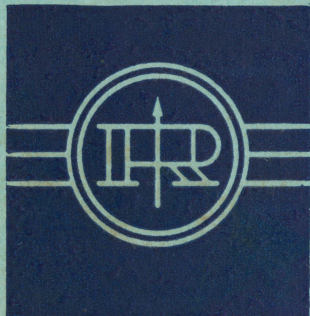


INSTRUCTION MANUAL

DC - AC Voltmeter
Type RV24



RADIOMETER

ELECTRONIC MEASURING INSTRUMENTS
FOR SCIENTIFIC AND INDUSTRIAL USE

**Instruction Manual
for**

**DC - AC Voltmeter
Type RV24**

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DC - AC Voltmeter Type RV24

Section A. Introduction

The DC-AC Voltmeter, type RV24, comprises a DC voltmeter with high input impedance, a wideband AC diode-type voltmeter, and an ohmmeter.

Owing to its high measuring stability this VTVM is ideal as a general-purpose instrument for the laboratory and the workshop.

The large mirror-backed meter with its four voltage scales and one resistance scale has a knife-edge pointer which combines with fine-scale graduation to give accurate reading free from parallax. It reads the rms value of a sine wave, but responds to the positive peak value of the input voltage.

A conveniently located series of push-buttons switches the instrument to the measuring ranges and modes as follows:

DC MEASUREMENTS

from ± 1 to ± 1000 V f.s.

-using the two regular, floating binding posts for direct measurements, with a $60\text{ M}\Omega$ input impedance.

-using the $2\text{ M}\Omega$ Probe, type PB3, to minimize AC loading.

-extended up to 30.000 V with optional $1200\text{ M}\Omega$ Probe, type PB2.

AC MEASUREMENTS

1 to 300 V f.s.

-within 10 cps to 50 Mc , using a UHF socket, for direct measurements.

-extended up to 1000 Mc , with optional UHF probe, type UPB1. Together with Probe "T" Connector, type UPB2, the VSWR is less than 1.2 on $50\text{ }\Omega$ systems.

RESISTANCE MEASUREMENTS

0 to $500\text{ M}\Omega$, with a test voltage of 1.5 V from a built-in battery, using the same terminals as for DC direct measurements.

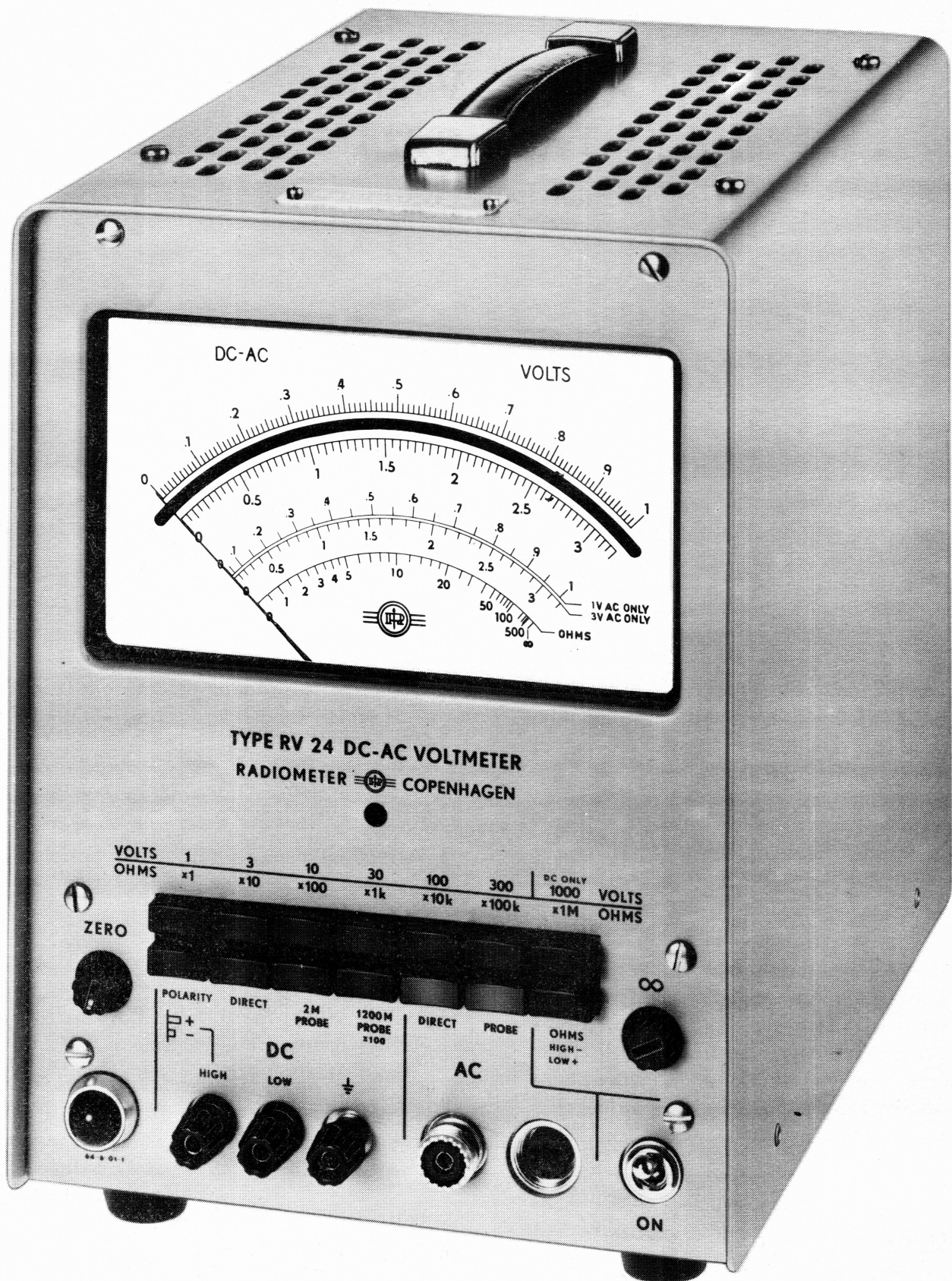


Fig.1 The DC-AC Voltmeter, type RV24.

Section B. Specifications

DC VOLTAGE

Voltage Ranges

1, 3, 10, 30, 100, 300, and 1000 V DC f.s.

First scale division at 10 mV.

(Up to 30 kV with optional 1200 M Ω Probe, type PB2, which reduces the input voltage in the ratio of 100 to 1).

Max. Input Voltage

AC: 450 V peak

DC: AC peak voltage plus DC voltage should not exceed 1000 V.

Accuracy

Better than 3% of full-scale reading.

Input Resistance

60 M Ω between terminals HIGH and LOW. By using optional 2 M Ω Probe, type PB3, the DC loading can be kept at 60 M Ω , and the AC loading at not less than 2 M Ω shunted by 1 pF.

Floating Input

Input may be floated up to 400 DC above chassis.

Impedance from LOW terminal to chassis is 25 M Ω shunted by 5000 pF.

Polarity

A polarity push-button reverses the polarity of the HIGH terminal referred to the LOW terminal, the HIGH terminal being negative with respect to the LOW terminal when the push-button is pressed.

AC VOLTAGE

Voltage Ranges

1, 3, 10, 30, 100, and 300 V f.s.

First scale division at 50 mV.

Max. Input Voltage

450 V Peak.

Accuracy

3% of full-scale reading at 1 Mc.

Frequency Response

Within 0.2 dB from 50 cps to 25 Mc.

Within 1 dB from 10 cps to 50 Mc.

Calibration

Meter reads the rms value of a sine wave, but responds to the positive peak value of the input voltage.

Input Impedance

10 pF shunted by 10 M Ω at low frequencies. At higher frequencies the resistance decreases due to dielectric losses. With UHF Probe, type UPB1, approximately 1.2 pF shunted by 10 M Ω (at low frequencies).

OHMMETEROhm Ranges

Scale: 0 to 500 Ω . Mid-scale value 10 Ω .
0 to 500 M Ω in 7 ranges with multipliers
 $\times 1$, $\times 10$, $\times 10^6$.

Accuracy

5% at mid-scale.

Test Voltage

1.5 V from built-in battery.

Power Supply

Voltages: 110, 115, 127, 200, 220 and
240 V.

Frequencies: 50 to 60 cps.

Consumption: 20 W.

Tube Complement

2 type ECC81 or 12AT7

1 type EAA91 or 6AL5

Battery

1.5 volts, 33 x 61 mm.

Dimensions and Weight

Length: 260 mm (10 1/4 inches)

Width: 200 mm (8 inches)

Depth: 320 mm (12 5/8 inches)

Weight: 5.6 kg net (12 lbs)

ACCESSORIES AVAILABLE

1200 M Ω Probe, type PB2, for max. 30 kV. DC voltage measurement.

2 M Ω Probe, type PB3, to minimize AC loading.

UHF Probe, type UPB1, which makes possible measurements up to 1000 Mc.

Probe "T" Connector, type UPB2, for UHF Probe, type UPB1. Max. VSWR \leq 1.2 at 1000 Mc with probe inserted. For 50 Ω systems.

Coaxial Cable (75 Ω), type 3A3, with two UHF plugs, type P2-259.

SPECIFICATIONS FOR ACCESSORIES:

See "SECTION C".

Section C. Accessories

DC PROBES:

2 MΩ Probe, type PB3:

Is a probe to be used with the DC-AC Voltmeter, type RV24, when the AC loading must be kept low. It contains a 2 MΩ resistor in series with the VTVM. It is 135 mm long and is connected to the VTVM by means of a banana plug inserted in the HIGH terminal, the LOW terminal being connected directly to the other terminal of the object under test.

1200 MΩ Probe, type PB2:

Is a probe for high voltage up to 30,000 V. It contains a 1200 MΩ resistor in series with the VTVM. It is about 260 mm long and is connected through a lead to a banana plug that fits the HIGH terminal of the VTVM, the LOW terminal being directly connected to the other terminal of the object under test. As regards adjustment of the DC-AC Voltmeter, type RV24,

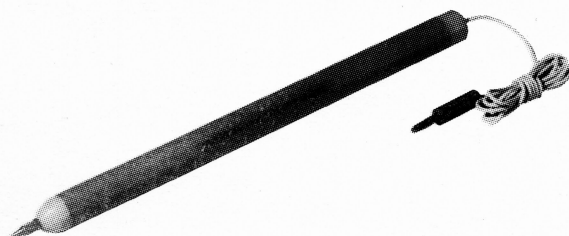


Fig.2 The 1200 MΩ Probe, type PB2.

when used with the 1200 MΩ Probe, type PB2, see page 18 under MAINTENANCE.

AC PROBE AND PROBE "T" CONNECTOR

UHF Probe, type UPB1:

Is a diode-probe which contains a thermionic diode, a blocking capacitor, and a resistor. The circuit of the UHF Probe functions as a peak detector charging the capacitor to a voltage equal to the positive peak of the signal.

Measurements are practical up into the region of 400 megacycles, but at higher frequencies distributed stray inductance will ordinarily restrict measurements to coaxial transmission lines only (see following section).

NOTE: Unless the UHF Probe, type UPB1, has been delivered with the VTVM, the latter must be adjusted before use. (see MAINTENANCE, page 18).

Specifications

AC Voltage

300 V up to 100 Mc
decreasing linearly to 30 V at 1000 Mc.

Accuracy

3% of full-scale at 1 Mc

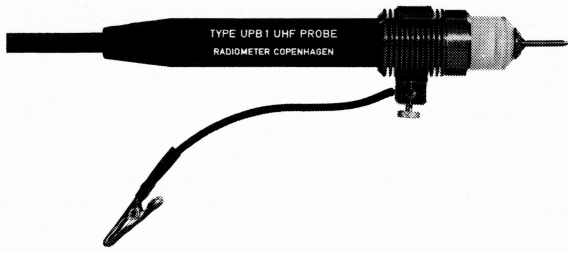


Fig.3 The UHF Probe, type UPB1.

Frequency Response

20 cps to 1000 Mc within ± 1 dB
 100 cps to 100 Mc within ± 0.2 dB

Input Impedance

1.2 pF shunted by 10 M Ω at low frequencies.

DC Voltage

The AC peak voltage plus the DC voltage must not exceed 1000 V.

Accessories supplied with UHF Probe, type UPB1.

Grounding clip
 Grounding lead with alligator clip
 Probe head tip.

Probe "T" Connector, type UPB2:

Voltage measurements at high frequencies can be divided into two types, viz.: measurements on coaxial transmission lines and measurements on accessible circuits such as the wiring in a high-frequency amplifier. The type UPB2 "T" Connector has been developed to measure voltages in coaxial lines. This connector allows for measuring or monitoring the voltage in a transmission line and functions as a section of transmission line with a matching impedance of 50 Ω . Provision is made for connecting the probe of the voltmeter across the line. The "T" Connector can be connected into a nominal 50 Ω line without causing serious disturbance, and the VSWR introduced by it is less than 1.2 at 1000 Mc with probe inserted.

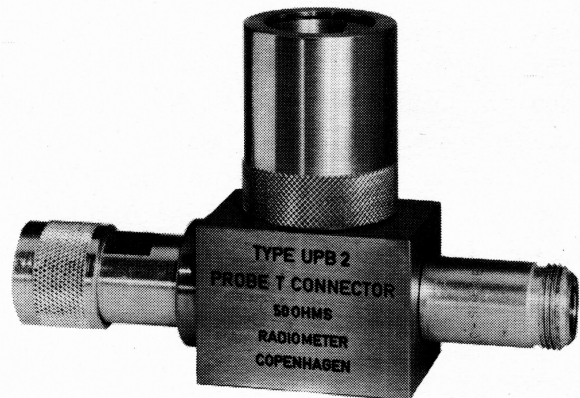


Fig.4 The Probe "T" Connector, type UPB2.

Section D. General Description

GENERAL

The DC-AC Voltmeter, type RV24, consists of two cathode-follower stages following a symmetrical 2-stage DC amplifier with heavy negative feedback which provides for less dependence on line voltage variations and tube ageing. The built-in power supply operates with only a slightly loaded selenium rectifier. Furthermore, the tubes are so conservatively rated that long trouble-free service may be expected.

Printed circuit-boards are utilized for the greater part of the VTVM circuit to ensure a reliable and robust construction, and to reduce its weight to a minimum.

CONTROLS, TERMINALS, AND METER

As shown in Fig.5, the DC-AC Voltmeter, type RV24, is equipped with the following controls, terminals, and meter:

Power Switch (OFF) and Pilot Lamp (POWER)

Power switch (1) and pilot lamp (2) are located on either side of the front panel.

Range Switch and Operational Switch

The upper row of push-buttons (3) selects the desired measuring range.

The lower row of push-buttons (4) selects the desired mode of operation and the polarity for DC voltage measurements. The

terminal HIGH (5) is positive with respect to LOW (6) when the POLARITY button is released, and negative with respect to LOW when the POLARITY button is pressed.

The DC DIRECT button must be pressed when it is desired to use the instrument for DC voltage measurements without a probe.

If the 2 M Ω Probe, type PB3, or the 1200 M Ω Probe, type PB2, is used, the button 2 M Ω PROBE \times 1 or 1200 M Ω PROBE \times 100 respectively must be pressed. The inscriptions " \times 1" and " \times 100" indicate that the meter readings must be multiplied by 1 or 100, respectively, when measurements are made using the 2 M Ω Probe, type PB3, and the 1200 M Ω Probe, type PB2. Further, the AC DIRECT button must be pressed when AC measurements without a probe are made, and the button AC PROBE must be pressed when AC measurements are made with UHF probe, type UPB1.

For resistance measurements, the button marked OHMS must be pressed.

Zero and Infinity Balance knobs

The ZERO knob is used to set the zero balance when measuring DC voltage or resistance. It is located on the left-hand side of the front panel.

The infinity balance is set by means of the ∞ knob (8) located on the right-

hand side of the front panel on a level with the ZERO knob when measuring resistance.

Terminals

For DC voltage measurements and resistance measurements, two terminals accommodating regular banana plugs are provided. The terminals marked HIGH and LOW, located on the left-hand lower part of the front panel, are insulated from the chassis, whereas the

ground bushing, which also accommodates a regular banana plug, is connected to chassis.

For AC voltage measurements, the DC-AC Voltmeter, RV24, has two inputs:

a UHF socket (9) for direct measurements

a five-pole socket (10) for connection to external probe

They are both located on the right-hand lower part of the front panel.

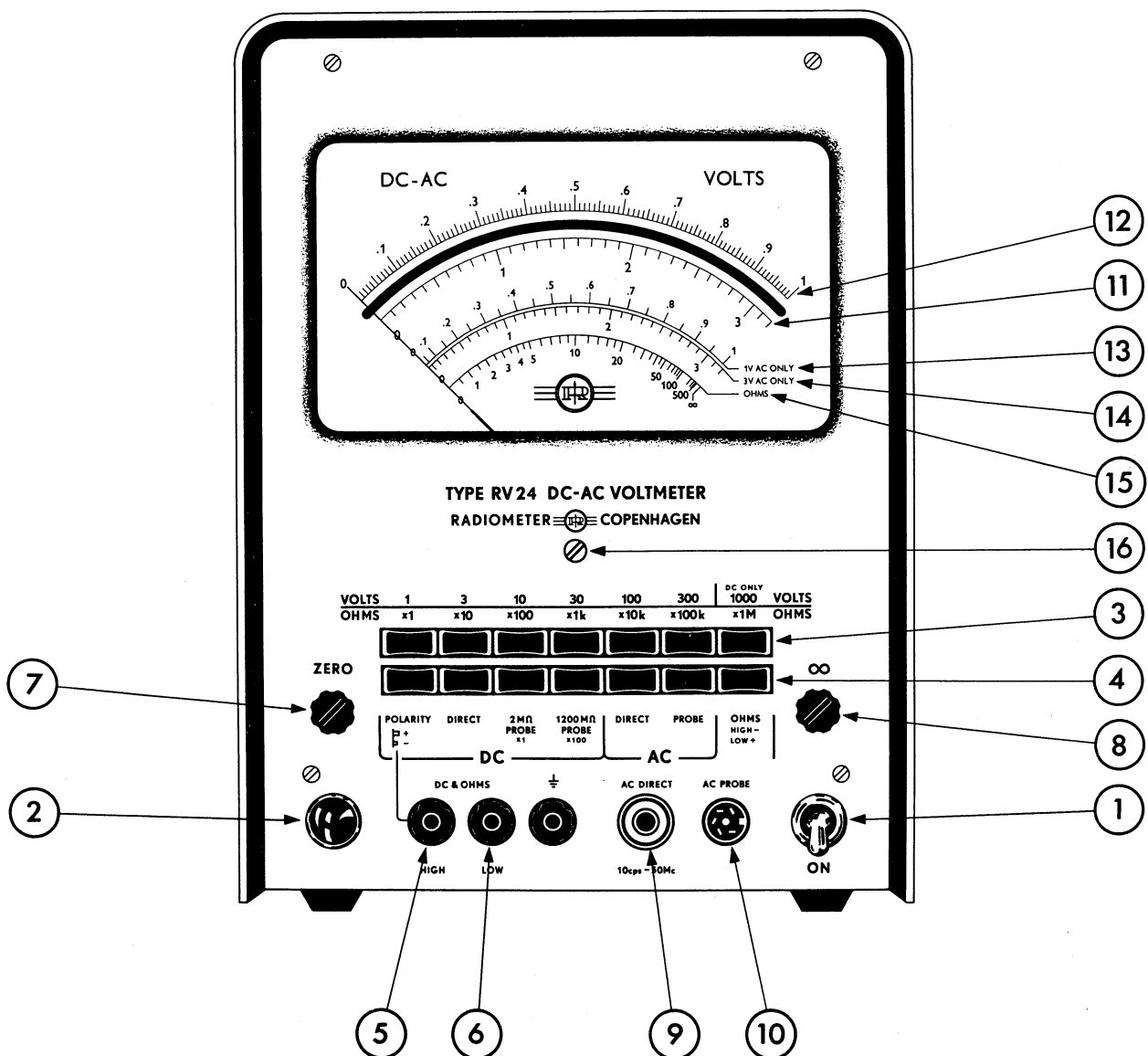


Fig.5 Front plate of the DC-AC Voltmeter, type RV24.

Meter

The meter is equipped with a mirror-backed scale and a knife-edge pointer providing for accurate reading free from parallax.

The voltage scales are located immediately above and below the mirror. The lower scale (11) is graduated into 60 divisions and is used in the ranges 3-30-300 V DC, and in the ranges 30-300 V AC.

The top scale (12) is graduated into 100 divisions and is used in the ranges 1-10-

100-1000 V DC and in the ranges 10-100 V AC.

The two mid-scales are used in the ranges 1 V AC (upper scale (13)) and 3 V AC (lower scale (14)). The bottom scale (15) is used for resistance measurements.

The mechanical zero adjustment screw (16) is accessible through a hole in the front panel, immediately above the range switches. Zero adjustment is seldom required but may be necessary after long usage, or following transportation. Before making this adjustment, the power switch should be thrown to OFF and the instrument placed in its normal operating position.

Section E. Operating Instructions

PREPARING THE DC-AC VOLTMETER, TYPE RV24

Check that the instrument is switched to the correct line voltage as indicated by the plate on the rear of the cabinet. When leaving the factory, the instrument is set to 220 V.

Slow-blow fuses, 0.1 A for 200-240 V operation, and 0.2 A for 110-127 V operation, must be inserted. 2 fuses for 220-240 V or 110-127 V operation are supplied with the instrument. Remember to change fuse when switching from 220-240 V to 110-127 V or conversely.

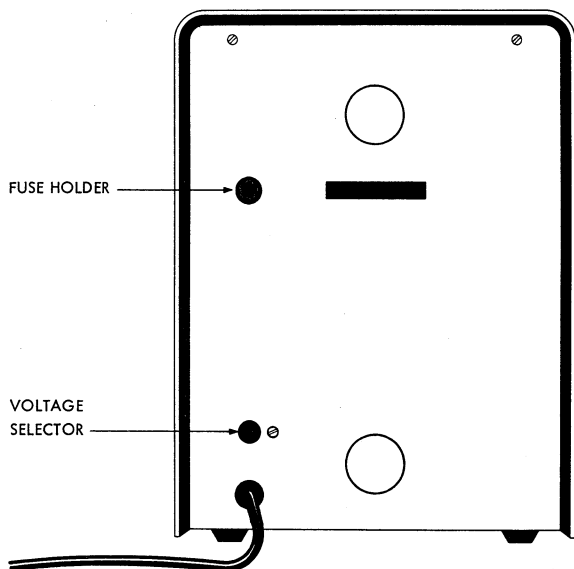


Fig.6 Rear view of the DC-AC Voltmeter, type RV24.

Connect the instrument to the power line and switch on. The VTVM will be ready for use after about two minutes warm-up time.

DC MEASUREMENTS

- 1) Short-circuit terminals HIGH and LOW, ground the instrument, then set the Zero DC balance on the 1V range by means of the ZERO knob.
- 2) Use the 2 M Ω Probe, type PB3, connected to the HIGH terminal, with "2 M Ω Probe \times 1" selected, when the capacitive loading on the voltage source is to be as low as possible.
- 3) Use the 1200 M Ω Probe, type PB2, connected to the HIGH terminal with "1200 M Ω Probe" selected, when voltages exceeding 1000 V are to be measured. As regards adjustment of the DC-AC Voltmeter, type RV24, when used with the 1200 M Ω Probe, type PB2, see MAINTENANCE, page 18.

Connect the LOW terminal to the reference point of the object under test.

- 4) Select the desired measuring range. The range designation on the panel multiplied by the multiplying factor of the probe employed (if any) indicates the full-scale sensitivity.
- 5) Press the button corresponding to the appropriate mode of operation.

- 6) Connect the positive terminal of the object under test to the HIGH terminal and the negative terminal of the object under test to the LOW terminal of the VTVM, when no probe is used, and via the probe when employed. If required, the polarity of the HIGH and LOW terminals can be reversed by pressing the POLARITY switch.
- 7) The value of the voltage measured is then read on one of the two upper meter scales.

AC MEASUREMENTS

- 1) Use the AC DIRECT socket for direct AC measurements for frequencies between 10 cps and 50 Mc.
- 2) Use the UHF Probe, type UPB1, connected to the AC PROBE five-pole socket for frequencies up to approx. 400 Mc, and together with the Probe "T" Connector, type UPB2, for frequencies up to 1000 Mc. As regards adjustments when using the UHF Probe, type UPB1, and the Probe "T" Connector, type UPB2, see MAINTENANCE, page 18.
- 3) Select the desired measuring range.
- 4) Press the button corresponding to the appropriate mode of operation.
- 5) Connect the object under test to the UHF socket when measuring in the AC DIRECT mode, or via the probe.

- 6) The value of the voltage measured is then read on one of the two upper scales with full scale sensitivity 3 to 300 V, or on one of the two lower scales with full scale sensitivity 1 to 3 V.

RESISTANCE MEASUREMENTS

- 1) Press the button OHMS.
- 2) Set the zero and infinity balance by means of the corresponding knobs with the input terminals shorted and opened respectively.
- 3) Select the desired measuring range.
- 4) Connect the measuring object to the HIGH and LOW terminals.
The HIGH terminal is negative with respect to the LOW terminal.
- 5) The value of the resistance measured is then read on the lower scale multiplied by the multiplying factor corresponding to the inserted push-button.

Note:

When measuring low resistances, the zero adjustment should be made with short-circuited test leads, as their resistance otherwise will affect the measurement. When measuring very high resistances (above 1 MΩ), one of the chassis terminals of the VTVM should be grounded to avoid errors due to induced hum voltages.

Section F. Circuit Description

DC MEASUREMENTS

Such measurements are made without the diode rectifier. The voltage is passed through an RC filter to a voltage divider. The sensitivity of the DC-AC Voltmeter, type RV24, can be reduced by means of an input attenuator with three stages of 20 dB, and an attenuator in the meter circuit also with three stages of 20 dB. In the ranges 1-3 and 10 volts, the total voltage is carried on to the grid of the input tube. In the ranges 30 and 100 volts, 1/10 of the voltage is carried on, and in the ranges 300 and 1000 volts only 1/100.

The input tube is a double triode operating as a balanced amplifier. The zero setting is accomplished by varying the bias of the balancing triode.

The second double triode operates as cathode-followers with the meter and its series resistance connected directly to the cathodes. The series resistance is unchanged in the 1000, 100 and 10 volts ranges and in the 300, 30 and 3 volts ranges, whilst the 1 volt range employs a third resistance value. The amplifier operates only with maximum amplification in the 1 volt range, and the inevitable zero drift is therefore 3 to 10 times smaller in all the other ranges than the 1 volt range.

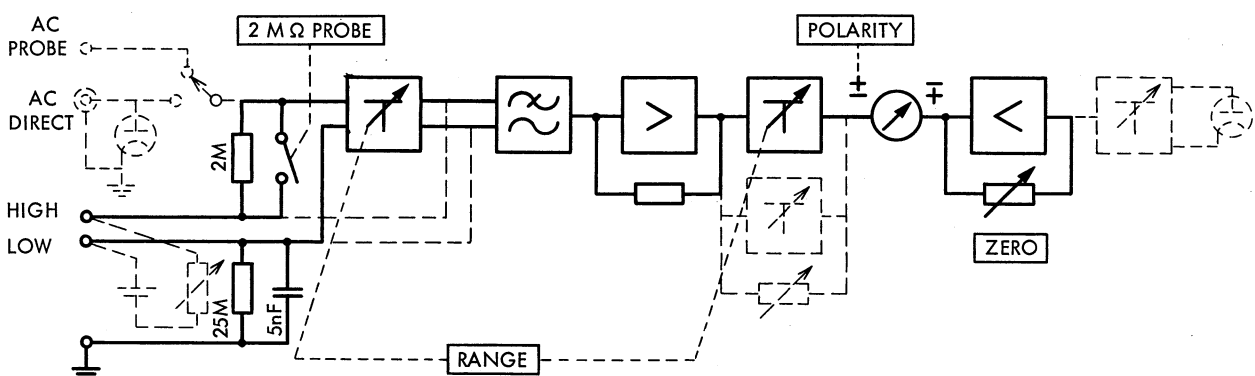


Fig. 7 Block diagram of the DC-AC Voltmeter, type RV24, set to dc measurements.

The HIGH and LOW inputs are floating with respect to chassis, the negative input being isolated from chassis with 25 M Ω and 5 nF. Inserting the 2 M Ω Probe, type PB3, or the 1200 M Ω Probe, type PB2, causes no change in the VTVM proper. The probes, however, introduce an attenuation ratio indicated by a multiplying factor, $\times 1$ and $\times 100$, respectively.

AC MEASUREMENTS

Direct

When the button AC DIRECT is pressed, a thermionic detecting diode is connected to the input attenuator. The signal source to be measured is connected to the UHF socket, which in turn is connected to the diode via a capacitor. The AC voltage is detected by the diode, and the resulting DC voltage over the diode is divided by three resistors according to the DC sensitivity. The diode efficiency decreases with the rectified AC voltage. To compensate for this effect, the DC sensitivity is increased in the three lower AC ranges by means of a potentiometer that shunts the meter series resistor. Because of the diode initial current, and its dependence on heater voltage variations, a compensation of the diode voltage is required. This compensation is accomplished by means of

a circuit containing three series diodes. The circuit output voltage, which is equal to the initial voltage of the detecting diode, is fed through an attenuator to the grid of V201B.

Probe

Instead of the built-in diode, the VTVM can operate with a UHF Probe, type UPB1, together with the "T" Connector, type UPB2. When using the UHF probe, the built-in diode circuit is automatically disconnected.

RESISTANCE MEASUREMENTS

When the button OHMS is pressed, the input attenuator is disconnected, and at the same time the instrument attenuator is changed to a sensitivity of about 1.5 V. Fine adjustment is made by means of the potentiometer INFINITY (R134). A 1.5 V battery is connected in series with a reference resistor (R115 - 121) over the input terminals. In order to reduce the influence of the grid current of the input tube to a minimum, the positive pole of the battery is connected to the LOW terminal. This accounts for the polarity of the HIGH & LOW terminals being reversed when measuring resistance. The current flows from the LOW terminal through the unknown

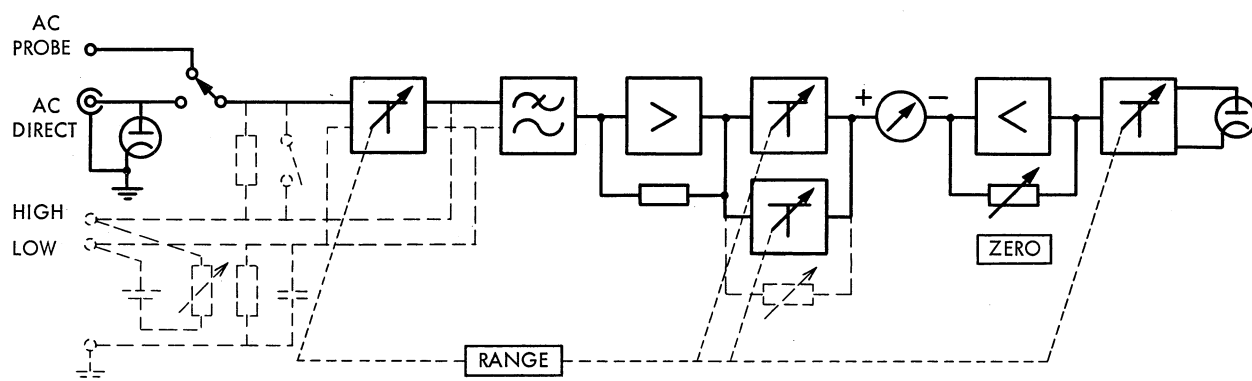


Fig.8 Block diagram of the DC-AC Voltmeter, type RV24, set to ac measurements.

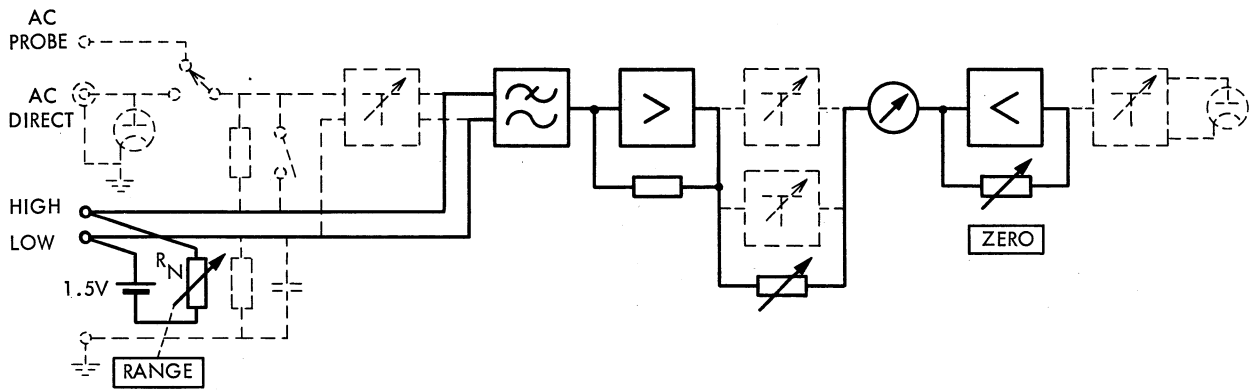


Fig.9 Block diagram of the DC-AC Voltmeter, type RV24, set to resistance measurements.

resistor to the HIGH terminal and onwards through the reference resistance. The VTVM

measures the voltage drop across the unknown resistor.

Section G. Maintenance

GENERAL

The VTVM is designed to withstand normal treatment, but careful handling and proper operation assure a long life and high reliability.

Necessary repairs should be carried out only by skilled personnel provided with the proper equipment to ensure that the repairs are correctly made.

REMOVING THE CABINET

Withdraw the power plug from the power outlet before removing the cabinet.

The cabinet consists of three sections: a front panel, a one-piece back and bottom, and a cover (top and sides).

1) The Cover

The cover is attached to the chassis by means of 4 screws on the top, and is fastened on either side by 4 riveted spacers at the bottom. When the 4 top screws are removed the cover can be lifted off the chassis.

2) One-Piece Back and Bottom

The bottom part is fastened with 4 screws, while the back part is secured by means of 2 screws near the upper edge.

Place the instrument upside down on a protective padding and remove the six aforementioned screws. The one-piece back and bottom can now be removed, if care is exercised to allow for the power cord to pass freely through the hole.

3) Front Panel

The meter is mounted on the instrument chassis, but is spring-loaded so as to press against the front panel which is fastened to the chassis with 6 screws.

Place the instrument with the front panel upwards on a protective padding, and first remove the 2 screws nearest the base. As the remaining four screws are loosened, the meter springs will press out the front panel

TUBE REPLACEMENT

Tubes should be replaced only when they are defective, since a tube replacement requires a subsequent adjustment. If attempts are made to locate a defective tube, only one at a time should be replaced. The tube should be returned to its former position if it does not prove to be the source of trouble. This procedure will simplify the subsequent adjustments.

Replacing tubes in the measuring circuit may cause deviations in calibration.

ADJUSTMENTS

DC Zero Setting

Set the potentiometer ZERO at mid-course. Short-circuit the input terminals and select 1 V DC range and DC DIRECT. By means of ADJ5 (ZERO COARSE), set the balance until the pointer reads zero.

Variations of DC ZERO setting due to variations in line voltage.

If the variation is greater than ± 10 mV in the 1 V DC range, check the variations of the zener diode voltage (CR203). If it is greater than 170 mV, the diode has to be removed because of a too high dynamic resistance. If the variation remains higher than 10 mV with a new diode, change the amplifier tube V201 and re-check.

DC Adjustments

1) Calibrating the 10 V DC range (ADJ4)

Connect the HIGH and LOW terminals to a DC voltage source. Set the Zero balance on the 1 V DC range, switch to the 10 V DC range and adjust to 10 V DC by means of ADJ 4. Switch to -10 V. The variations read on the VTVM should be less than 0.2%.

2) Calibrating the 1, 3, 30, 100, 300 and 1000 V DC ranges

range	adjust
1 volt	ADJ 8
3 volts	ADJ 9
30 volts	ADJ 10
100 volts	ADJ 11
300 volts	ADJ 12
1000 volts	ADJ 13

Select the aforementioned ranges successively, and by means of the corresponding potentiometers adjust to the full-scale deflection value of the selected range.

3) 1200 M Ω Probe (ADJ 3)

Insert the push-buttons "1200 M Ω \times 100" and "1 V DC range". Feed in a 100 V DC signal, and adjust to this value by means of ADJ 3.

AC DIRECT Adjustments

1) Zero setting 1 V AC (ADJ 6)

Short-circuit the AC and DC inputs with short leads and ground the instrument. Set the zero DC balance as described above, then switch over to "1 V AC DIRECT" and set the zero AC balance by means of ADJ6.

2) Calibrating the 100 V AC range (ADJ 1)

Feed in the AC DIRECT socket a 100 V - 1 kc signal and adjust by means of ADJ1 so that the reading is correct.

Note: The calibration is common to the 30, 100, 300 ranges.

3) Calibrating the 1 V AC range (ADJ 17)

Check the zero setting in the 1 V AC range with short-circuited inputs.

Feed in a 1 V - 1 kc signal and adjust to the correct value, using ADJ17.

4) Calibrating the 3 V and 10 V AC ranges

Same procedure as above (readjusting the zero balance is not necessary), however using the potentiometers ADJ18 and ADJ19

AC PROBE Adjustments

1) Zero setting 1 V AC (ADJ 7)

Short-circuit the AC and the DC inputs, with short leads and ground the instrument. Set the zero DC balance as described above, then switch over to "1 V AC PROBE" and set the zero AC balance by means of ADJ7.

2) Calibrating the 100 V AC range (ADJ2)

Feed in a 100 V - 10 kc signal and adjust by means of ADJ2 until the reading is correct.

Note: The calibration is common to the 30, 100, 300 ranges.

3) Calibrating the 1 V AC range (ADJ14)

Set the zero DC balance as described above. Feed in a 1 V - 10 kc signal and set the correct reading with ADJ14.

4) Calibrating the 3 V and 10 V ranges

Same procedure as above, however using the potentiometers ADJ15 and ADJ16 respectively.

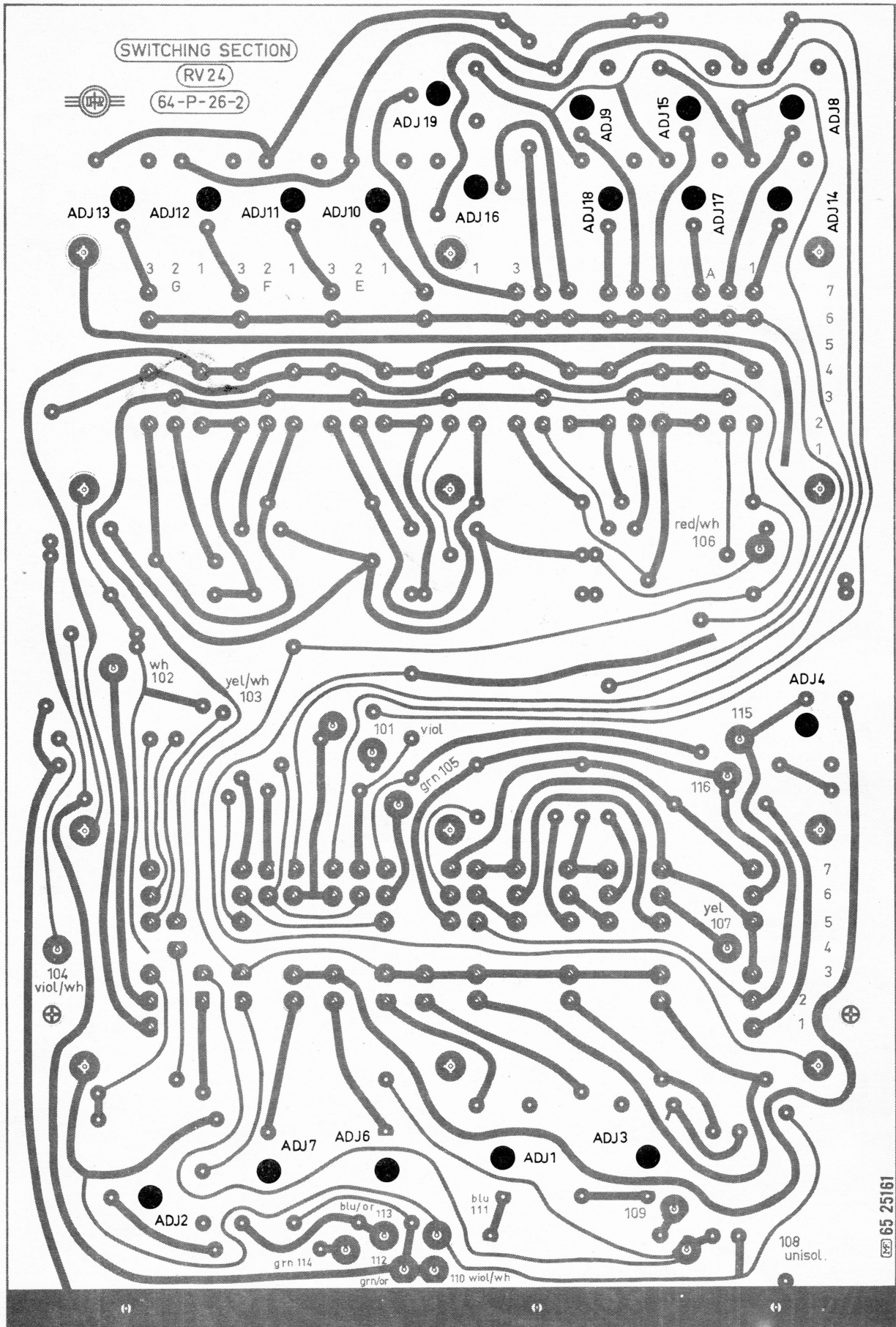
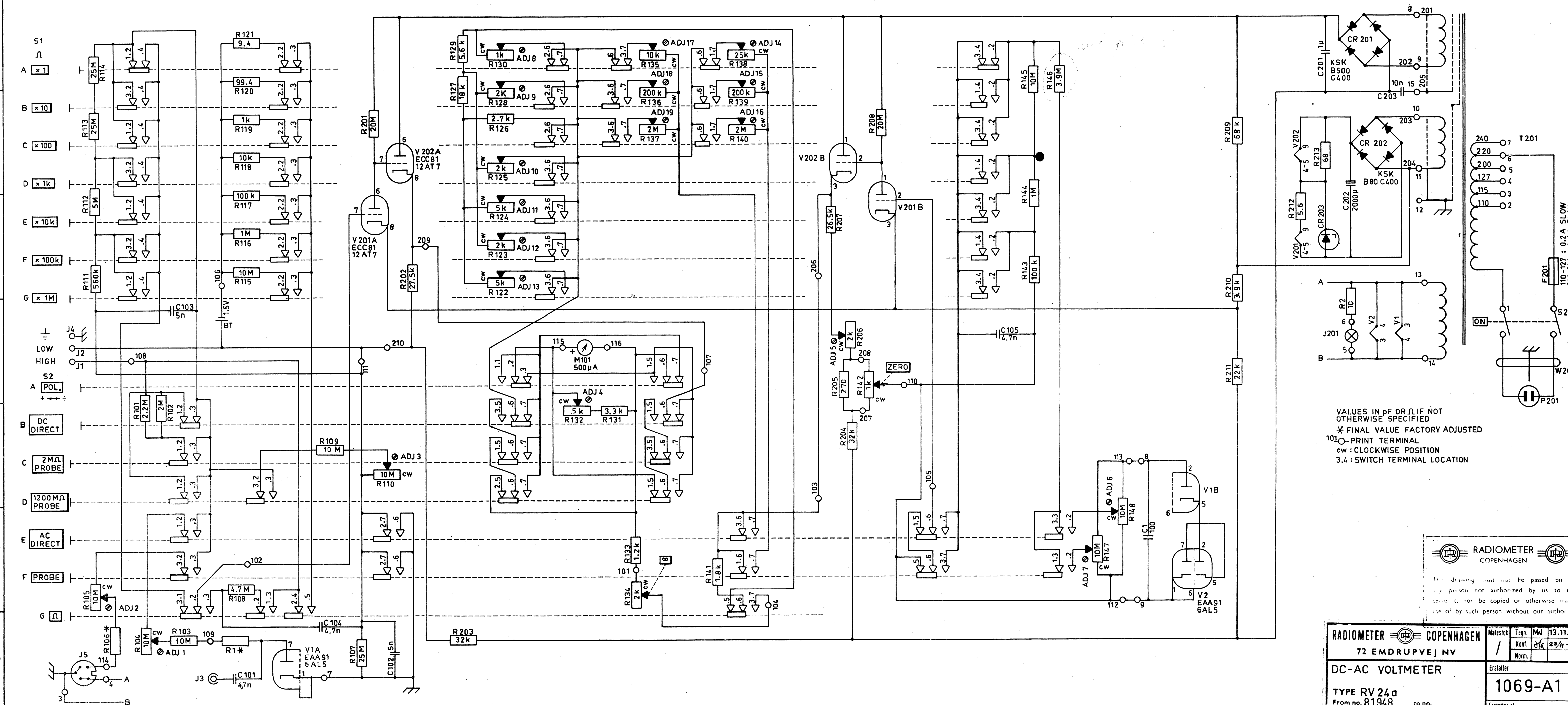


Fig.10 Switching section of the DC-AC Voltmeter, type RV24,
showing the different adjusting potentiometers.



VALUES IN pF OR Ω IF NOT OTHERWISE SPECIFIED
* FINAL VALUE FACTORY ADJUSTED
101 PRINT TERMINAL
cw : CLOCKWISE POSITION
3.4 : SWITCH TERMINAL LOCATION

RADIOMETER COPENHAGEN
This drawing must not be passed on to any person not authorized by us to receive it, nor be copied or otherwise made use of by such person without our authority.

RADIOMETER COPENHAGEN		Maleslot	Tegn.	MW	13.11.64
72 EMDRUPVEJ NV		Kont.	8/6	23/4-64	
DC-AC VOLTMETER		Erstatter			
TYPE RV 24a		1069-A1			
From no. 81948		Erstattes af			

2	103974	23-8-67	PAB	2/4					
1		20-8-65	BL	1/4					
Rt. Nr.	Fra Fab. Nr.	Dato	Rt. al	Kont.	Norm				