 Mc/s.

The marker signal provides calibration pips on the curve.

At frequencies far outside the pass band of a tuned circuit it is difficult to produce a suitable marker pip. At certain investigations, however, it is important to state the response of a filter outside the pass band and therefore the instrument has been equipped with a special marker arrangement providing a pair of marker pips with a fixed frequency difference of 5.5 Mc/s. These pips are fed to the Y input of the oscilloscope directly from the instrument, and the magnitude can be adjusted by means of a control on the front panel of the instrument.

If the oscilloscope is provided with terminals for beam intensity modulation, the difference marker output can also be used for "cutting holes" in the trace on the oscilloscope screen.

SPECIFICATIONS

A) Carrier Frequency Generator:

CARRIER FREQUENCY RANGE:

Band A: 5-50 Mc/s
Band B: 50-120 "
Band C: 150-260 "

CARRIER FREQUENCY DIAL:

Three scales, one for each band, calibrated directly in Mc/s. Accuracy of calibration better than 2 Mc/s.

FREQUENCY MODULATION:

Deviation continuously variable up to about ±10 Mc/s. The modulation frequency is that of the power line.

B) Marker Frequency Oscillator:

MARKER FREQUENCY RANGE:

Band A: 5.1-5.9 Mc/s
Band B: 18-47 "

MARKER FREQUENCY DIAL:

Two scales, one for each band, calibrated directly in Mc/s on fundamental frequencies. Accuracy of calibration better tan 0.5%.

FIXED MARKER FREQUENCIES:

10 fixed frequencies on standard TV channel pix-frequencies (European standard) marked with channel numbers. The frequencies are:

Channel No.	Pix Frequency Mc/s
2	48.25
3	55.25
4	62.25
5	175.25
6	182.25
7	189.25
8	196.25
9	203.25
10	210.25
11	217.25

Accuracy of calibration better than 0.5%.

MARKER LEVEL CONTROL:

The marker oscillator output is added to the carrier output inside the instrument at the input end of the attenuator. The relative level of marker output can be adjusted by means of the marker level control.

C) Difference Marker Circuit:

The difference marker circuit provides for a pair of pips with a constant frequency difference of 5.5 Mc/s.

The output from the difference marker circuit is available from terminals on the front panel and can be fed to the Y or intensity modulation input of the oscilloscope. The magnitude of the pips can be adjusted by means of the difference marker output control.

D) General

ATTENUATOR:

Continuously variable. Dial arbitrarily calibrated. Attenuation about 65 db.

OUTPUT IMPEDANCE:

75 ohms approx. resistive

OUTPUT VOLTAGE:

From about 50 μV to about 0.1 volt open circuit voltage.

POWER SUPPLY:

110, 127, 150, 200, 220, 240 volts, 50-60 c/s. Primary consumption approx. 44 watts.

TUBES:

1 type EC 81 (6R4)
3 - ECC81 (12AT7)
3 - EF80 (6BX6)
1 - OA2

ACCESSORIES SUPPLIED:

1 power cord type C12H13-1.5
1 output cable type C3A3

EXTRA ACCESSORIES AVAILABLE:

Type UBT1 Transformer for 300 ohm balanced output.
Type OSG43 Oscilloscope

OVER-ALI DIMENSIONS:

Height: 250 mm
Width: 560 -
Depth: 260 -

NET WEIGHT:

17.5 kilos

SECTION I

OPERATING PRINCIPLE

A complete circuit diagram (drawing No. 856-A2) of the Sweep Generator is appended to the instructions.

1-1 THE CARRIER-FREQUENCY GENERATOR SYSTEM

The carrier-frequency generator system consists of a beat frequency oscillator incorporating a frequency modulated oscillator with fixed center frequency, a wideband buffer and limiter stage, a mixer stage, and a variable frequency oscillator.

The frequency modulated oscillator consists of the circuit associated with the left half of the tube No. 1, which is operated as a Hartley oscillator with grounded cathode.

The tank coil L_3 (location A2 of the circuit diagram) is wound on a small ferrite rod. The rod is mounted between the poles of an electromagnet (Tr2, loc. B2) with two windings. A d-c current in one of the windings provides for a constant magnetic field, and an a-c current in the other winding provides for an alternating magnetic field in the ferrite rod. The resulting magnetic field in the ferrite rod will mainly consist of the superposition of these two fields. It is a well-known fact that the effective permeability of ferrite is a function of the field strength.. Thus the varying magnetic field in the ferrite rod will cause a variation of the inductance of the tank coil and consequently of the oscillator frequency.

By setting the d-c magnetizing current properly it is possible to obtain a nearly linear dependence on frequency deviation to a-c magnetizing current up to ±10 Mc/s when the center frequency of the oscillator is about 135 Mc/s as in this case.

The d-c magnetizing current is drawn from the anode voltage supply through suitable resistors and the a-c magnetizing current is drawn from the heater voltage supply through an arrangement of two ganged potentiometers (loc. E3-4) providing a nearly logarithmic variation of the deviation or sweep width from 0 to ±10 Mc/s.

When the instrument is used for displaying the frequency response of a circuit on a cathode-ray oscilloscope, a deflection voltage for the CRO can be drawn from the terminals marked TO CRO X-INPUT. This voltage is derived from a separate winding on the power transformer and the phase of the voltage is so adjusted that the beam deflection will depend on the instant frequency of the oscillator in a linear manner.

If the phase relations happen to be wrong, they can be reset by means of the internal phase control P_1 (loc. G3).

To avoid double traced curves on the oscilloscope a blanking circuit has been provided for. The blanking circuit injects a negative pulse into the frequency modulated oscillator circuit in such a way that oscillations are stopped during half the cycle. Thus the electron beam in the oscilloscope traces out the response curve of the circuit under test on its first trip across the screen and a zero reference line on the return trip.

The blanking circuit is associated with the right-hand half of the tube No. 1 which works as a pulse forming circuit. An a-c voltage derived from the deflection voltage for the CRO is fed to the grid of the tube. Half the cycle grid current will be present and strong current will flow through the anode resistor of the tube. The voltage across the anode resistor is coupled into the grid circuit of the frequency modulated oscillator making it oscillate for only half the cycle.

The R-C filter inserted in the grid lead of the blanking tube provides for a phase shift of 90° of the deflection voltage so that the oscillator runs in the proper part of the cycle.

The frequency modulated oscillator is followed by a wideband amplifier and limiter stage, tube No. 2. The principle of this stage is that of a class C amplifier followed by a band-pass filter. After this stage follows the mixer stage, tube No. 3. In the mixer stage the output from the frequency modulated oscillator is mixed with the output from the variable frequency oscillator.

This oscillator consists of the tube No. 4 and the circuits associated with this tube. It gives off a signal for the mixer stage in the frequency ranges 140-185, 185-255, and 285-395 Mc/s converting the frequency modulated signal with a center frequency of 135 Mc/s to an output frequency in the

the ranges 5-50, 50-120, and 150-260 Mc/s, representing the lower sideband of the modulation.

The 75Ω resistor (loc. B8) in the anode circuit of the mixer matches the output cable connecting the mixer stage with the attenuator (loc. E13).

The attenuator is in fact a variable Kelvin line with a characteristic impedance of 75Ω and a total attenuation of about 65 db.

The carrier frequency generator can be switched on and off by means of the SELECTOR switch (loc. F11).

1-2 THE MARKER GENERATOR SYSTEM

The marker generator system consists of an oscillator and buffer amplifier (tube No. 5) and a marker output control. The oscillator can be switched so that the frequency can be varied in two bands, viz. 5.1-5.9 Mc/s including the sound channel IF in TV receivers using the principle of intercarrier sound, and 18-47 Mc/s including the most commonly used picture channel IF.

The tuning is accomplished by means of a variable condenser (loc. A12).

In addition to the two positions of the MARKER RANGE switch corresponding to the variable frequency ranges mentioned above, 10 positions of the switch provide for 10 different fixed marker frequencies corresponding to the pix-frequencies of the normally used European TV standard channels.

The marker output is drawn from the cathode of the buffer amplifier tube through a coaxial cable.

The output is available across a potentiometer (loc. D12) which in conjunction with a 75Ω resistor forms a termination of the cable.

A suitable part of the marker output can now be drawn from the arm of the potentiometer and be added to the carrier output at the input end of the attenuator. A relatively large resistor is inserted in series with the potentiometer arm to avoid disturbance of the impedance relations at the attenuator input.

The potentiometer acts as a marker level control for adjusting the marker output to a suitable value.

The resulting relative level of marker to carrier output will remain unaffected by the setting of the attenuator.

The marker frequency generator can be switched on and off by means of the SELECTOR switch (loc. F11)

1-3 THE DIFFERENCE MARKER CIRCUIT

The difference marker circuit provides for a pair of negative going frequency difference identification pulses occurring when the carrier frequency deviates ±2.75 Mc/s from the center frequency. The output from this circuit can be drawn from the terminals marked DIFFERENCE MARKER OUTPUT (loc. F10). The output can be used for interpolation purposes, such as determining the position of the sound carrier frequency on a display of the response curve of a TV receiver when the position of the picture carrier frequency is known. The output is fed to the oscilloscope directly from the Sweep Generator. When fed to the CRO Y-input, marker pips standing on the trace will occur, but it is also possible to feed the output to the CRO beam modulation input, if any. In this case the marking pulses will produce "holes" in the trace.

The marker pulses are generated by means of two tuned circuits loosely coupled to the frequency modulated oscillator of the carrier generator system (loc. B2).

When the oscillator frequency passes through the tuning frequency of one or the other tuned circuit, RF voltage will occur across the crystal rectifier which gives off d-c pulses.

These pulses, however, are relatively long and unsuitable for marking purposes.

After amplification in tube No. 6 the pulses are shaped in a double-clipper (tube No. 7) and a differentiating and rectifying circuit. The clipper acts so that only a small slice of the top of the primary pulses is cut out and amplified. From the front edge of the slice the differentiating and rectifying current produces a sharp negative pip.

The output from the difference marker circuit is controlled by means of the potentiometer (loc. G9) marked DIFFERENCE MARKER AMPLITUDE. The impedance looking into the output terminals is made high by means of a 100 kΩ resistor.

1-4 THE POWER SUPPLY

The instrument operates from a 50-60 cycle power line. The line voltage selector (loc.E-F2) can be set to the following voltages: 110, 127, 150, 200, 220, or 240 volts, a-c.

The full-wave rectifier circuit associated with the selenium-iron type rectifier (loc. F3) supplies a d-c voltage for the carrier generator difference marker circuits and for the stabilisation circuit incorporating the voltage stabilizer-tube No. 8 providing anode voltage for the marker generator.

The 6.3 volt winding of the power transformer provides filament power for all the tubes and power for the frequency modulation circuit of the frequency modulated oscillator.

SECTION II

OPERATING INSTRUCTIONS

2-1 CONNECTION

Before connecting the instrument 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 on the back of the cabinet is removed. Before the instrument leaves the factory, the voltage selector is always set to 220 volts

Switch the instrument on with the power switch and allow to warm up for some minutes.

2-2 CONTROLS, DIALS AND TERMINALS

All controls are located on the front panel.

(a) Carrier frequency controls
The CARRIER RANGE switch provides for the selection of carrier frequency range.

The main tuning dial of the carrier generator is calibrated directly in Mc/s. Three scales are used, one for each frequency range.

(b) Sweep width control
The sweep width or deviation of the carrier frequency generator is set with the SWEEP-WIDTH knob which controls the deviation from zero to ±10 Mc/s in a single range. Provisions have been made for nearly logarithmic variation of the deviation thus facilitating the setting of small deviations. The calibration of the dial of the control is arbitrary.

(c) Marker/carrier selector switch
The SELECTOR switch provides for switching the carrier generator and marker generator on and off.

Three positions are available, viz.

1) Carrier on - marker off
2) Carrier on - marker on
3) Carrier off - marker on

(d) Marker generator frequency controls
The MARKER RANGE switch provides for the selection of marker frequency range or frequency. Two ranges of variable marker frequency and ten fixed frequencies can be selected.

The main tuning dial of the marker generator is calibrated directly in Mc/s. Two scales are used, one for each range.

The main tuning dial is operated by means of a friction drive knob.

(e) Output controls
The output level is set with the HF-ATTENUATOR. The total attenuation is about 65 db. The dial is calibrated arbitrarily from 0-10.

The marker generator output is added to the carrier output at the input end of the attenuator. Consequently the two signals are equally attenuated so that the relative level of marker output to carrier output is not affected by the setting of the attenuator.

The relative marker/carrier level is set by means of the MARKER LEVEL control.

(f) Difference marker output control
By means of the DIFFERENCE MARKER AMPLITUDE control the output from the difference marker circuit can be adjusted to a suitable value.

(g) Terminals
The power input terminals are placed on the back of the instrument cabinet. A 1.5 m long power cord, type C12H13-1.5 is supplied with the instrument.

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

From the terminals marked TO CRO X-INPUT a deflection voltage of the order of 60 volts is available for the cathode-ray oscilloscope.

At the DIFFERENCE MARKER OUTPUT terminals a pair of marking pulses are available the amplitude of which can be controlled by means of the DIFFERENCE MARKER AMPLITUDE control. The difference marker output can be fed directly to the Y-input of the oscilloscope giving short pulses standing on the trace, or it can be fed to the beam modulation input of the oscilloscope to produce holes in the trace. The difference between the markers is 5.5 Mc/s.

2-3 STEP-BY-STEP OPERATION

(1) Set the line voltage selector to the voltage on which the instrument is to operate.

(2) Connect the instrument to the power line, switch on, and allow it to warm up.

(3) Connect the terminals marked TO CRO X-INPUT to the oscilloscope and adjust the X-amplification to a suitable value.

(4) Connect the terminals marked DIFFERENCE MARKER OUTPUT to the Y-input or beam modulation input of the oscilloscope and set the DIFFERENCE MARKER AMPLITUDE control to a suitable position.

(5) Connect the HF OUTPUT terminal to the desired point in the TV receiver via a low-pass RC-filter (series resistor about 200 kΩ, shunt capacitor about 300 pF) to the Y-input of the oscilloscope.

(6) With the SELECTOR switch in position CARRIER ON select the desired frequency by means of the CARRIER RANGE switch and the carrier frequency dial knob.

(7) The setting of HF ATTENUATOR and SWEEP WIDTH control depends on the conditions of the test.

(8) If frequency calibration by means of the marker generator is desired, set the SELECTOR switch to CARRIER ON/MARKER ON and select the desired frequency by means of the MARKER RANGE switch and the marker frequency dial knob.

Using the MARKER LEVEL control set the marker output to a suitable value.

(9) If CW signals from the instrument are desired, set the SELECTOR switch to MARKER ON and select the desired frequency by means of the MARKER RANGE switch and the marker frequency dial knob. Set the MARKER LEVEL control to maximum and, using the HF ATTENUATOR, set the output to a suitable value.

SECTION III

MAINTENANCE

3-1 GENERAL

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. Attempts to improve the instrument should not be 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.

Protect the instrument from dust, moisture, and extreme temperatures. It is advisable from time to time to inspect the exterior for dust, dirt and corrosion.

3-2 REMOVING THE INSTRUMENT FROM THE CABINET

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

3-3 TUBE REPLACEMENT

Generally the tubes require no replacement until they cause some kind of trouble.

Usually tubes with average characteristics can be used for any replacement.

The tubes No. 6, 7, and 8 are readily replaced when the instrument is removed from the cabinet.

The tubes No. 1, 2, 3, 4, and 5 in the RF assembly can be replaced when the shield cover of the assembly has been removed.

On replacing tubes No. 4 or 5 it is advisable to check the output frequency of the carrier and marker, respectively. Generally the replacement of these two tubes will not seriously affect the output frequencies. If this is the case, however, the tubes must be selected so that the calibration remains unaffected.

3-4 ADJUSTMENT OF THE PHASE OF THE DEFLECTION VOLTAGE FOR THE C.R.O.

If the phase of the deflection voltage for the cathode-ray oscilloscope available at the terminals marked TO CRO X-INPUT happens to be wrong, it can be readjusted by means of the internal phase control P_1 (loc. G3). The control is accessible when the instrument has been removed from the cabinet.

3-5 ADJUSTMENT OF FIXED MARKER FREQUENCIES

If the setting of one or several of the fixed marker frequencies changes, it can easily be reset by means of a screw driver of insulating material inserted through the hole in the back of the cabinet.

3-6 ADJUSTMENT OF THE DIFFERENCE MARKER CIRCUIT

The frequency difference indicated by means of the output pulses from the difference marker circuit can be adjusted by means of the trimmer capacitors 3-33 pF (loc. B2). These trimmers are accessible through holes in the shield cover of the RF assembly when the instrument has been removed from the cabinet.

The adjustment can be made without additional test equipment in the following way:

With an ordinary test set-up for examining the IF response of a TV receiver start the marker generator and adjust the frequency to 5.5 Mc/s. By setting the marker output control properly a series of pips will occur on the trace on the oscilloscope. The frequency difference between the pips will be 5.5 Mc/s because the pips indicate the harmonics of 5.5 Mc/s incorporated in the IF pass band. By means of the carrier tuning control it is possible to align one of these pips with one of the difference marker pips. Now the other difference marker pip is brought into agreement with the neighbouring pip by means of the corresponding trimmer.

If the difference marker output disappears, a defective crystal diode (loc. B2) may be the cause.

If two undesired positive going pulses occur in the output of the difference marker circuit, the crystal diode (loc. G9) is defective and must be replaced.

3-7 OPERATING VOLTAGES AND CURRENTS OF THE SWEEP GENERATOR

The voltages and currents listed on the next page can be used as references when servicing the Sweep Generator. The values are mean values from a series of measurements, and deviations up to 20% may usually be neglected. The voltmeter should be one with a negligible consumption (such as a vacuum-tube voltmeter).

VOLTAGE MEASUREMENTS

from		to	d-c voltage	
tube No. 1	pin No. 1	chassis	255	volts
	2	"	28	"
	6	"	180	"
tube No. 2	pin No. 7	"	240	"
	8	"	125	"
tube No. 3	pin No. 7	"	240-260	"
	8	"	120-145	"
tube No. 4	pin No. 1	"	−10-−12	"
	8	"	115	"
tube No. 5	pin No. 1	"	150	"
	3	"	0.3	"
	6	"	92	"
	7	"	−3-−12	"
tube No. 6	pin No. 1	"	0.9	"
	7	"	140	"
	8	"	100	"
tube No. 7	pin No. 1	"	60	"
	3-8	"	35	"
	6	"	115	"
tube No. 8	pin No. 1-5	"	150	"

CURRENT MEASUREMENTS

Total primary consumption at 220 volt line voltage: 225 mA∿