

INSTRUCTION MANUAL

Type RV31

VACUUM-TUBE VOLTMETER



RADIOMETER

ELECTRONIC MEASURING INSTRUMENTS
FOR SCIENTIFIC AND INDUSTRIAL USE

Type RV31
VACUUM-TUBE VOLTMETER

These instructions apply to
model RV31 / only

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1) GENERAL DESCRIPTION

This instrument is designed for measuring a-c voltages in the carrier frequency and the video frequency technique where a wide frequency range and good sensitivity are required.

The instrument has 6 voltage ranges with full scale deflection for 3, 10, 30, 100, 300, and 1000 mV, respectively. A special dB scale indicates the voltage level in dB over 1 mV (or in special design, in dB below 0.775 volts). The frequency range is 20 cycles to 10 megacycles on all voltage ranges except on the 3 mV range, where the upper frequency limit is 3 megacycles.

It is a special feature of the type RV31 Vacuum-Tube Voltmeter that the input tube (a cathode-follower stage) is mounted in a small probe connected to the instrument by means of a flexible cable. In most cases this arrangement permits measurements to be made without special connecting leads so that the loading of the source under measurement will be as small as possible (at low frequencies the damping is 5 megohms shunted by 10 pF).

A detachable voltage divider type RV31R can be supplied for extending the measuring range to 100 volts. The voltage divider which can be mounted on the probe reduces the input voltage in the ratio 1:100. The frequency range is not restricted when the voltage divider is used.

The instrument can also be used as a wide-band amplifier with a gain of about 44 dB on the 3 mV range.

The instrument operates from an a-c power line. Carefully stabilized anode voltages and a heavy negative feedback make the indication almost independent of line voltage fluctuations and aging of tubes.

2) OPERATING PRINCIPLE

The type RV31 Vacuum-Tube Voltmeter consists of a cathode-follower input stage, a 3-stage voltage amplifier, an output stage, and a rectifier meter. A voltage divider which is inserted between the cathode-follower and the amplifier gives the voltages ranges.

The 3 mV range, however, is produced by increasing the sensitivity of the amplifier by 10 dB in proportion to the other ranges. The amplifier uses heavy negative feedback and is therefore virtually insensitive to line voltage fluctuations and ageing of tubes. The output stage supplies the current required for the rectifier meter which consists of two crystal diodes and a moving coil meter in a coupling which is insensitive to temperature fluctuations. When the Vacuum-Tube Voltmeter is used as an amplifier, the output tube operates as a cathode-follower.

The plate voltage supply of the Vacuum-Tube Voltmeter is electronically stabilized. By this means the reading of the meter will remain steady even on power lines with strong line surges. An HF filter is inserted in the line cord. This filter damps disturbing h-f voltages which might propagate from the power line to the instrument.

3) SETTING THE LINE VOLTAGE

When leaving the factory, the instrument is set to operate on a 220 volt line voltage. However, it can also operate on 110, 127, 150, 200, and 240 volts.

The instrument is switched to another line voltage by unsoldering the lead from the 220 volt tap and soldering it on to the transformer tap concerned.

Note: Do not forget to set the voltage indicator at the back of the instrument to the voltage chosen.

4) OPERATING THE VACUUM-TUBE VOLTMETER

Connect the probe to the instrument with the six-prong connector, and switch on the line voltage. Shortly afterwards the meter needle will deflect against stop. This deflection, which will not damage the meter, is due to oscillations in the amplifier during the warm-up period until the stabilized power supply is capable of operating in full. After about 1 minute the instrument is ready for use.

The Vacuum-Tube Voltmeter can only measure voltages one pole of which is grounded. The voltage is measured between the insulated jack of the probe, and the metal cap of the probe with the grounded pole connected to the metal cap. A superimposed d-c voltage of up to 250 volts may be allowed for. The "Amplifier Output" must not be loaded when the instru-

ment is used as a Vacuum-Tube Voltmeter.

If the source under measurement is not effectively grounded, it is recommended not to ground the instrument case, to prevent source-to-ground currents, if any, from setting up voltages in the probe cable which may give rise to erroneous measurements. (The reactance of the outer cable conductor is about 50 ohms at 10 Mc). The above error can be considerably reduced by connecting the instrument case and the source chassis through one or more extra leads.

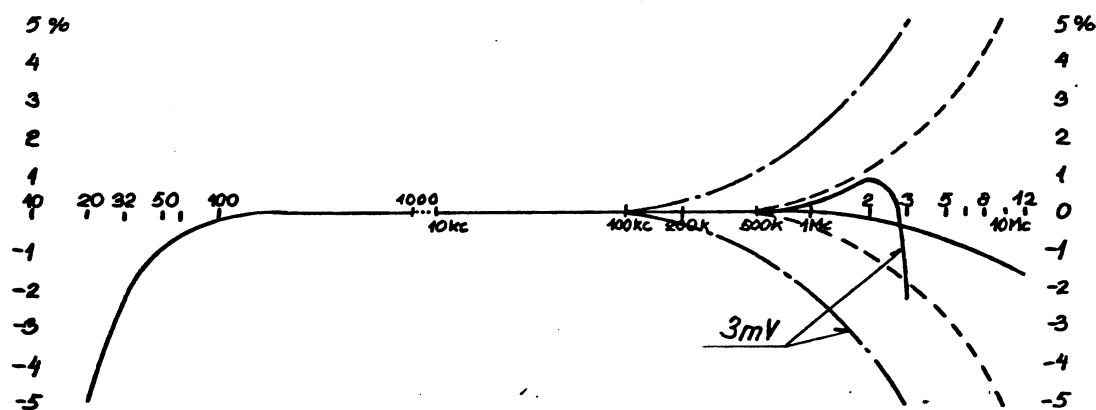
Note: Two thin leads will do better than one thick, their total reactance being smaller than that of the thick one.

The cable to the probe should not be exposed to sharp bendings or twistings, as this may involve a risk of breaking the conductors of the cable.

5) MEASURING RANGES

The Vacuum-Tube Voltmeter is provided with the following voltage and frequency ranges:

0-3 mV	with a frequency range of 20 cycles to 3 megacycles									
0-10	-	-	-	-	-	20	-	-	10	-
0-30	-	-	-	-	-	20	-	-	10	-
0-100	-	-	-	-	-	20	-	-	10	-
0-300	-	-	-	-	-	20	-	-	10	-
0-1000	-	-	-	-	-	20	-	-	10	-



Typical frequency response curves

6) ACCURACY AND FREQUENCY RESPONSE

The accuracy at 1000 cycles is 2% of full scale, and practically the same accuracy is maintained through the entire frequency range except at the extreme limits. The above figure shows typical frequency curves. The curves in full line illustrate the average response, while the dotted curve indicate the limit of variation within the various measuring ranges, or between the individual instruments (at the low frequencies the frequency response is independent of the measuring range).

A sensitivity peak of 20-50% will be found outside the range proper of the instrument at about 16 megacycles.

7) INPUT IMPEDANCE

The input capacitance of the probe is about 10 pF. The input resistance is about 5 megohms at low frequencies, and will remain over 1 megohm up to 1 megacycle. Over 1 megacycle the sign of the input resistance will change, but it is still numerically greater than 0.1 megohm.

8) RESISTANCE TO OVERLOAD

The indicating meter and the crystal diodes of the Vacuum-Tube Voltmeter cannot be damaged by overload. However, the input voltage should not exceed 25 volts because of the cathode-follower.

9) INFLUENCE OF WAVEFORM

The reading of the Vacuum-Tube Voltmeter is proportional to the mean value of both half-waves, but the instrument is so calibrated that it indicates the rms value of a sine curve. The indication is principally dependent on the fundamental and is only slightly influenced by harmonics or other frequencies.

10) INFLUENCE OF LINE VOLTAGE

In general a 5% change in the line voltage will cause less than 1% change in sensitivity in the greater part of the frequency range. Greater influence of line voltage indicates that one or several tubes have been worn out. Line voltage variations of more than -5% or +10% can not be permitted.

11) ADJUSTING THE VACUUM-TUBE VOLTMETER

The stability of the Vacuum-Tube Voltmeter is so good that in general it is not necessary to readjust it. When the tubes have become much worn or when they have been replaced, it may be desirable to make a readjustment of the sensitivity. This is done by means of the slotted shaft "Calibration" which is accessible when the cover is removed. The adjustment should be made at about 1000 cycles, and an oscillator with a distortion of less than 1% should be used (such as e.g. RADIOMETER Heterodyne Oscillator type HO12 or HO31).

12) HUM VOLTAGES

When the input jacks of the Vacuum-Tube Voltmeter have been short circuited, the meter generally deflects a little on the 3 mV range. This deflection (which is due to hum voltages) has no perceptible influence on the measuring accuracy, provided only that the voltage measured is 2-3 times higher than the hum voltage, as the rectifier circuit employed in the Vacuum-Tube Voltmeter provides a current which is almost exclusively dependent on the most powerful of the frequencies present. Only at frequencies close to the line frequency the hum voltage will be perceptible in the form of small fluctuations of the needle. The correct reading is the average value of the meter deflection. When measuring on the line frequency proper, there will be two deflections differing a little from each other, when reversing the poles of the line plug. Also in this case the correct reading will be the average value.

The hum voltages referred to the input will generally amount to less than 100 μ V or (in the less sensitive ranges) about 0.5% of full-scale deflection. Possibly the hum voltage may be reduced by means of the screwdriver-operated variable resistor, which is accessible through a hole in the back panel of the instrument

13) USING THE VACUUM-TUBE VOLTMETER AS AN AMPLIFIER

The amplifier gain amounts to about 44 dB on the 3 mV range, about 34 dB on the 10 mV range, etc. The frequency ranges are - within 1 dB - the same as when the instrument is used as a voltmeter. The output impedance is about 70 ohms in series with a condenser of 0.01 μ F.

14) TYPE RV31R VOLTAGE DIVIDER

Voltages up to 100 volts can be measured by means of this voltage divider, which consists of a capacitively compensated ohmic voltage divider with a ratio of division of 1:100. Accuracy about 1% up to 5 megacycles. At 10 megacycles the response is about 2% down. Input impedance 1 megohm shunted by 6.5 pF. Maximum allowable input voltage for the voltage divider is 500 volts.

15) SERVICING THE VACUUM-TUBE VOLTMETER

The function of the Vacuum-Tube Voltmeter is critically dependent on the wiring and the mutual location of the component parts in the lower part of the instrument which contains the voltage divider, the amplifier, and the rectifier circuit. The wirewound resistors are of a special design and cannot be replaced by resistors of another design. The anode-resistor R_4 of tube No. 4 is wirewound on a coil form in such a way that the self-inductance is stable and rather low. The resistor must be handled with care as the wire used is only 0.03 mm.

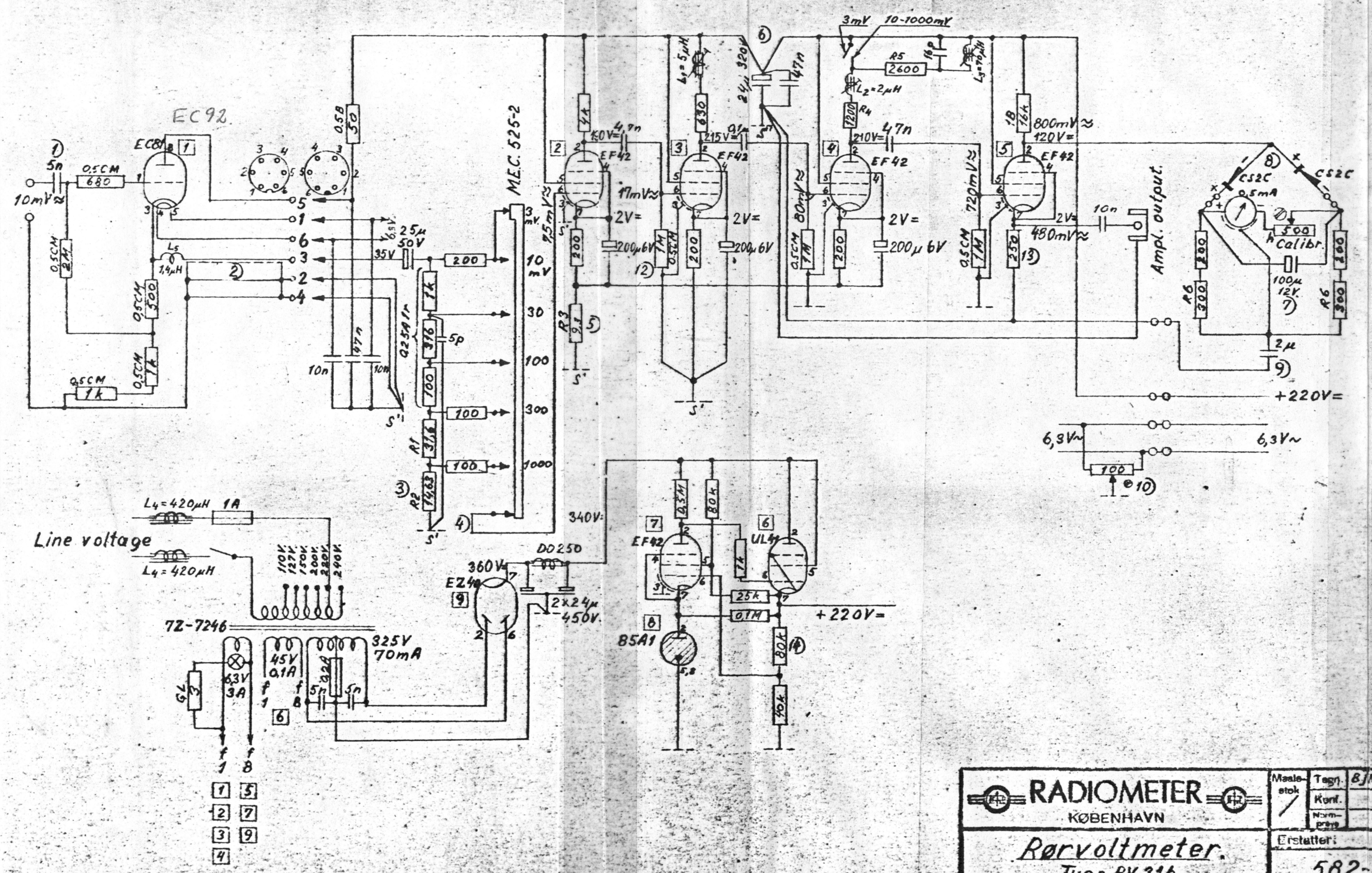
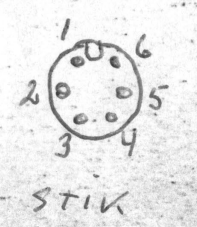
The crystal diodes can easily be damaged by electrostatic dischargings. At any interference in the rectifier circuit, therefore, the line plug of the instrument must be removed, and the crystal diodes must be short circuited by means of a short lead with two alligator clips. Note: The crystal diodes are on anode potential.

Replacement of tubes:

When replacing tube No. 5 the sensitivity should always be checked (see section 11). Tube No.1 only affects the sensitivity slightly, and the influence of tubes No.2, 3, and 4 is negligible. Tubes No.6, 7, 8, and 9 do not affect the sensitivity at all, but when replacing tube No.6, make sure that the stabilized plate voltage is 220 volts. If not, readjust the potentiometer "V = 220 V dc". Replacement of the tubes No.1 to 5 may affect the frequency response somewhat at the high frequencies. The frequency response for the ranges 10-1000 mV can be adjusted by means of the coil L_2 , while L_3 applies to the 3 mV range. L_2 and L_3 are located to the lower right in the instrument, L_2 being nearest to the center.

Excessive hum voltages may be caused by errors in tube No.1, 2 or 7.
(As regards adjustment of hum voltages to a minimum, see section 12).

If the Vacuum-Tube Voltmeter does not operate at all, check the power-supply fuses on the line transformer .



- Note 1) Metalleret på ir 350Volt "Hunt" (C1)
- 2) Telcon kabel type AS91W. Z- 130n afløst (C2)
 - 3) 14,63k modstand skal ligge mellem omskifter og stel med så korte ledninger som muligt og på egen loddeflig. (E3)
 - 4) Gitterledningen løber langs 14,63k modstanden, så at de danner en så lille sløjfe som muligt. (E4)
 - 5) R3 forbindes med så korte ledninger som muligt. (D4)
 - 6) Anodespændingeledningen føres således, at 24μF-elektrolytten skiller rørene 1, 2 og 3 fra 4 og 5 som vist i strømskemaet. (B5)
 - 7) Modstand i spærreledning mindst 50kΩ efter højest 30 sek. med Polymeter (kn x 1) (C8)
 - 8) Krystallerne indsættes under afprøvningen. (C8)
 - 8) Modstand i spærreledning mindst 15kΩ målt på Polymeter (kn x 1). Bemærk ved måling i (n x 1) kan krystallet ødelægges.
 - 9) Vandtæt. (D8)
 - 10) Kør nedad. (E8)
 - 11) Isoleret opspændt. (C8)
 - 12) Lavfrekvensgangen tilpasses her. (C5)
 - 13) Følsomheden tilpasses her. (C7)
 - 14) Anodespændingen tilpasses her. (F5)

RADIOMETER
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Rørvoltmeter.
Type RV 31b.
Diagram.

Måle- stok	Tegn.	B/N	15/5-50
Konf.			
Erstatter:			
582-A3.			
Erstattet af:			

RADIOMETER
KØBENHAVN

Bemærkninger.

Måle- stok	Tegn.	B/N	15/5-50
Konf.			
Erstatter:			
582-A3.			
Erstattet af:			