

instruction manual

ELECTRONIC MEASURING INSTRUMENTS FOR SCIENTIFIC AND INDUSTRIAL USE

Type RV33
VACUUM-TUBE VOLTMETER



RADIOMETER

INSTRUCTION AND OPERATING MANUAL
FOR

Type RV33
VACUUM-TUBE VOLTMETER

These instructions apply to
model RV33 only.

Type RV33
VACUUM-TUBE VOLTMETER

1) GENERAL DESCRIPTION

This vacuum-tube voltmeter is designed to measure a-c voltages in the sonic, the super-sonic, and the carrier frequency range or wherever there is a demand for a combination of great sensitivity, wide frequency range, and wide voltage range.

The instrument has 11 ranges with full deflection for 5-15-50-150 and 500 millivolts and 1.5-5-15-50-150 and 500 volts. An additional db scale indicates the voltage in db over 1 millivolt. The frequency range is 20 cps to 3 Mc in all ranges.

The instrument operates with cathode-follower input in the ranges 5 to 500 millivolts, and consequently with high input impedance. In the remaining ranges a 2 Megohm voltage divider is used before the cathode follower.

The instrument can be used as an amplifier with an amplification of approximately 70 db in the 5 millivolt range.

The instrument is designed for operation from an a-c 50-60 cps power-supply. The negative feedback employed renders the instrument substantially independent of variations in line voltage, tubes, circuit components, etc.

2) OPERATING PRINCIPLE

The instrument consists of a cathode-follower input stage, a 3-stage amplifier with negative feedback, a full wave crystal diode rectifier and a meter to indicate the rectified current. The different measuring ranges are selected by means of two attenuators, one of them mounted between the cathode follower and the amplifier, and the other mounted before the cathode follower. The amplifier operates with heavy negative feedback and is therefore almost independent of line voltage variations and tube aging. The rectifiers and the meter are automatically disconnected when the instrument is used as an amplifier.

3) SETTING THE LINE VOLTAGE

When leaving the factory the instrument is set to 220 volts line voltage,

but operation at the following voltages 110-127-150-200 and 240 is also possible. The adjustment is made by means of a switch mounted on the line transformer.

Note: After adjustment remember to set the dial at the back of the instrument to the voltage chosen.

4) OPERATING THE VACUUM-TUBE VOLTMETER

The instrument is ready for use approximately a minute after being switched on. It is only possible to measure sources where one terminal is connected to chassis. A superimposed d-c voltage of 300 volts can be allowed for.

5) MEASURING RANGES

The vacuum-tube voltmeter has 11 ranges with full deflection for: 5-15-50-150 and 500 millivolts and 1.5-5-15-50-150 and 500 volts. On all ranges the frequency range is 20 cps to 3 Mc.

6) ACCURACY AND FREQUENCY RESPONSE

The accuracy at 1 kc is 2% of full-scale deflection and about the same accuracy can be obtained in the frequency range from 60 cps to 1.5 Mc because the response of the amplifier is straight in this range. In the range 20 cps to 60 cps the response of the amplifier shows a maximum drop of about 1% at 30 cps. At 20 cps the drop is between 0 and 1%. The response at low frequencies is not affected by the range switch. At frequencies higher than 1.5 Mc the response depends somewhat on the position of the range switch and is generally between +2% and -2% to -3% at 3 Mc. At 4 Mc the limits are about +2% and -10%.

7) INPUT IMPEDANCE

The input impedance is dependent on the position of the switch. In the positions 5-15-50-150 and 500 millivolts the input voltage is fed directly to the grid of the cathode-follower, and an input impedance of 7 megohms in parallel with 19 pF is obtained at low frequencies. The ohmic component of the input impedance is dependent on the frequency. At 50 kc it is about 5 M Ω and it falls proportionally to the logarithm of the frequency to about 1 M Ω at 0.5 Mc. It then rises to an infinitely high positive value at about 1 Mc and turns over to an infinitely high negative value, which numerically goes down to some hundred kilohms as the

frequency rises.

In the positions 1.5 volt to 500 volts a 40 db attenuator is switched on before the cathode follower. The attenuator consists of $2\text{ M}\Omega$ in series with $20.2\text{ k}\Omega$. The input impedance is 11 pF in parallel with $2\text{ M}\Omega$ at frequencies up to 300 kc.

At higher frequencies the ohmic component drops proportional to the logarithm of the frequency to about $0.5\text{ M}\Omega$ at 3 Mc.

8) RESISTANCE TO OVERLOAD

The circuits are so designed that neither the rectifiers nor the meter can be damaged by overloading. During a long period the input voltage should not exceed approximately ten times the voltage that gives full-scale deflection, so as not to damage the cathode follower, and it should not go much over 500 volts, so as not to damage the switch.

9) INFLUENCE OF WAVEFORM

The indication of the meter is proportional to the average value of the a-c voltage, but the calibration is made so that the meter reads the rms value of a sinusoidal voltage. The deflection practically depends on the fundamental wave only, and the influence of harmonics or other (weaker) frequencies is negligible.

10) INFLUENCE OF LINE VOLTAGE

In general $\pm 5\%$ change in line voltage causes only about $\pm 1\%$ change in deflection. At the limits of the frequency range the change is about $\pm 2\%$ because the negative feedback is somewhat lower. If the influence of line voltage variations is much greater this indicates that one or more of the tubes are worn out.

11) ADJUSTING THE VACUUM-TUBE VOLTMETER

The voltmeter is so stable that in general calibration does not have to be made, except when replacing tubes or when compensating for the wear of tubes that have been used for a long time. The calibration is made by measuring an exact known voltage of e.g. 5 millivolts at 1 kc. The voltage has to be taken from a generator supplying a pure sinusoidal voltage, e.g. the Radiometer type HO32 or type HO12 Beat-Frequency Oscillator.

12) HUM VOLTAGES

With short circuited input a little deflection is observed with the switch in the 5 millivolt position. The deflection is due to hum voltages and these do not affect the reading, if only the voltage to be measured is 2 or 3 times higher. At frequencies in the neighborhood of the line frequency, the hum voltages causes small oscillations of the meter needle. The correct reading is obtained by taking the average of the highest and lowest deflection.

When measuring at the line frequency two different deflections are had if the line plug is reversed. Also in this case the correct value will be the average of the two readings. The hum voltage referred to the input is generally less than 100 microvolts. It is set to a minimum by means of a potentiometer across the filament winding of the transformer. The potentiometer shaft has a slot for screw-driver adjustment and is accessible through a hole in the bottom of the instrument.

13) USING THE VACUUM-TUBE VOLTMETER AS AN AMPLIFIER

When using the instrument as an amplifier the amplification is about 70 db in the 5 mV position, 60 db in the 15 mV position, etc. When a banana plug is inserted in the output jack, the rectifiers and the meter are automatically switched off. The output impedance is 10 k Ω in series with 0.1 μ F. The frequency response depends on the load. With a load of 10 pF the amplification has dropped about 3 db at 500 kc and about 6 db at 1 Mc. The maximum output voltage is about 60 volts. At a 20 volt output, unloaded, the distortion is about 0.5%, and at 40 volts it is about 1%. At higher output voltages the distortion increases rapidly.

14) SERVICING THE VACUUM-TUBE VOLTMETER

The frequency response is critically dependent on the wiring and the placing of components in the amplifier and the attenuator. The wire-wound resistors of the attenuator are a non-inductive type and should not be replaced by resistors of any other type.

The attenuator mounted before the cathode-follower consists of a 2 M Ω resistor in series with 20.2 k Ω . A trimmer is placed in parallel with

the 2 M Ω resistor. This trimmer is accessible through the hole in the ground-jack beneath the INPUT jack. It will probably never be necessary to trim the trimmer (only if the frequency response in the ranges 1.5-500 volts is not straight at frequencies beyond 50 kc).

After replacement of a tube the sensitivity and the hum must be checked.

Tube No. 1 is a type EF 40 and only a very few specimens will give rise to too much hum. Tubes No. 2, 3, and 4 are of the type EF 42 and some specimens used as tube No. 2 will cause too much hum, even after setting the hum compensating potentiometer to its optimal position.

If the instrument does not operate at all, the fault may be due to a defective fuse. The fuse is mounted at the line transformer, and has to be a 125 mA slow blow type at line voltages of 200 to 240 volts. A 250 mA type is used at line voltages of 110-127 and 150 volts.

