

PHILIPS

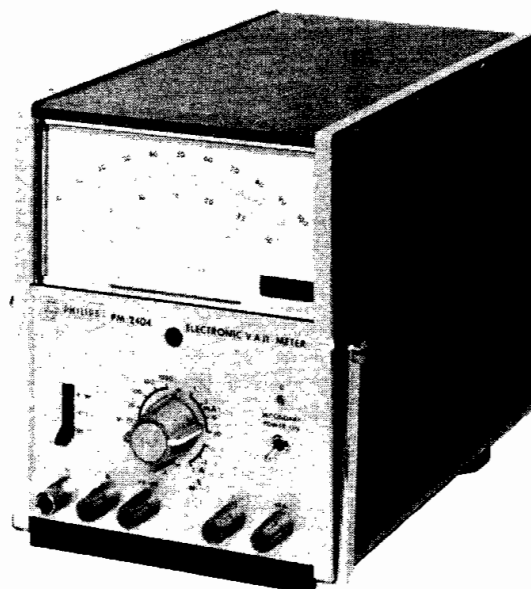


PM 2404

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PHILIPS



Manual

ELECTRONIC VAΩ METER

PM 2404

9447 024 04..1

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IMPORTANT

In correspondence concerning this instrument please quote the type number and the serial number as given on the type plate at the back of the instrument.

FIGURES

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II. TECHNICAL DATA

Numerical values with tolerance stated are guaranteed by the factory. Values without statement of tolerance represent the properties of an average instrument and merely serve as information.

A. D.C. AND A.C. VOLTAGES

Total range	5 mV to 1000 V in the following nine full scale deflection ranges: 0.1 V, 0.3 V, 1 V, 3 V, 10 V, 30 V, 100 V, 300 V, and 1000 V																				
Accuracy	$\pm 2\%$ of f.s.d. at the reference frequency and after internal calibration long term stability: 0.5 %																				
Frequency range	20 Hz to 100 kHz: $\pm 1\%$ (additional) 10 Hz to 20 Hz and 100 kHz to 200 kHz: $\pm 3\%$ (additional) The reference frequency is 1 kHz																				
Input impedance	<table> <tr> <th>Range</th><th>$R_i // C_i$</th></tr> <tr> <td>0.1 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 65 pF</td></tr> <tr> <td>0.3 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 47 pF</td></tr> <tr> <td>1 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 43 pF</td></tr> <tr> <td>3 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 33 pF</td></tr> <tr> <td>10 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 30 pF</td></tr> <tr> <td>30 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 30 pF</td></tr> <tr> <td>100 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 30 pF</td></tr> <tr> <td>300 V</td><td>$10\text{ M}\Omega \pm 1\%$ // 30 pF</td></tr> <tr> <td>1000 V</td><td>$10\text{ M}\Omega \pm 1\%$ // (not frequency compensated)</td></tr> </table>	Range	$R_i // C_i$	0.1 V	$10\text{ M}\Omega \pm 1\%$ // 65 pF	0.3 V	$10\text{ M}\Omega \pm 1\%$ // 47 pF	1 V	$10\text{ M}\Omega \pm 1\%$ // 43 pF	3 V	$10\text{ M}\Omega \pm 1\%$ // 33 pF	10 V	$10\text{ M}\Omega \pm 1\%$ // 30 pF	30 V	$10\text{ M}\Omega \pm 1\%$ // 30 pF	100 V	$10\text{ M}\Omega \pm 1\%$ // 30 pF	300 V	$10\text{ M}\Omega \pm 1\%$ // 30 pF	1000 V	$10\text{ M}\Omega \pm 1\%$ // (not frequency compensated)
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1000 V	$10\text{ M}\Omega \pm 1\%$ // (not frequency compensated)																				

B. D.C. AND A.C. CURRENTS

Total range	50 μA to 10 A in the following nine full scale deflection ranges: 1 mA, 3 mA, 10 mA, 30 mA, 100 mA, 300 mA, 1 A, 3 A, 10 A Note that a separate terminal is used for the 10 A range
-------------	--

Accuracy $\pm 2\%$ of f.s.d. at the reference frequency and after internal calibration

Frequency range 20 Hz to 1 kHz $\pm 1\%$
The reference frequency is 200 Hz

Voltage loss	Range	Loss
	1 mA	< 95 mV
	3 mA	< 95 mV
	10 mA	< 95 mV
	30 mA	< 95 mV
	100 mA	< 100 mV
	300 mA	< 110 mV
	1 A	< 150 mV
	3 A	< 70 mV
	10 A	< 200 mV

C. RESISTANCE MEASUREMENTS

Total range 1 Ω to 10 M Ω in the following twelve full scale deflection ranges:
30 Ω , 100 Ω , 300 Ω , 1 k Ω , 3 k Ω , 10 k Ω , 30 k Ω , 100 k Ω , 300 k Ω , 1 M Ω , 3 M Ω , 10 M Ω
Note that any selected resistance scale may be expanded by a factor of 0.3 by operating the x0.3 knob

Accuracy
Mains operation $\pm 2.5\%$ (except the 3 M Ω and 10 M Ω ranges which are $\pm 3.5\%$)

Battery operation $\pm 3.5\%$ falling to $\pm 6\%$ at minimum battery supply unit voltage

Scale characteristic Linear

Measuring voltage 90 mV max.

Measuring current < 0.9 mA

D. DIODE RANGE

Current passed by the diode 0.9 mA

Approximate voltage 1 V f.s.d.

E. GENERAL

Temperature range

0 °C to 40 °C

Protection

Voltage ranges: by spark gap conduction at voltages in excess of 1700 V

Current ranges (except the 10 A range): by a 6 A fuse and power diodes.

Resistance ranges: no damage will be sustained when voltages of up to 220 V are connected to the input.

Max. allowable voltage between $\frac{1}{3}$ (BU1) and 0 (BU2) is 600 V d.c.

Maximum allowable voltage between $\frac{1}{3}$ (BU1) and VR (BU3) is 1600 V d.c.

The amplifier is protected by means of diodes

Indication

Tautband moving coil meter with a mirror scale

Internal resistance 500 Ω

Current at f.s.d. 200 μ A

Scale length 11 cm

Polarity indication

Indicates polarity of terminals VR, I, or 10 A with respect to terminal 0.

A 10 % meter reading corresponds to a full deflection of the indicator

Input

Floating

dB scale

Range

0.1 V	−40 dB to −18 dB
0.3 V	−30 dB to − 8 dB
1 V	−20 dB to + 2 dB
3 V	−10 dB to +12 dB
10 V	0 to +22 dB
30 V	+10 dB to +32 dB
100 V	+20 dB to +42 dB
300 V	+30 dB to +52 dB
1000 V	+40 dB to +62 dB

Supply

Voltage: 115 V or 230 V \pm 15 %

Frequency: Between 45 and 400 Hz

A battery supply unit (PM 9204) may be connected via socket BU7

F. MECHANICAL DATA

Overall dimensions	Height	190 mm
	Width	162 mm
	Depth	270 mm
Weight	3.7 kg approximately	

III. ACCESSORIES

A. ACCESSORIES SUPPLIED AS PART OF THE EQUIPMENT

- Set of measuring leads
- Mains lead
- Short circuiting strip
- Manual

B. OPTIONAL ACCESSORIES

- EHT probe PM 9240

This probe, which has an input impedance of $1000\text{ M}\Omega \pm 5\%$, enables d.c. voltages of up to 30 kV to be measured. The maximum measuring error when the probe is used in conjunction with the PM 2404, is 8 %.

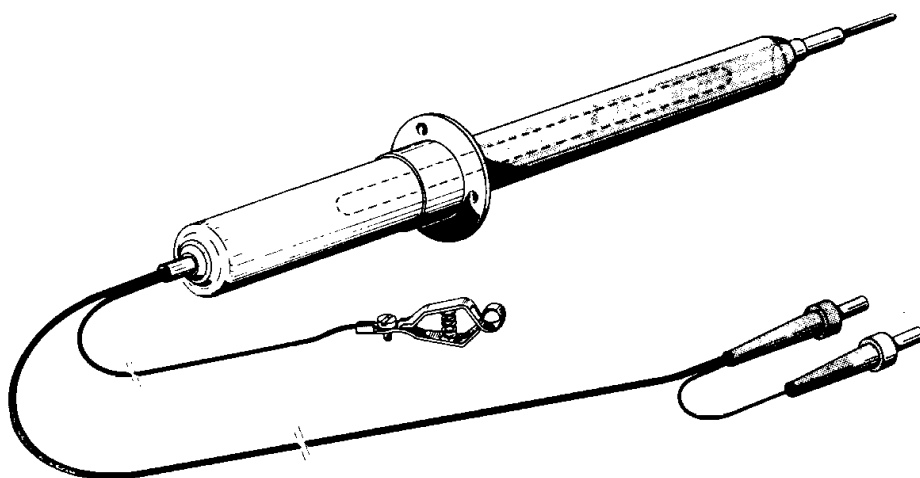


Fig. 1. EHT probe PM 9240

- UHF probe PM 9200

This probe is suitable for measuring alternating voltages from 30 mV to 16 V.

The frequency response is as follows:

100 kHz to 1 MHz $\pm 10\%$

1 MHz to 300 MHz $\pm 5\%$

300 MHz to 800 MHz $\pm 10\%$

At frequencies above 30 MHz, the T-connector must be used if the stated tolerances are to be met.

The calibration graph, included in delivery, should be observed.

The maximum permissible d.c. voltage which may be applied to the probe is 450 V.

Input impedance at 1 MHz: 110 k Ω

10 MHz: 80 k Ω

50 MHz: 25 k Ω

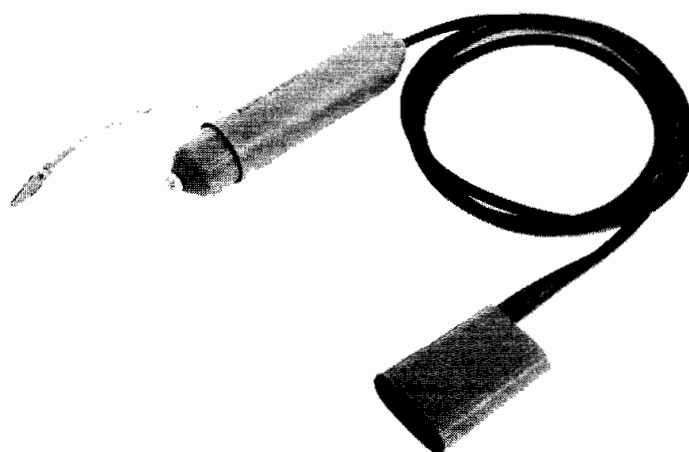


Fig. 2. UHF probe PM 9200

— **UHF T-connector PM 9250**

Input impedance: 50 Ω

Frequency response: 100 kHz to 1000 MHz

Standing wave ratio: up to 800 MHz 1.1

up to 1000 MHz 1.2

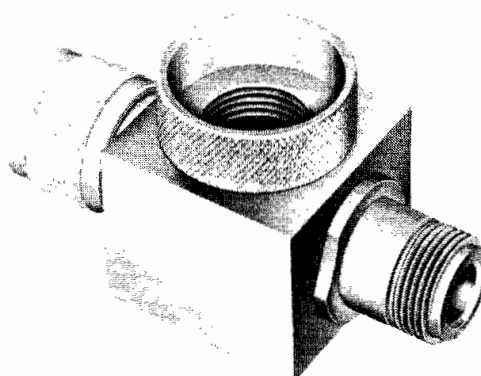


Fig. 3. UHF T-connector PM 9250

— **Current transformer PM 9052**

This transformer enables alternating currents within the range of 3 A to a maximum of 100 A, to be measured.

The maximum measuring error when the transformer is used in conjunction with the PM 2404, is 3 %.

Power: 2.5 VA (secondary voltage at 3 A may be 833 mV max.).

Frequency: 30 Hz to 400 Hz.

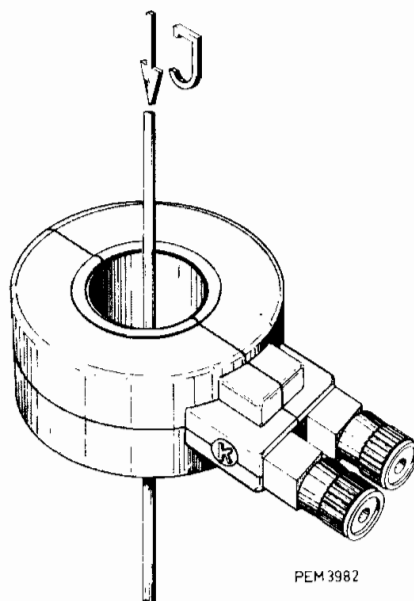


Fig. 4. Current transformer PM 9052

— **Battery supply unit PM 9204**

This battery supply unit may be attached to the rear of the instrument in order to provide battery operation. The batteries are charged by current obtained from the power supply circuits of the instruments.

Characteristics

Nominal voltage	5 V
Capacity	3.5 Ah
Maximum charge current	350 mA
Maximum trickle charge current	35 mA
Operation time provided by one charge in conjunction with the PM 2404	100 h (approx.)
Recharge time	15 h

— **Shunt PM 9242**

This shunt enables the d.c. current range to be extended up to 30 A

Voltage drop	max. 100 mV
Accuracy	1 %
Dimensions	130 x 65 x 95 mm

IV. EXPLANATION OF THE BLOCK DIAGRAM

The mode selector (handle switch SKII) is in two sections:

- SKII/1 which is in the input circuit
- SKII/2 which is connected between the selector and the amplifier input.

Mode selector switch section SKII/1 is used to select either the AC/DC attenuator or the resistance measurement circuit. For voltage measurements, the input signal is attenuated to a level of 90 mV before being passed to the amplifier via mode selector switch section SKII/2. Resistance measurement is made by passing a current of a magnitude fixed by the R-selector, through the resistor under test. This current is supplied via the mode selector switch section SKII/1, and the resulting voltage drop across the unknown resistor is presented to the amplifier input. Current measurement is made by selection of an appropriate shunt value by means of the I-selector.

The voltage across this shunt is then passed to the amplifier input.

The amplifier has a f.e.t. input stage and is an operational amplifier. The indication meter is connected in the feedback line which also includes the a.c. rectifiers. The polarity meter is connected directly to the output of the amplifier. The feedback voltage, which is connected to the second input of the operational amplifier, can be adjusted by means of the CAL potentiometer, and this enables the instrument to be calibrated. Zero setting is effected by the "0" potentiometer. The amplifier is supplied by a d.c.-to-d.c. convertor which produces stable +12 V and –12 V supplies from the rectified mains or battery voltage.

The 1 V reference supply available at the REF. 1 V terminal is an accurate voltage source which may be used to calibrate the instrument.

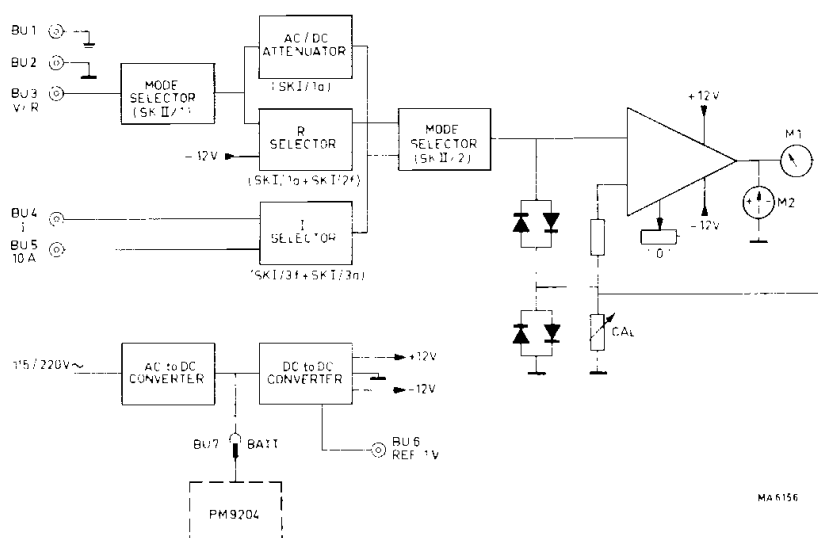


Fig. 5. Block diagram

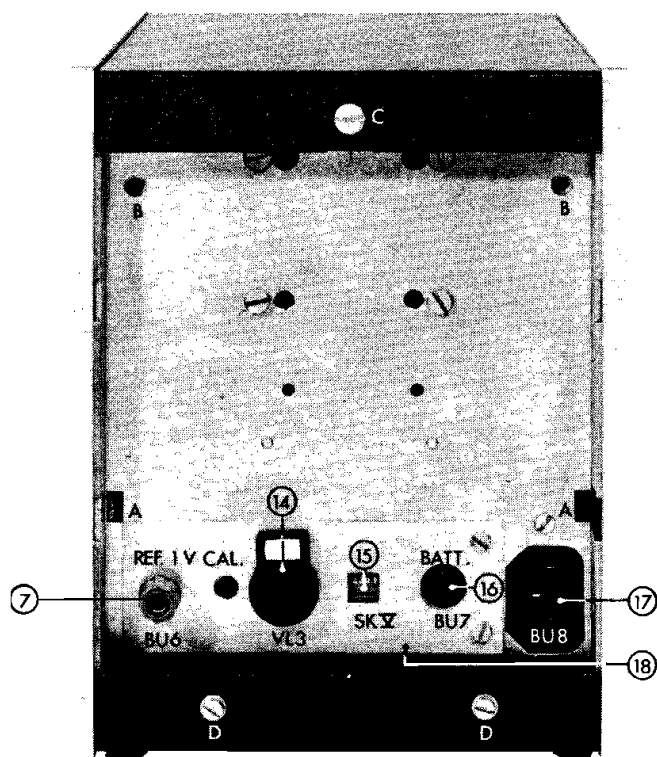


Fig. 6. Rear view

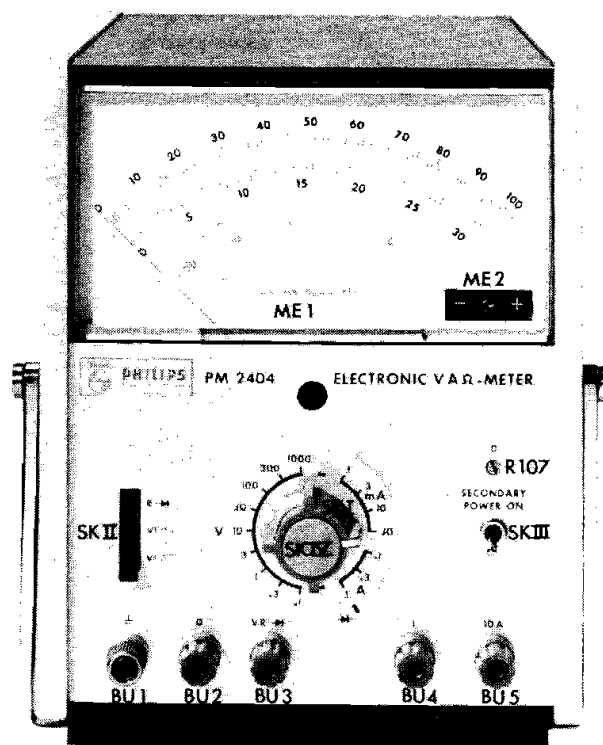


Fig. 7. Front view

directions for use

V. INSTALLATION

A. SUPPLY

1. Mains supply

Check that the slide switch SKV at the rear of the instrument is set in accordance with the local mains voltage before switching on the instrument.

- Set the slide switch to 115 V for mains voltages between 100 and 132 V.
- Set the slide switch to 230 V for mains voltages between 220 and 230 V.

Use the three-core cable to connect the instrument to a wall socket having rim earth contacts.

2. Battery supply

To fit the battery supply unit PM 9204 to the rear of the instrument, engage its cams with the recesses A (Fig. 6) and secure the unit with screws B.

Connect the 6-pole supply plug of the battery supply unit to the BATT. socket BU7 at the rear of the instrument.

The battery supply unit contains four rechargeable batteries which provide approximately 100 operating hours when fully charged. The batteries are automatically charged when the PM 2404 is connected to the mains and the instrument can be used during the charge process as in this case automatically is switched over to mains supply.

B. EARTHING

The instrument should be connected by means of its mains cable, to a wall socket which has rim earth contacts. For safety, the instrument housing is connected to earth.

If the instrument cannot be earthed via the mains lead, a separate earth lead should be connected to terminal BU1 (\perp) at the front of the instrument.

All local safety regulations must be observed.

C. COUPLING

The dimensions of the instrument (two modules) enable coupling with other instruments of the modular system. For further information, refer to the modular l.f. system.

VI. OPERATION

A. SWITCHING ON

The PM 2404 does not have a mains switch. Its SECONDARY POWER ON switch SKIII only controls the secondary circuit and is used to switch on the instrument for mains supply as well as for battery supply.


WARNING : With the instrument connected to the mains, its primary circuit is alive irrespective of the SECONDARY ON switch setting.

B. ZERO SETTING


1. Mechanical

Switch off the instrument and check the zero setting of the meter. If necessary, correct the setting by means of the screw located beneath the meter.

2. Electrical

- Switch on the instrument.
- Interconnect terminals "0" (BU2) and VR (BU3).
- Set the function switch SKII to the VI  position.
- Set the range switch SKI to the .1 V position.
- Set the polarity indicator to its mid-position using the "0" screwdriver adjuster (R107). The exact mid-position is the position occupied by the pointer when the instrument is switched off.

C. CALIBRATION

- Set the function switch SKII to the VI  position.
- Set the range switch SKI to the 1 V position.
- Interconnect terminals REF. 1 V (BU6 at the rear) and VR (BU3 at the front).
- Set the indication to read 100 by means of the CAL potentiometer (R127).

*NOTE : The 1 V reference supply is taken from a mercury cell. If, during calibration, the deflection is too low to allow the meter to be adjusted to 100, the calibration cell should be replaced.
For details of cell replacement, see chapter IX.G.*

D. MEASURING

Performing the zero setting and calibration procedures is only necessary in the case of temperature variations or switching from mains to battery supply or vica verca.

The required measuring mode may be selected by setting the handle switch SKII to either the VI $\overline{\text{---}}$, VI \sim , or R \blacktriangleright position.

1. Direct and alternating voltages

- Select the required measuring mode (i.e. $\overline{\text{---}}$ or \sim)
- Interconnect terminal "0" (BU2) and VR \blacktriangleright (BU3).
- Select the appropriate measuring range using SK1.

NOTES: -- For practically all measurements, the " $\overline{\text{---}}$ " and "0" terminals (BU1 and BU2) may be linked by the interconnecting strip which is supplied with the instrument. This link must be removed when floating measurements are being made.

- The capacitance between terminals " $\overline{\text{---}}$ " and "0" (BU1 and BU2) is $\leq 1.5 \text{ nF}$.*
- For d.c. voltages, the polarity indicator shows the polarity of terminal VR with respect to terminal "0". When a.c. voltages are connected, the indicator shows " \sim ".*
- D.C. voltages between 1 kV and 30 kV can be measured using the instrument in conjunction with the h.t. measuring probe PM 9240.*

2. H.T. voltages up to 30 kV using the probe PM 9240

- Select the VI $\overline{\text{---}}$ measuring mode.
- Connect the probe between terminals VR \blacktriangleright and "0" (terminals "0" and " $\overline{\text{---}}$ " should be linked by the interconnecting strip).
Connect the earthing clip to a proper earth.
- The following table lists the ranges which may be selected:

Range selector position	H.T. range	Scale
30 V	3 kV	0 to 30
100 V	10 kV	0 to 100
300 V	30 kV	0 to 30

The maximum permissible voltage is 30 kV.

3. U.H.F. voltage measurements using probe PM 9200 and T-connector PM 9250

- Select the V_{IHF} measuring mode.
- Connect the plug of the probe to terminals VR and "0". The earthing pin (" \perp ") of the probe must be connected to terminal "0" and the interconnecting strip must be used to link terminals "0" and " \perp ".
- Set the measuring range selector to the required range (100 mV to 30 V).

NOTES: -- The maximum permissible voltage which may be applied to the probe is $16 V_{r.m.s.}$.

-- The correction factor shown by the probe calibration curve should be taken into account.

4. D.C. and A.C. currents

- Select either the --- or \sim measuring mode.
- Connect current source to terminals "0" and I (BU4).
- Use SKI to select the required measuring range.

NOTES: -- Currents within the limits of 1 A and 10 A should be connected to terminals "0" and 10 A (BU5).

-- The 3 A f.s.d. measuring range is switched in by depressing the x0.3 button SKIV.

-- The polarity indicator shows the polarity of d.c. current at either terminal I, or terminal 10 A, with respect to terminal "0". When a.c. currents are connected, the indicator shows \sim .

-- Use the shunt PM 9242 to measure d.c. currents of between 10 A and 30 A.

-- Use the current transformer PM 9052 to measure a.c. currents of between 10 A and 100 A.

-- A fuse rated at 6 A is connected to terminal I of the current circuit. This fuse, which is located in a holder on the underside of the instrument, is designed to protect resistors R34 to R41 against overloads. For details of fuse replacement, see chapter IX.F.

5. D.C. current measurements using the shunt PM 9242

- Select the V_{IHF} measuring mode.
- Connect the output sockets of the shunt to terminals VR and "0".
- Set the range selector to the .1 V position.
- Connect the current source to terminals "--" and "30 A" of the shunt.
- The current value can be read directly from the 0 to 30 scale.

The maximum permitted d.c. current is 30 A.

6. A.C. current measurements using the current transformer PM 9052

- Select the VI~ measuring mode.
- Connect the transformer between terminals "0" and I of the instrument.
- Set the range selector to the 1 A position.
- Isolate the supply to be measured and fit the current transformer to a current-carrying conductor and switch on the supply again.

The maximum permitted a.c. current which can be measured with the PM 9052 transformer is 100 A.

7. Resistance measurements

- Select the R- \blacktriangleright measuring mode.
- Connect the unknown resistance between terminals "0" and VR- \blacktriangleright
- Select the appropriate measuring range.

The x0.3 push button switch (SKIV on the range selector knob) modifies the selected resistance range by a factor of 0.3.

The following table is an example of this range modification:

<i>Selected range</i>	<i>Range, when SKIV is operated</i>
100 Ω	$0.3 \times 100 \Omega = 30 \Omega$
1 k Ω	$0.3 \times 1 \text{ k}\Omega = 300 \Omega$
1 M Ω	$0.3 \times 1 \text{ M}\Omega = 300 \text{ k}\Omega$

8. Diodes

- Select the R- \blacktriangleright measuring mode.
- Select the 10 A- \blacktriangleright measuring range.
- Connect the cathode of the diode to the VR- \blacktriangleright terminal and the anode to terminal "0".
- The following table quotes typical indications:

<i>Diode type</i>	<i>Reading in scale divisions</i>
Germanium	Between 20 and 30
Silicon	Between 50 and 80

service data

VII. CIRCUIT DESCRIPTION

A. ATTENUATORS

1. Voltage attenuator

Switch wafers SKI/1a and SKI/3a select a separate attenuator for each voltage. The attenuator resistors are located between the switch wafers and the sum of the resistors for all ranges is 10 MΩ. Capacitors are connected in parallel with the attenuator resistors in order to provide frequency-independent attenuation for each range, except the 1000 V range.

All ranges, with the exception of the selected range, are connected to the circuit zero point, via switch SKI/2a.

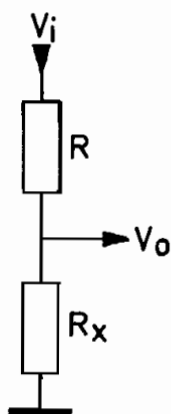
The input circuit is protected by a spark gap which is designed to conduct when the applied voltage exceeds approximately 1700 V.

2. Current measuring range

The current-measuring circuit is based upon the ring shunt principle; resistors R34 to R40 form the shunt. The current flowing through the selected resistor combination causes a volt drop which is measured by the amplifier circuit.

The current circuit is protected by the 6 A fuse VL2 and by the power diodes GR2 and GR3 which are connected in parallel with R42. In the event of a heavy current, the resulting voltage across the shunt will be limited by GR2 and GR3.

3. Resistance measuring circuit



The resistance measuring circuit consists of resistors R18 to R31.

Reference to the figure will show that

$$V_0 = \frac{R_x}{R + R_x} V_i$$

$$\text{Since } R \gg R_x, V_0 = \frac{R_x}{R} V_i.$$

This results in a practically linear-scale characteristic for resistance measurements.

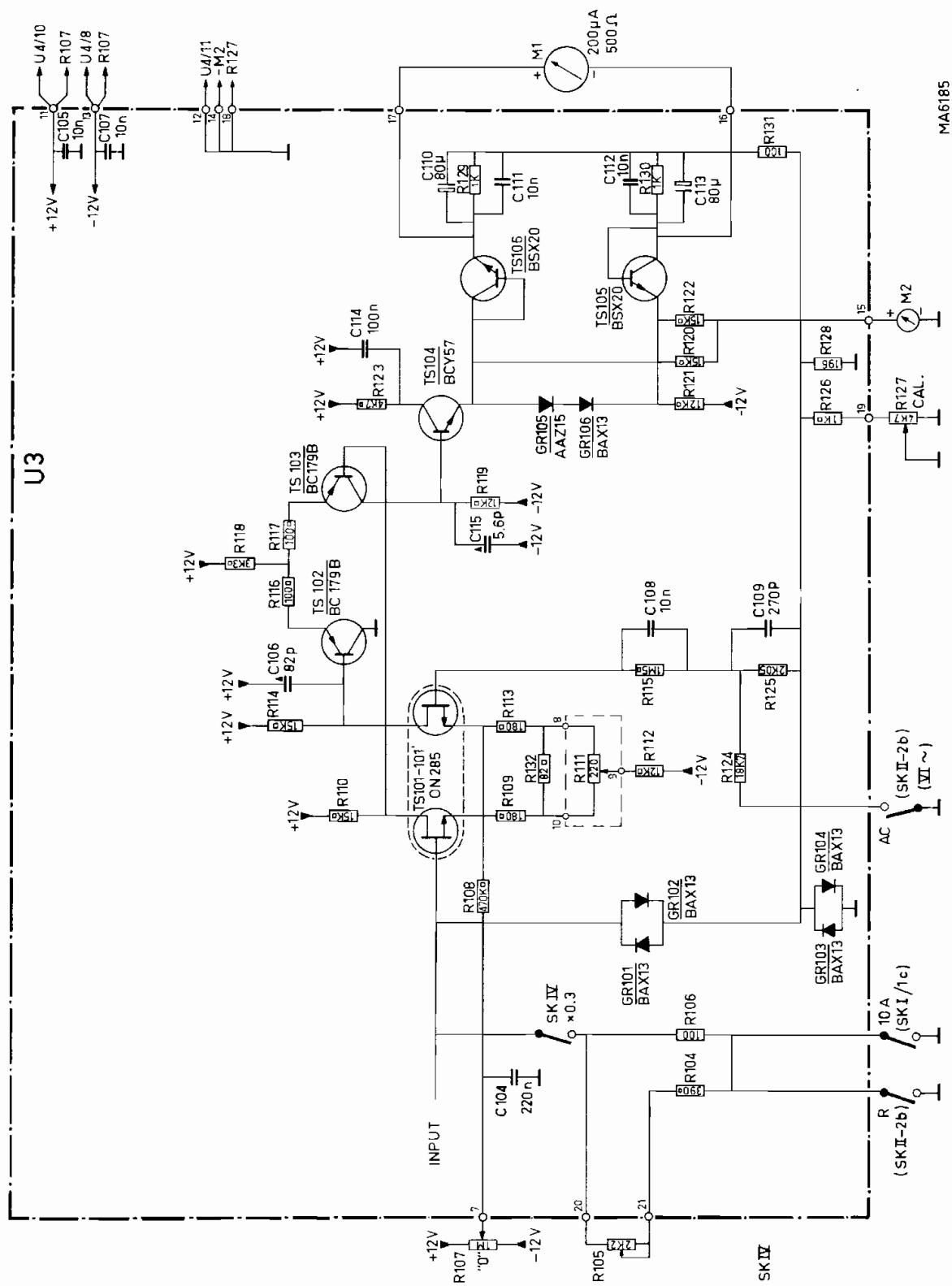


Fig. 8. Amplifier

The voltage V is derived from the supply and voltage V_0 across R_x is fed to the amplifier.

Operation of the $\times 0.3$ push button switch, in order to decrease the selected range, causes the resistor combination $R104$ to $R106$ to be connected in parallel with the combination $R126$ to $R128$.

The rating of resistors $R18$ to $R31$ is sufficient to allow voltages of up to $220 V_{rms}$ to be connected to the input circuit without risk of damage.

B. FILTER

With the mode switch set to the $V1 \text{---}$ position, a filter consisting of $R101$, $C101$, $C102$ and the attenuator resistor is connected into the circuit. This circuit attenuates any a.c. component which may be superimposed upon the d.c. level. If the switch is set to the $V1 \sim$ position, the d.c. content of the signal is blocked by the capacitor $C201$.

C. AMPLIFIER (Fig. 8)

1. Amplifier circuit

The amplifier consists of three d.c. coupled stages, the first of which is a difference amplifier formed by the f.e.t. pair $TS101$ and $TS101'$.

Feedback in this stage is by the source resistors $R109$, $R111$, $R113$ and $R132$. Use of the f.e.t. pair in the input stage makes the zero point stability very high; their gate leakage current is low and this enables the input impedance to be extremely high.

The first stage output signal, which is developed across $R110$ and $R114$, is used to control the second stage of the amplifier. This second stage is a difference amplifier formed by transistors $TS102$ and $TS103$, whose emitter resistors provide feedback. The asymmetrical output of the second stage drives the emitter follower $TS104$, which supplies current to the rectifier circuit. In the event of an overload, the current supplied to the rectifier circuit is limited by $R123$.

With no input signal, potentiometers $R111$ (coarse) and $R107$ (fine) enable the output of the amplifier to be set to zero potential.

Potentiometer $R107$ is accessible from the front of the instrument.

2. Rectifier circuit

The rectifier circuit is included in the feedback branch of the amplifier. The voltage across the rectifier has been minimized by use of transistors $TS105$ and $TS106$ which are connected as diodes and resistors $R129$, $R130$.

The transistors are biased via diodes GR105 and GR106. This minimization of voltage across the rectifier, combined with the high degree of amplification, results in a linear current in the feedback branch and therefore through the meter M1. Meter M2 provides a direct indication of the voltage output of the amplifier. The voltage divider R124/R125 is included in the feedback branch of the amplifier in order to facilitate a.c. measurements. The divider has a division ratio of 1 : 1.11, i.e. the form factor, so that the reading of a.c. signals is given in r.m.s. values.

3. Protection

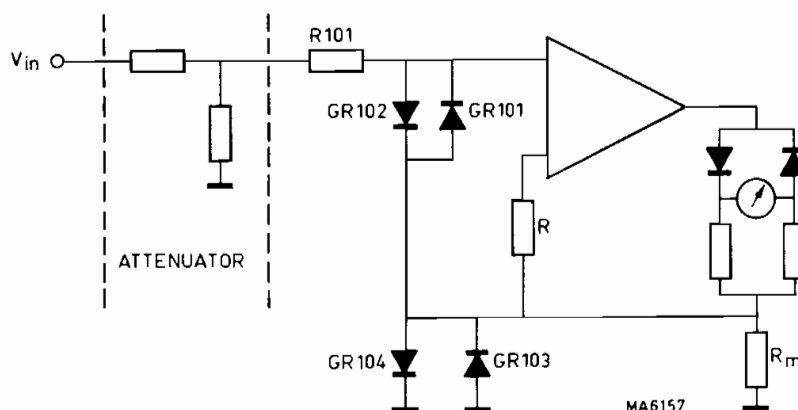


Fig. 9. Amplifier protection

During normal measurements, the signal amplitude at the input of the amplifier is equal to the amplitude across load R_m ($R_m = R126 + R127 // R128$). The voltage across GR101 and GR102 is very low, and the input impedance of the amplifier is unaffected. During an overload condition, the voltage across R_m will not match the value of the input signal to the amplifier. Dependent upon polarity, one of the two diodes GR101 or GR102 will conduct. This causes a reduction in the input impedance of the amplifier. A voltage divider, consisting of R101 and the attenuator resistor, is formed. Since diodes GR103 and GR104 are connected across R_m , the input voltage to the amplifier can never exceed the threshold voltage of these diodes.

D. SUPPLY (Fig. 10)

1. Mains supply circuit

The two primary windings S1 and S1' of transformer T301 may be connected either in series or in parallel, by operation of switch SKV. Series connection enables the instrument to be supplied from 200–245 V mains and parallel connection enables operation from 110–145 V mains.

The output voltage obtained from the secondary winding of transformer T301 is rectified by GR301, smoothed by C301, and stabilized by GR302.

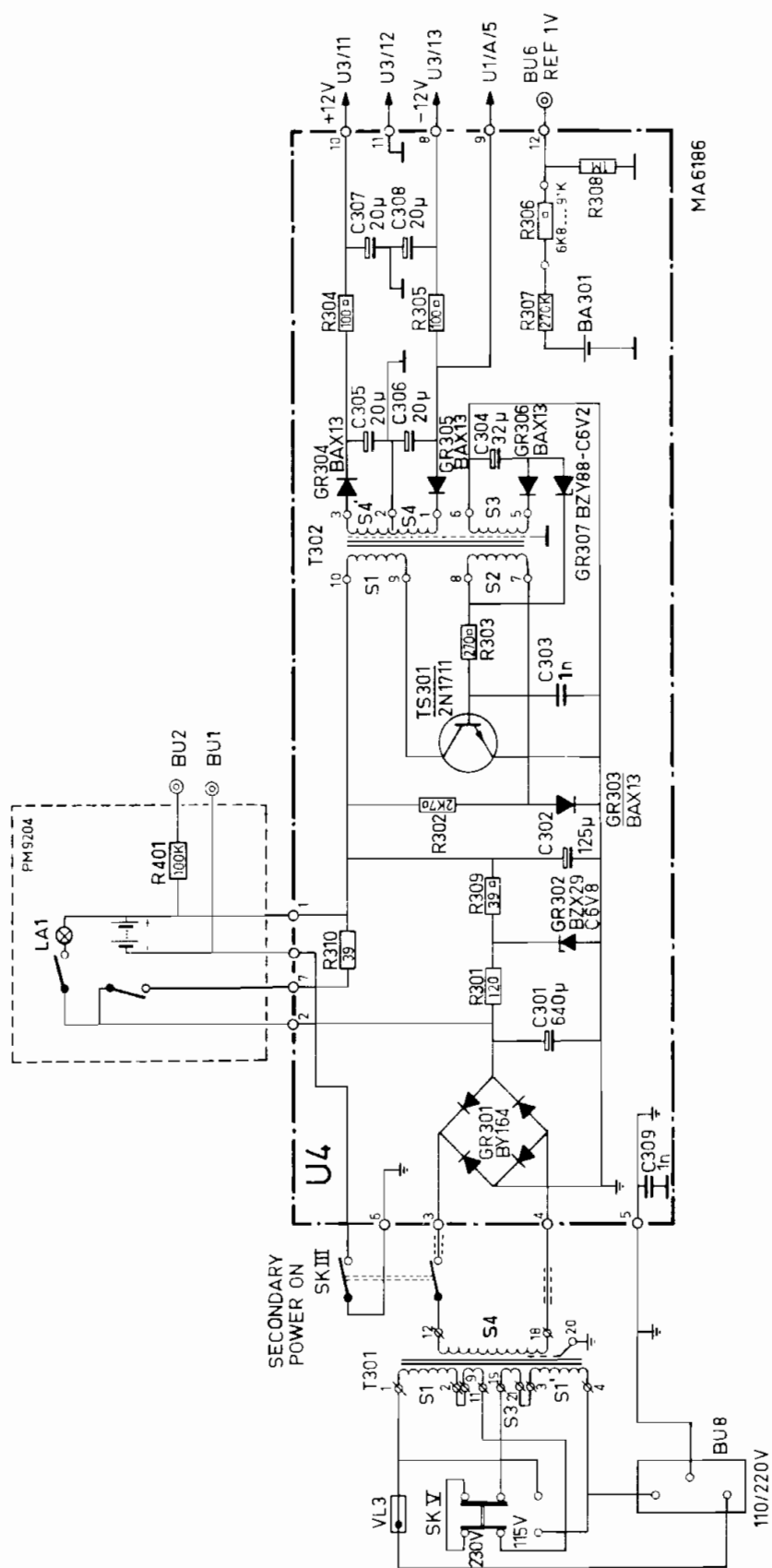


Fig. 10. Supply

When the battery supply unit PM 9204 is connected to the instrument via BU7, the accumulators are charged by a maximum current of 35 mA (the trickle charge) which flows through resistors R301/R309. Setting the battery supply control switch to FAST CHARGING results in resistor R310 and lamp LA1 being connected in parallel with R301/R309. This results in an increase in charge current of up to 300 mA. This charging current is stabilized by lamp LA1. When the instrument is disconnected from the mains, the d.c.-to-d.c. converter is supplied by the battery supply unit.

2. D.C.-to-D.C. converter

The two asymmetrical 12 V supplies required by the amplifier are derived from the voltage across GR302, or from the battery voltage.

The two 12 V supplies are produced by the d.c.-to-d.c. converter as follows: Transistor TS301 becomes conductive immediately a d.c. input voltage is applied to the d.c.-to-d.c. converter, due to the voltage drop across GR303. The collector current flowing through winding S1 causes a voltage to be induced in winding S2, and this causes the base current of TS301 to increase. Collector current through TS301 increases in step with the increase in base current, until the transistor is saturated. At the point of saturation, the field becomes stationary and this causes a decrease in base current. The resulting decrease in collector current causes the voltage induced in winding S2 to be reversed in polarity, so TS301 is cut off. The process is then continuously repeated.

If the rectified output voltage from winding S3 is greater than the zener voltage of GR307, the base bias of TS301 is limited and the average collector current is made smaller. This limit of base bias prevents current surges due to core saturation. The stabilized output voltages taken from windings S4 and S4' are rectified and are then used to power the instrument.

3. Calibration voltage

The calibration voltage, which is derived from a mercury cell, can be adjusted with R306 in such a way that calibration of the amplifier is effected with an accuracy of 0.2 % in the 1 V range.

VIII. DISMANTLING

A. REMOVING THE CABINET

1. Top cover

- Turn the bayonet screw C (Fig. 7) at the rear of the instrument, a quarter-turn.
- Slide the cover slightly to the rear.
- The top cover can now be removed by lifting it at the front.

2. Tilting assembly

- Move the small outer nylon slides 29 (Fig. 11).
- Remove the tilting assembly.

3. Bottom plate

- Loosen screws D (Fig. 7) at the rear of the instrument.
- Withdraw the plate in a backwards direction.

4. Left and right hand side plates

- Loosen the screws E (Fig. 15) which secure the handle.
- Remove the handle.
- Withdraw the side plate.

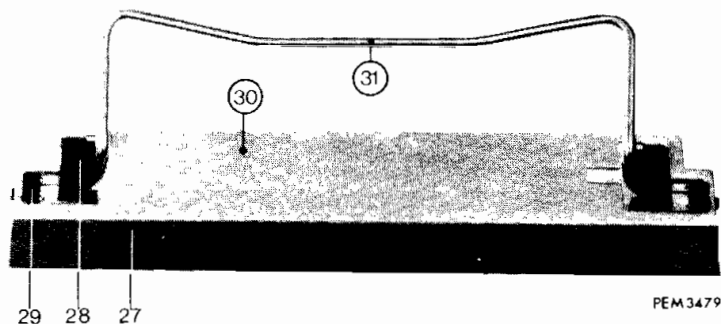


Fig. 11. Tilting assembly

B. REMOVING THE SELECTOR KNOB

Remove the x0.3 button by pressing the pin F (Fig. 12) in the forward direction.

- Use an 11 mm box spanner to loosen the nut from the clamping cone.

C. REMOVING THE ATTENUATOR U1

Remove the cabinet (see VIII.A.).

- Remove the selector knob (see VIII.B.)
- Disconnect U1/A/1 to U1/A/5 inclusive, and U1/B/1 to U1/B/4 inclusive (see Fig. 17).
- Disconnect U1/B/23, U1/B/24, U3/22, and U3/23 (see Fig. 16).
- Remove screws G (Figs. 12 and 13).
- Unscrew nut H (Fig. 17) using a 14 mm open-ended spanner.
- Remove the attenuator block.

D. AMPLIFIER/SUPPLY BLOCK

- Remove the cabinet (see VIII.A.).
- Disconnect U1/B/1 to U1/B/4 (Fig. 17).
- Disconnect U3/22 and U3/23 (Fig. 16).
- Withdraw the cable harness from the two tool clips.
- Loosen screw J (Fig. 12).
- Carefully hinge out the block from the bottom.

E. REAR PANEL

- Remove the cabinet (see VIII.A.).
- Remove four screws M (Figs. 12 and 13).
- Loosen screws K (Figs. 12 and 13).
- Press the side frames outwards in order to hinge out the rear panel.

F. FRONT PANEL

1. Meter section

- Remove the cabinet (VIII.A.).
- Remove the reinforcing piece by loosening the two screws N (Figs. 12 and 13).
- Remove the two ornamental frames by loosening the screws in the feet.

- Unsolder the four leads to the meter.
- Remove the four screws P (Figs. 12 and 13).
- Loosen screws Q (Figs. 12 and 13).
- Carefully press the text plate forward in order to remove the meter section.

2. Text plate section

- Remove the meter section as detailed in para F1 above.
- Loosen screw R and remove the rod for SKII-1 (Fig. 12).
- Loosen screws S (Fig. 12).
- Disconnect U1/A/1.
- Loosen nut H (Fig. 17).
- Remove the four screws Q (Figs. 12 and 13).
- Hinge down the text plate.

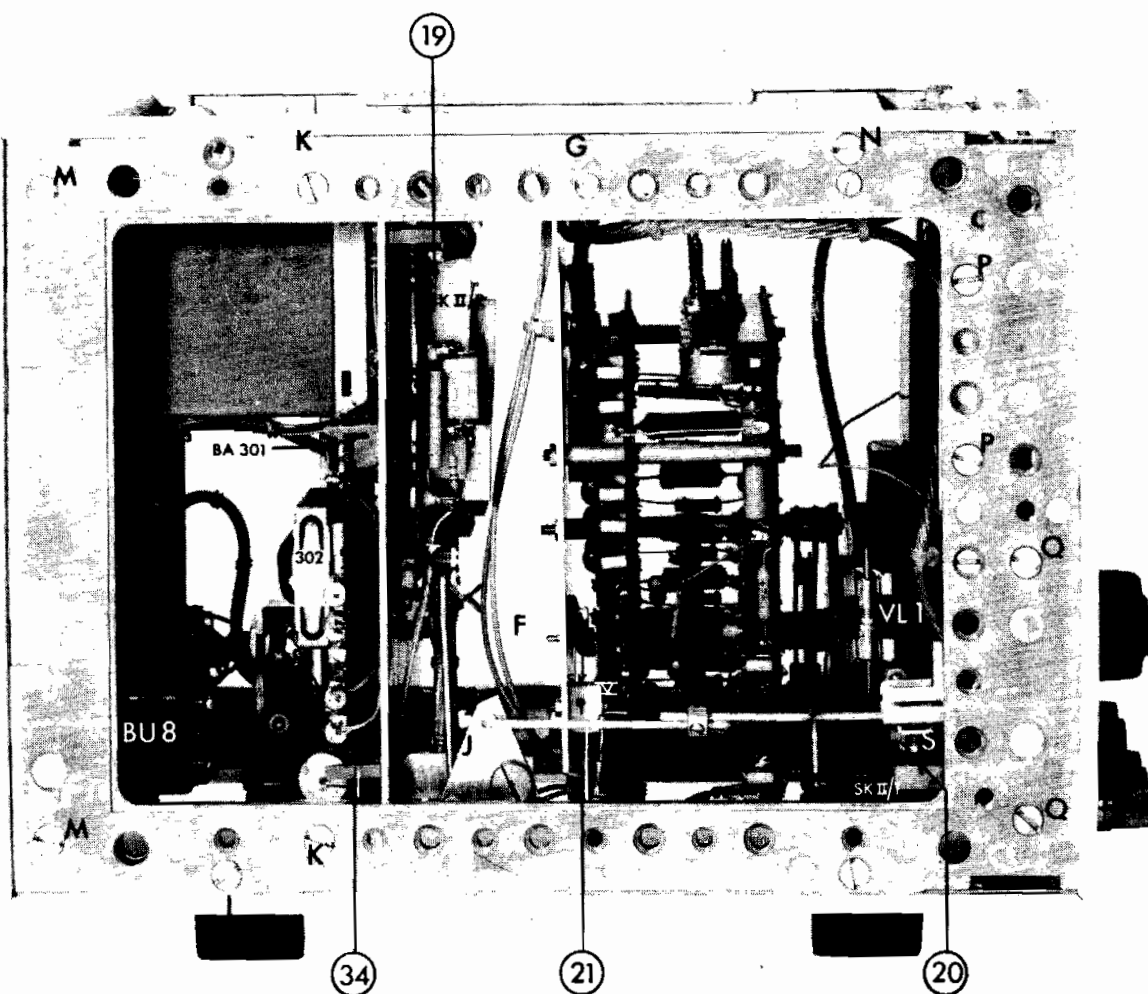


Fig. 12. Left-side view

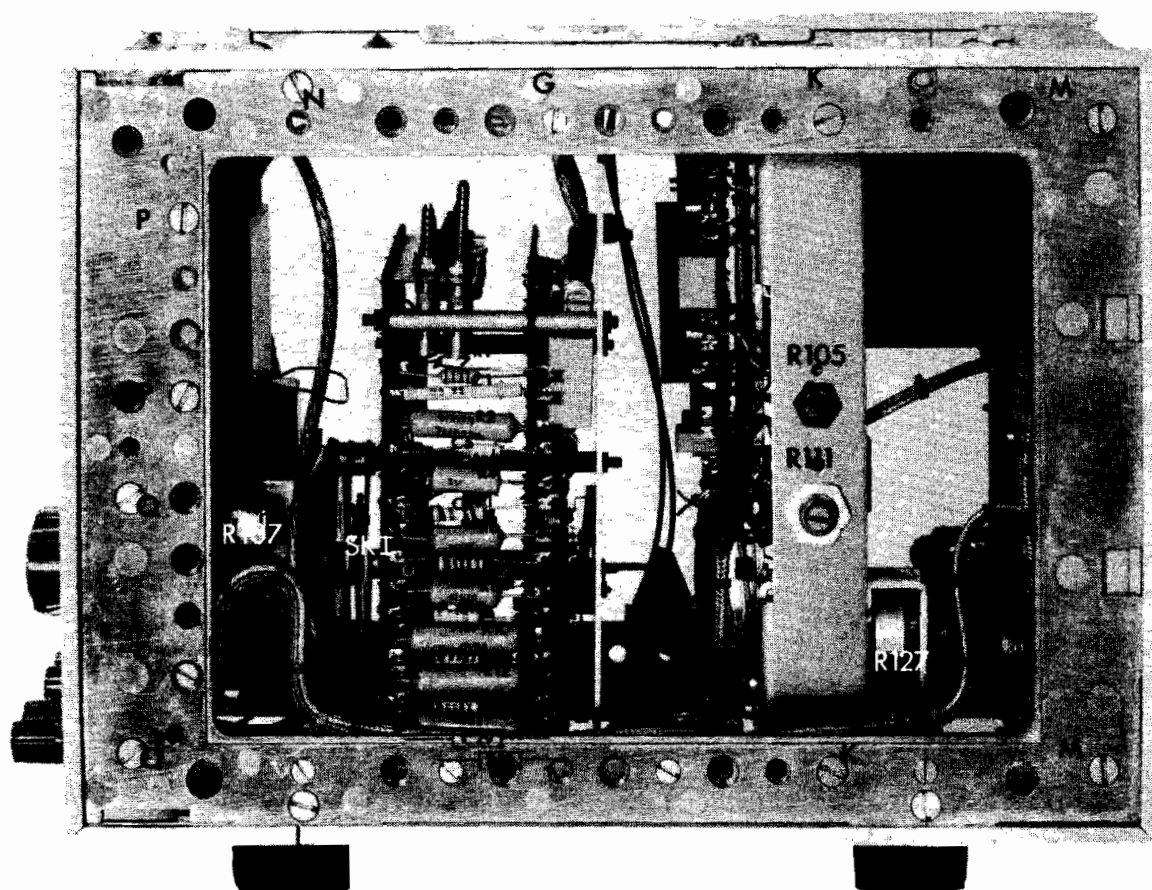


Fig. 13. Right-side view

IX. REPLACING PARTS

A. PRINTED WIRING BOARDS

1. U1/A and U1/B

These boards may be replaced when the complete attenuator block has been removed (see VIII.C.).

2. U2

Board U2 can be replaced when the text plate section has been removed (see VIII.F.2.).

3. U3 and U4

These boards can be replaced when the amplifier/supply block has been hinged out (see VIII.D.).

B. MOVING COIL METER M1

- Remove the meter section (see VIII.F.1).
- Remove the meter mounting plate.

NOTE : The moving coil meter assembly called up in the list of parts includes the polarity indicator. If a faulty polarity indicator has to be replaced, the moving coil meter assembly must therefore be opened.

C. TEXT PLATE

The text plate can be replaced by hinging down the text plate section and removing the five input terminals and the SECONDARY POWER ON switch.

D. FUNCTION SWITCH SKII

- Hinge down the text plate section (see VIII.F.2).
- Press the upper metal part of the switch together and press the rear portion in a downward direction.
- Withdraw the switch.

E. TRANSFORMER T301

The transformer may easily be replaced when the rear panel has been hinged down.

F. FUSE VL2

Fuse VL2 protects the instrument against current overloads during the use of all current ranges up to 1 A. The fuse is located on the underside of the instrument close to terminal 1. Replacement is as follows:

- Remove the tilting assembly.
- Open the fuse holder by pulling the cam with a pair of tweezers.
- Loosen the two screws.
- Pull a suitable length of silver wire from the reel and clamp it under the heads of the screws.

NOTE : The reel supplied contains approximately 30 cms of silver wire which is sufficient for 20 fuse renewals.

G. MERCURY CELL BA301

This cell, which is an extremely constant voltage source, is used for instrument calibration purposes. When defective, the cell can be replaced as follows:

- Remove the left and right hand side panels (see VIII.A).
- Turn the contact spring from the cell.
- Remove the cell.

NOTE : The chemical properties of the cell give it a life expectancy of two years.

X. MAINTENANCE

In general, the VA Ω electronic meter should not require maintenance, since it does not contain parts which are subject to wear. Faultless operation and reliability can be maintained by avoiding exposure of the instrument to moisture, heat, corrosive fumes, and excessive dust.

1. Service hints

The instrument is electrically and mechanically separated within its attenuator and amplifier blocks. Fault location procedures should begin by checking the amplifier as follows:

- Set the mode switch to the VI \equiv position.
- Disconnect U1/B/1 and U1/B/4.
- Connect a 90 mV d.c. supply between the two disconnected leads, positive to U1/B/1 and negative to the screen U1/B/4.
- Switch on the instrument and check that the reading is 100.

If this check shows that the amplifier is serviceable, then the fault must exist in the attenuator block.

2. Shipment of the instrument

In case of breakdown, one can always apply to the world-wide PHILIPS Service Organisation for assistance.

Whenever the instrument is sent to a PHILIPS Service Centre, the following should be observed:

- Tie a label bearing your full name and address, to the instrument.
- Specify the fault(s) found.
- Carefully pack the instrument in a sealed plastic bag and then in its original packing.
- Send the instrument to the address provided by your local PHILIPS representative.

XI. SURVEY OF ADJUSTMENTS

Checking and adjusting procedures are detailed in chapter XII.

<i>Control element</i>	<i>Fig.</i>	<i>Checking or adjusting point</i>	<i>Required checking instrument</i>	<i>Adjustment according to</i>
—	—	Current consumption	Multimeter (PM 2411)	XII.C.1
—	—	Supply	D.C. supply (PE 4818) D.C. meter (PM 2421)	XII.C.2.3
R107,R111	13	Amplifier		
R127	13	Zero-point		XII.D.1
		Calibration	D.C. supply (PE 4818) and accurate divider	XII.D.2
—	—	Direct voltages	D.C. supply 1000 V D.C. meter (PM 2421)	XII.E
—	—	Direct current	Current source 10 A	XII.F
Resistance ranges				
R29	17	100 Ω range	100 Ω , 0.25 % resistor	XII.G.1
R30	17	1 k Ω range	1 k Ω , 0.25 % resistor	XII.G.2
R31	17	10 k Ω range	10 k Ω , 0.25 % resistor	XII.G.3
R22	16	100 k Ω range	100 k Ω , 0.25 % resistor	XII.G.4
R105	13	x0.3 button	30 k Ω , 0.25 % resistor	XII.G.4
R24	16	1 M Ω range	1 M Ω , 0.25 % resistor	XII.G.5
R27	16	10 M Ω range	10 M Ω , 0.5 % resistor	XII.G.6
		diode range	Silicon diode	XII.G.7
Alternating voltages				
C2	16	.1 V range	L.F. generator, 10 Hz to 100 kHz 0 to 60 V \pm 0.5 % and l.f. millivoltmeter \pm 0.5 % (e.g. PM 2421)	XII.H
C3	16	.3 V range		
C7	16	1 V range		
C11	16	3 V range		
C15	16	10 V range		
C19	16	30 V range		
C23	16	100 V range		
C27	16	300 V range		
R306	22	Calibration voltage	Decade resistance box	XII.K

XII. CHECKING AND ADJUSTING

The numerical values given in this chapter with tolerance stated, are factory data and apply only to a fully adjusted instrument. The values may differ from those given in chapter II, Technical Data.

Values without tolerances stated represent the properties of an average instrument and merely serve for information.

A. MECHANICAL ADJUSTMENT OF FUNCTION SWITCH SKII

- Set the function switch SKII to its R ➔ position.
- Loosen screw S (Fig. 12).
- Slide the rod in such a way that the lower part of the switch SKII/2 housing (on amplifier unit U3) lies over the mark on the slide (Fig. 14).
- Fasten screw S.
- Loosen screw R (Fig. 12).
- Slide the rod which is connected to SKII/1 on unit U2, in such a way that the SKII/1 housing lies over the mark on the slide (Fig. 14).
- Fasten screw R.



Fig. 14. Slide of switch SKII

B. MECHANICAL ZERO SETTING

With the instrument switched off, and with the instrument in a horizontal position, check that the pointer is properly zeroed. The pointer setting may be adjusted by means of the correction screw.

C. SUPPLY

1. Current consumption for mains supply

Approximately 30 mA at 220 V, or 60 mA at 115 V.

2. Voltages

- Connect the instrument to a 220 V mains supply.
- Set SKIII to SECONDARY POWER ON.
- Check that the voltage between BU2 and U4/10 is +12.3 V.
- Check that the voltage between BU2 and U4/8 is -12.3 V.



3. Battery supply

- Connect a 5 V supply to socket BU7: positive to pin b and negative to pin d.
- Check that the voltage between BU2 and U4/9 is -12.4 V.
- Check that the current consumption does not exceed 33 mA.
- Reduce the supply from 5 V to 4.4 V and check that the corresponding reduction in voltage between BU2 and U4/9 is less than 0.4 V.
- Increase the supply to 5.45 V.

D. AMPLIFIER

1. Zero point


- Interconnect terminals BU2 ("0") and BU3 (VR➡+).
- Set the mode switch SKII to the VI== position.
- Set the "0" potentiometer (R107, at the front of the panel) to its mid position.
- Connect the slider of R107 to BU2.
- Using R111, set the polarity indicator to its mid position.
- Remove the connection between R107 and BU2.
- Turn potentiometer R107 to its fully anticlockwise position. The meter should show a deflection of approximately five divisions and the polarity indicator should display the minus sign.
- Turn potentiometer R107 to its fully clockwise position. The polarity indicator should display the positive sign and the meter should again show a deflection of approximately five divisions.
- Set the polarity indicator to its mid position using R107.
- Set the range selector SKI to .3 V.
- Set the mode selector SKII to VI~.
- Check that the predeflection shown by the meter is less than one division.

2. Calibration

- Set the mode selector SKII to VI==
- Connect a 90 mV d.c. supply to U3/U4 (junction of R101, C102).
- Disconnect BU2 from BU3.
- Turn the CAL potentiometer (R127, at the rear of the instrument) to its fully anticlockwise position. The meter should show a deflection of approximately

- 97 divisions and the polarity indicator should display the positive sign.
- Turn potentiometer R127 fully clockwise. The pointer of the meter should be against its rest.
 - Using R127, adjust the deflection of the meter to 100 scale divisions.

E. DIRECT VOLTAGES

- Set the mode selector SKII to VI .
- Check the instrument in accordance with the following table:


<i>Position of range selector SKI</i>	<i>Supply to BU3 (+) and BU2</i>	<i>Indication</i>	
		<i>0 to 100 scale</i>	<i>0 to 30 scale</i>
.1 V	100 mV $\pm 0.5\%$	97.5 to 102.5	
.3 V	300 mV $\pm 0.5\%$		29.25 to 30.75
1 V	1 V $\pm 0.5\%$	97.5 to 102.5	
3 V	3 V $\pm 0.5\%$		29.25 to 30.75
10 V	10 V $\pm 0.5\%$	97.5 to 102.5	
30 V	30 V $\pm 0.5\%$		29.25 to 30.75
100 V	100 V $\pm 0.5\%$	97.5 to 102.5	
300 V	300 V $\pm 0.5\%$		29.25 to 30.75
1000 V	1000 V $\pm 0.5\%$	97.5 to 102.5	

The voltages at terminals BU2 and BU3 should be checked with an accurate measuring instrument, e.g. PM 2421.

A check should next be made of scale linearity at 80 %, 60 %, 40 % and 20 %, in the 10 V range. Permissible deviation is $\pm 2.5\%$ of f.s.d.

Note that theoretically the total accuracy consists of the accuracy of the supplied voltage and the accuracy of the measuring ranges.

F. DIRECT CURRENTS

- Set the mode selector SKII to VI .
- Check the instrument in accordance with the following table:

Position of range selector SKI	Supply to BU4 (+) and BU2	Indication	
		0 to 100 scale	0 to 30 scale
1 mA	1 mA $\pm 0.5\%$	98 to 102	
3 mA	3 mA $\pm 0.5\%$		29.4 to 30.6
10 mA	10 mA $\pm 0.5\%$	98 to 102	
30 mA	30 mA $\pm 0.5\%$		29.4 to 30.6
.1 A	100 mA $\pm 0.5\%$	98 to 102	
.3 A	300 mA $\pm 0.5\%$		29.4 to 30.6
1 A	1 A $\pm 0.5\%$	98 to 102	
1 A	Supply 10 A $\pm 0.5\%$ to BU2 and BU5	98 to 102	
1 A	Supply 3 A $\pm 0.5\%$ to BU2 and BU5, x0.3 button SKIV depressed		29.4 to 30.6

Note that theoretically the total accuracy consists of the accuracy of the supplied voltage and the accuracy of the measuring ranges.

G. RESISTANCE RANGES

- Set the mode selector SKII to R➡
- For an optimum adjustment of the resistance ranges it is advisable to supply the instrument with 5.45 V d.c. via socket BU7 point c (+) and d (–).

1. 100 Ω range

- Set the range selector to .1 k Ω .
- Connect a 100 $\Omega \pm 0.25\%$ to terminals BU2 and BU3.
- Connect a resistance decade box between U1/A/29 and U1/A/30 (R29).
- Adjust the meter deflection to 100 divisions by setting the decade box.
- Determine the resistance value to which the decade box is set, and insert this value between U1/A/29 and U1/A/30.

2. 1 k Ω range

- Set the range selector to 1 k Ω .
- Connect a resistor of 1 k $\Omega \pm 0.25\%$ to terminals BU2 and BU3.
- Connect a decade resistance box between U1/A/31 and U1/A/32 (R30).
- Adjust the meter deflection to 100 divisions by setting the decade box.
- Determine the resistance value to which the box is set, and insert this value between U1/A/31 and U1/A/32.

3. 10 k Ω range

- Set the range selector SKI to 10 k Ω .
- Connect a 10 k $\Omega \pm 0.25\%$ resistor between terminals BU2 and BU3.
- Connect a resistance decade box between U1/A/33 and U1/A/34 (R31).
- Adjust the meter deflection to 100 divisions by setting the decade box.
- Determine the resistance value to which the box is set, and insert this value between U1/A/33 and U1/A/34.

4. 100 k Ω range

- Set the range selector SKI to 100 k Ω .
- Connect a 100 k $\Omega \pm 0.25\%$ resistor between terminals BU2 and BU3.
- Adjust the meter deflection to 100 divisions by setting potentiometer R22.
- Connect a resistor of 30.1 k $\Omega \pm 0.25\%$ to terminals BU2 and BU3.
- Depress the x0.3 button SKIV and use potentiometer R105 to adjust the meter deflection to 30 scale divisions (lower scale).

5. 1 M Ω range

- Set the range selector SKI to 1 M Ω .
- Connect a 1 M $\Omega \pm 0.25\%$ resistor to terminals BU2 and BU3.
- Adjust the meter deflection to 100 scale divisions, using potentiometer R24.

6. 10 M Ω range

- Set the range selector SKI to 10 M Ω .
- Connect a 10 M $\Omega \pm 0.5\%$ resistor to terminals BU2 and BU3.
- Adjust the meter deflection to 100 divisions using potentiometer R27.

7. Diode range

- Set the range selector SKI to \blacktriangleright 10 A.
- Connect a silicon diode to terminals BU2 and BU3 (anode to BU2).
- Check that the indication is between 50 and 60 divisions.

H. ALTERNATING VOLTAGES

- Set mode selector SKII to the VI \sim position.
- Adjust the instrument in accordance with the following table:

<i>Position of range selector SKI</i>	<i>Supply to BU2 and BU3</i>	<i>Adjust with</i>	<i>Adjust to</i>
.1 V	100 mV $\pm 0.5\%$, 240 Hz	R127	100 scale divisions
.1 V	100 mV $\pm 0.5\%$, 80 kHz	C2	
.3 V	316.2 mV $\pm 0.5\%$, 240 Hz	R127	
.3 V	316.2 mV $\pm 0.5\%$, 80 kHz	C3	
1 V	1 V $\pm 0.5\%$, 240 Hz	R127	
1 V	1 V $\pm 0.5\%$, 80 kHz	C7	
3 V	3.16 V $\pm 0.5\%$, 240 Hz	R127	
3 V	3.16 V $\pm 0.5\%$, 80 kHz	C11	
10 V	10 V $\pm 0.5\%$, 240 Hz	R127	
10 V	10 V $\pm 0.5\%$, 80 kHz	C15	
30 V	31.6 V $\pm 0.5\%$, 240 Hz	R127	60 scale divisions
30 V	31.6 V $\pm 0.5\%$, 80 kHz	C19	
100 V	60 V $\pm 0.5\%$, 240 Hz	R127	60 scale divisions
100 V	60 V $\pm 0.5\%$, 80 kHz	C23	

- Set selector switch SKI to its 300 V position.
- Connect a 60 V $\pm 0.5\%$, 240 Hz supply and adjust the meter indication to 100 divisions using potentiometer R127.
- Connect a 60 V $\pm 0.5\%$, 80 kHz to terminals BU2 and BU3.
- Connect an a.c. voltmeter (e.g. PM 2454) between terminals BU2 and U3/24 (junction of R101 and C102). Keep the connections as short as possible.
- Adjust C27 in order to obtain a reading of 20 mV on the a.c. voltmeter.
- Set the range selector SKI to .1 V.
- Connect a 100 mV $\pm 0.5\%$, 240 Hz supply and adjust the meter indication to 100 divisions using potentiometer R127.
- Connect a 100 mV $\pm 0.5\%$, 200 kHz supply.
- Check that the meter reading is larger than 97 and less than 103 divisions.

J. FILTER

- Set the mode selector SKII to VI==
- Set the range selector SKI to .1 V.
- Connect a 3 V $\pm 1\%$, 240 Hz.
- Check that the meter reading is less than 41 divisions.

K. CALIBRATION VOLTAGE

- Set the mode selector SKII to VI==
- Connect a 90 mV d.c. supply to U3/24 (junction R101/C102) and "0".
- Adjust R127 in order to obtain a reading of 100 divisions.
- Set the range SKI to 1 V.
- Connect terminal BU3 with BU6.
- Connect a resistance decade box to U4/13 and U4/14 (R306).
- Set the decade resistance box in order to obtain a meter deflection of 100 ± 0.2 divisions.
- Determine the value at which the decade resistance box is set, and insert this value between U4/13 and U4/14.

XIII. LIST OF PARTS

A. MECHANICAL

<i>Item</i>	<i>Fig.</i>	<i>Qty.</i>	<i>Ordering number</i>	<i>Description</i>	<i>Remark</i>
1	15	1	4822 347 40015	Moving coil meter M1	200 μ A, 500 Ω
2	15	1	4822 347 10061	Polarity indicator	M2
3	15	1	4822 455 90404	Text plate	front
4	15	1	4822 277 10323	Mains switch	SKIII
5	15	1	4822 410 40022	Push button	for SKIV
6	15	1	4822 413 40112	Knob	
7	6+15	5	4822 290 40011	Terminal	BU2...BU6
8	15	1	4822 290 40012	Earth terminal	BU1
9	15	1	4822 404 60058	Handle switch	SKII
10	15	2	4822 310 10044	Washer for handle bracket screw	
11	15	2		Handle bracket screw	
12	15	2		Handle bracket	
13	15	2		Screw for handle bar	
14	6	1	4822 256 40012	Fuse holder	VL3
15	6	1	4822 277 20014	Slide switch	SKV
16	6	1	4822 267 40127	6-pole socket	BU7
17	6	1	4822 265 30066	Mains input socket	BU8
18	6	1	4822 455 90405	Text plate	rear
19	12	1	4822 277 30503	Slide switch	SKII/2
20	12	1	4822 277 30504	Slide switch	SKII/1
21	12	1	4822 271 30142	Switch	SKIV
22	13	1	4822 273 40278	Switch	SKI, frame with wafer SKI/2
23	18	1	4822 278 60057	Switch wafer	SKI/1 on U1/A
24	19	1	4822 278 60058	Switch wafer	SKI/3 on U1/B
25	17	1	4822 256 30125	Fuse holder	VL2
26	17	2	4822 460 60014	Ornamental frame	
27	11	2	4822 460 60017	Ornamental strip	width of 6 modules
28	11	2	4822 520 10182	Bracket pivot	
29	11	2	4822 462 70366	Slide piece	
30	11	1	4822 256 90086	Strip holder	

Item	Fig.	Qty.	Ordering number	Description	Remark
31	11	1	4822 404 50541	Stand-up	
32	17	1	4822 462 40157	Foot cap	
33	17	1	4822 462 50101	Foot	metal part
34	12	7	4822 693 40001	Print support	
35	17	2	4822 404 50544	Tool holder	
36	17	2	4822 530 70214	Retaining ring	
37	—	1	4822 290 30001	Interconnection strip	
38	—	1	4822 321 10071	Mains cable	

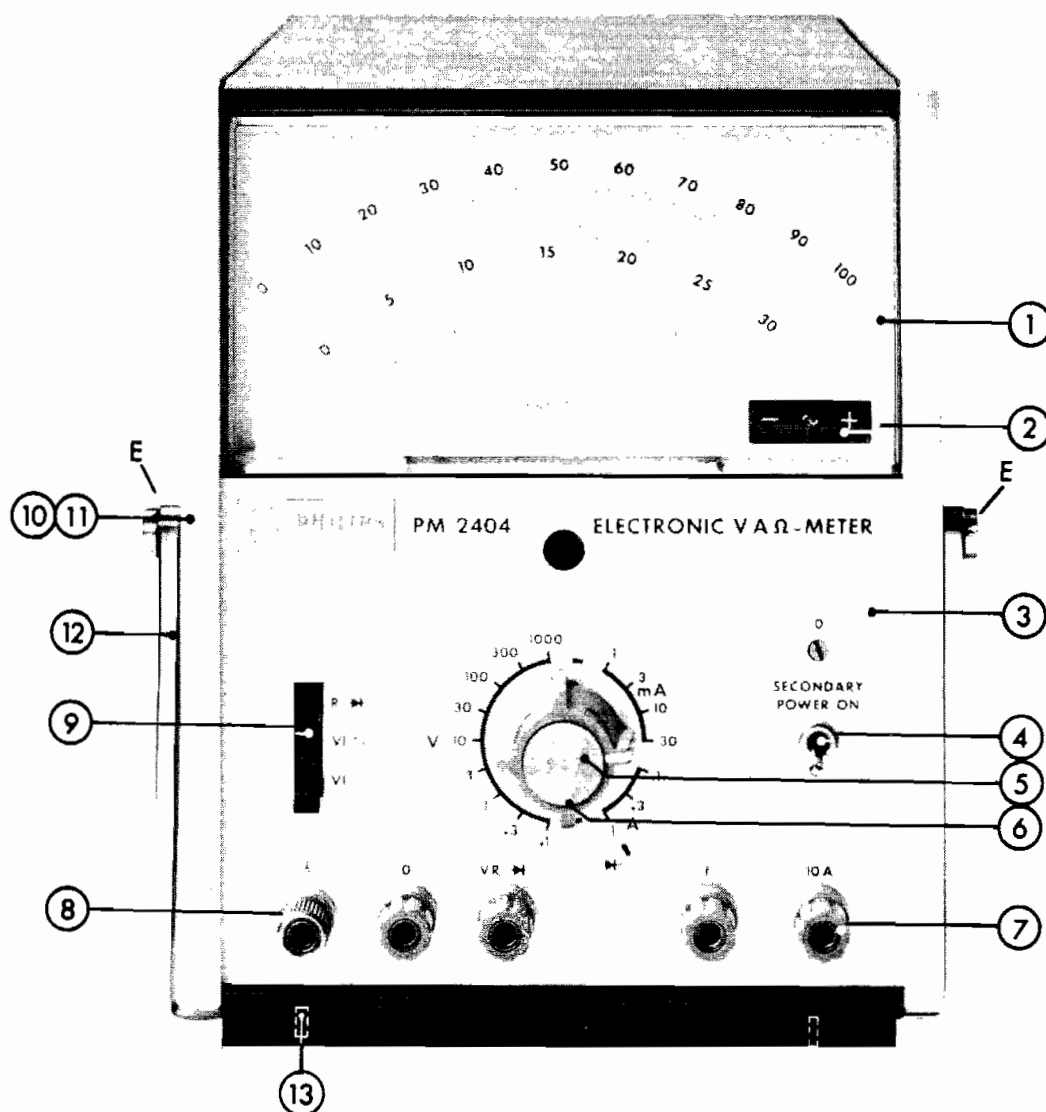


Fig. 15. Front view with item numbers

B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS




















This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het prinsipschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs spécifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

 Carbon resistor E24 series Kohleschichtwiderstand, Reihe E24 Koolweerstand E24 reeks Résistance au carbone, série E24 Resistencia de carbón, serie E24	$\left. \begin{array}{l} 0,125 \text{ W} \\ 5\% \end{array} \right\}$	 Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12	$\left. \begin{array}{l} 1 \text{ W} \leq 2,2 \text{ M}\Omega, 5\% \\ > 2,2 \text{ M}\Omega, 10\% \end{array} \right\}$
 Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12	$\left. \begin{array}{l} 0,25 \text{ W} \leq 1 \text{ M}\Omega, 5\% \\ > 1 \text{ M}\Omega, 10\% \end{array} \right\}$	 Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12	$\left. \begin{array}{l} 2 \text{ W} \\ 5\% \end{array} \right\}$
 Carbon resistor E24 series Kohleschichtwiderstand, Reihe E24 Koolweerstand E24 reeks Résistance au carbone, série E24 Resistencia de carbón, serie E24	$\left. \begin{array}{l} 0,5 \text{ W} \leq 5 \text{ M}\Omega, 1\% \\ > 5 \text{ M}\Omega, 2\% \\ > 10 \text{ M}\Omega, 5\% \end{array} \right\}$	 Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	$\left. \begin{array}{l} 0,4 - 1,8 \text{ W} \\ 0,5\% \end{array} \right\}$
 Carbon resistor E12 series Kohleschichtwiderstand, Reihe E12 Koolweerstand E12 reeks Résistance au carbone, série E12 Resistencia de carbón, serie E12	$\left. \begin{array}{l} 0,5 \text{ W} \leq 1,5 \text{ M}\Omega, 5\% \\ > 1,5 \text{ M}\Omega, 10\% \end{array} \right\}$	 Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	$\left. \begin{array}{l} 5,5 \text{ W} \leq 200 \Omega, 10\% \\ > 200 \Omega, 5\% \end{array} \right\}$
 Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada		$\left. \begin{array}{l} 10 \text{ W} \\ 5\% \end{array} \right\}$	
 Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular	$\left. \begin{array}{l} 500 \text{ V} \end{array} \right\}$	 Polyester capacitor Polyesterkondensator Polyesterkondensator Condensateur au polyester Condensador polyester	$\left. \begin{array}{l} 400 \text{ V} \end{array} \right\}$
 Tubular ceramic capacitor Rohrkondensator Keramische kondensator, buistype Condensateur céramique tubulaire Condensador cerámico tubular	$\left. \begin{array}{l} 700 \text{ V} \end{array} \right\}$	 Flat-foil polyester capacitor Miniatur-Polyesterkondensator (flach) Platte miniatuur polyesterkondensator Condensateur au polyester, type plat Condensador polyester, tipo de placas planas	$\left. \begin{array}{l} 250 \text{ V} \end{array} \right\}$
 Ceramic capacitor, "pin-up" Keramikkondensator "Pin-up" (Perltyp) Keramische kondensator "Pin-up" type Condensateur céramique, type perle Condensador cerámico, versión "colgable"	$\left. \begin{array}{l} 500 \text{ V} \end{array} \right\}$	 Paper capacitor Papierkondensator Papierkondensator Condensateur au papier Condensador de papel	$\left. \begin{array}{l} 1000 \text{ V} \end{array} \right\}$
 "Microplate" ceramic capacitor Miniatur-Scheibenkondensator "Microplate" keramische kondensator Condensateur céramique "microplaque" Condensador cerámico "microplaca"	$\left. \begin{array}{l} 30 \text{ V} \end{array} \right\}$	 Wire-wound trimmer Drahttrimmer Draadgewonden trimmer Trimmer à fil Trimmer bobinado	
 Mica capacitor Glimmerkondensator Micakondensator Condensateur au mica Condensador de mica	$\left. \begin{array}{l} 500 \text{ V} \end{array} \right\}$	 Tubular ceramic trimmer Rohrtrimmer Buisvormige keramische trimmer Trimmer céramique tubulaire Trimmer cerámico tubular	



For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.

Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.

Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.

Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.

Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

RESISTORS

<i>No.</i>	<i>Ordering number</i>	<i>Value</i>	<i>Series</i>	<i>Description</i>
R1	4822 111 40198	1 M Ω	CR68	Carbon
R2	4822 111 40193	7.5 M Ω	CR68	Carbon
R3	4822 111 40192	4.6 M Ω	CR68	Carbon
R4	4822 111 40195	9.1 M Ω	CR68	Carbon
R6	4822 111 40196	9.72 M Ω	CR68	Carbon
R7	4822 111 20327	294 k Ω	CR37	Carbon
R8	4822 111 40197	9.91 M Ω	CR68	Carbon
R9	4822 111 20326	91 k Ω	CR37	Carbon
R10	4822 111 40189	10 M Ω	CR68	Carbon
R11	4822 111 20323	28.5 k Ω	CR37	Carbon
R12	4822 111 40189	10 M Ω	CR68	Carbon
R13	4822 111 20325	9 k Ω	CR37	Carbon
R14	4822 111 40189	10 M Ω	CR68	Carbon
R15	4822 111 20322	2.85 k Ω	CR37	Carbon
R16	4822 111 40189	10 M Ω	CR68	Carbon
R17	4822 111 20324	900 Ω	CR37	Carbon
R20	5322 111 24004	1.2 M Ω	CR37	Carbon
R21	4822 111 40189	10 M Ω	CR68	Carbon
R22	4822 101 20408	100 k Ω		Potentiometer
R23	4822 111 50341	100 M Ω	CR68	Carbon
R24	4822 101 20408	100 k Ω		Potentiometer
R25	4822 111 50353	220 M Ω	CR68	Carbon
R27	4822 101 20238	10 k Ω		Potentiometer
R33	4822 111 40194	9 M Ω	CR68	Carbon
R34	4822 113 10182	61.9 Ω		Wire wound 0.4 W
R35	4822 113 10178	19.3 Ω		Wire wound 0.4 W
R36	4822 113 10181	6.12 Ω		Wire wound 0.4 W
R37a	4822 113 10179	3.88 Ω		Wire wound 0.4 W
R37b	4822 113 10179	3.88 Ω		Wire wound 0.4 W
R38 } R39 }	4822 115 80102	615.5 m Ω 193.5 m Ω		Shunt
R40 } R41 }	4822 115 80101	81 m Ω 9 m Ω		Shunt
R105	4822 101 20237	2.2 k Ω		Potentiometer
R106	4822 116 50746	100 Ω	MR31C	Metal film
R107	4822 101 20413	1 M Ω		Potentiometer

<i>No.</i>	<i>Ordering number</i>	<i>Value</i>	<i>Series</i>	<i>Description</i>
R111	4822 101 20411	220 Ω		Potentiometer
R124	4822 116 50558	18.7 k Ω	MR25	Metal film
R125	4822 116 50664	2.05 k Ω	MR25	Metal film
R127	4822 101 20412	4.7 k Ω		Potentiometer
R128	4822 116 51028	196 Ω	MR31C	Metal film
R129	4822 116 50747	1 k Ω	MR31C	Metal film
R130	4822 116 50747	1 k Ω	MR31C	Metal film
R131	4822 116 50746	100 Ω	MR25	Metal film
R307	4822 116 50531	270 k Ω	CR37	Carbon
R308	4822 111 20317	1 M Ω	CR37	Carbon

CAPACITORS

<i>No.</i>	<i>Ordering number</i>	<i>Value</i>	<i>o/o</i>	<i>V</i>	<i>Description</i>
C1	4822 121 50418	390 pF		125	Polyester
C2	5322 125 64001	18 pF			Trimmer
C3	5322 125 64001	18 pF			Trimmer
C7	4822 125 60037	6 pF			Trimmer
C10	4822 121 50416	150 pF		125	Polyester
C11	4822 125 60037	6 pF			Trimmer
C14	4822 121 50416	150 pF		125	Polyester
C15	4822 125 60037	6 pF			Trimmer
C18	4822 121 50418	390 pF		125	Polyester
C19	4822 125 60037	6 pF			Trimmer
C22	4822 121 50432	1.5 nF		125	Polyester
C23	4822 125 60037	6 pF			Trimmer
C26	4822 121 50503	4.3 nF		63	Polyester
C27	4822 125 60037	6 pF			Trimmer
C30	4822 121 50502	15 nF		63	Polyester
C102	4822 121 40042	47 nF			Polyester
C103	4822 121 40045	22 nF			Polyester
C104	4822 121 40232	220 nF			Polyester
C105	4822 121 40047	10 nF			Polyester
C107	4822 121 40047	10 nF			Polyester

<i>No.</i>	<i>Ordering number</i>	<i>Value</i>	<i>%</i>	<i>V</i>	<i>Description</i>
C108	4822 121 40047	10 nF			Polyester
C109	4822 121 50409	270 pF			Polyester
C110	4822 124 10012	80 μ F		4	Electrolytic
C111	4822 121 40047	10 nF			Polyester
C112	4822 121 40047	10 nF			Polyester
C113	4822 124 10012	80 μ F		4	Electrolytic
C114	4822 121 40323	100 nF			Polyester
C301	4822 124 20411	640 μ F		16	Electrolytic
C302	4822 124 20393	125 μ F		10	Electrolytic
C304	4822 124 20273	32 μ F		10	Electrolytic
C305	4822 124 20362	20 μ F		16	Electrolytic
C306	4822 124 20362	20 μ F		16	Electrolytic
C307	4822 124 20362	20 μ F		16	Electrolytic
C308	4822 124 20362	20 μ F		16	Electrolytic

MISCELLANEOUS

VL1	4822 252 60019	Spark gap
VL2	4822 115 90076	Roll of fuse wire
VL3	4822 253 30007	Fuse 125 mA, delayed action
T301	4822 146 30277	Transformer
T302	4822 142 60131	Transformer
BA301	RM-625R	Malory
U1/A	4822 216 70141	Printed wiring board, complete
U1/B	4822 216 70142	Printed wiring board, complete
U2	4822 216 70139	Printed wiring board, complete
U3	4822 216 70143	Printed wiring board, complete
U4	4822 216 70144	Printed wiring board, complete

TRANSISTORS

TS101-101'	4822 130 40702	ON285 (FET)
TS102	4822 130 40369	BC179B
TS103	4822 130 40369	BC179B
TS104	4822 130 40491	BCY57
TS105	4822 130 40417	BSX20
TS106	4822 130 40417	BSX20
TS301	4822 130 40019	2N1711

DIODES

GR1	4822 130 30292	BZY88 - C15 Zener
GR2	4822 130 30554	BYX42/300
GR3	4822 130 30554	BYX42/300
GR4	4822 130 30195	BYX10
GR101	4822 130 40182	BAX13
GR102		
GR103		
GR104		
GR105	4822 130 30229	AAZ15
GR106	4822 130 40182	BAX13
GR301	4822 130 30414	BY164
GR302	4822 130 30609	BZX29-CV8 Zener
GR303	4822 130 40182	BAX13
GR304		
GR305		
GR306	4822 130 30286	BZY88 - C6V2 Zener
GR307		

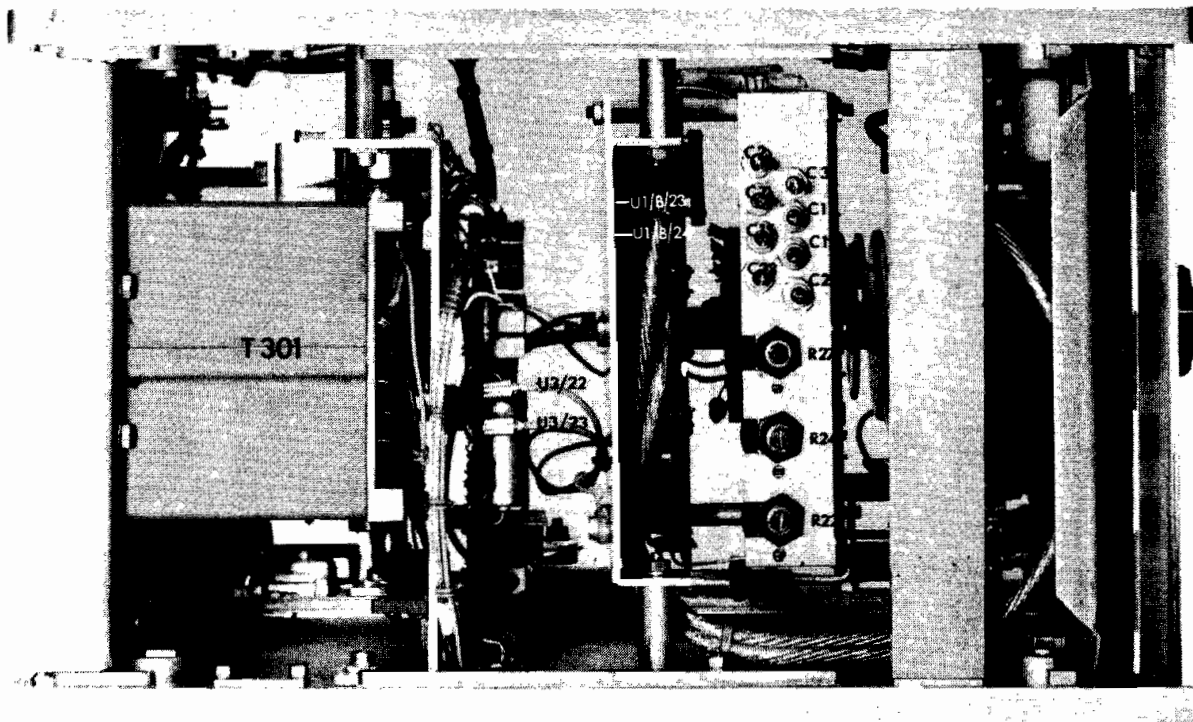


Fig. 16. Top view

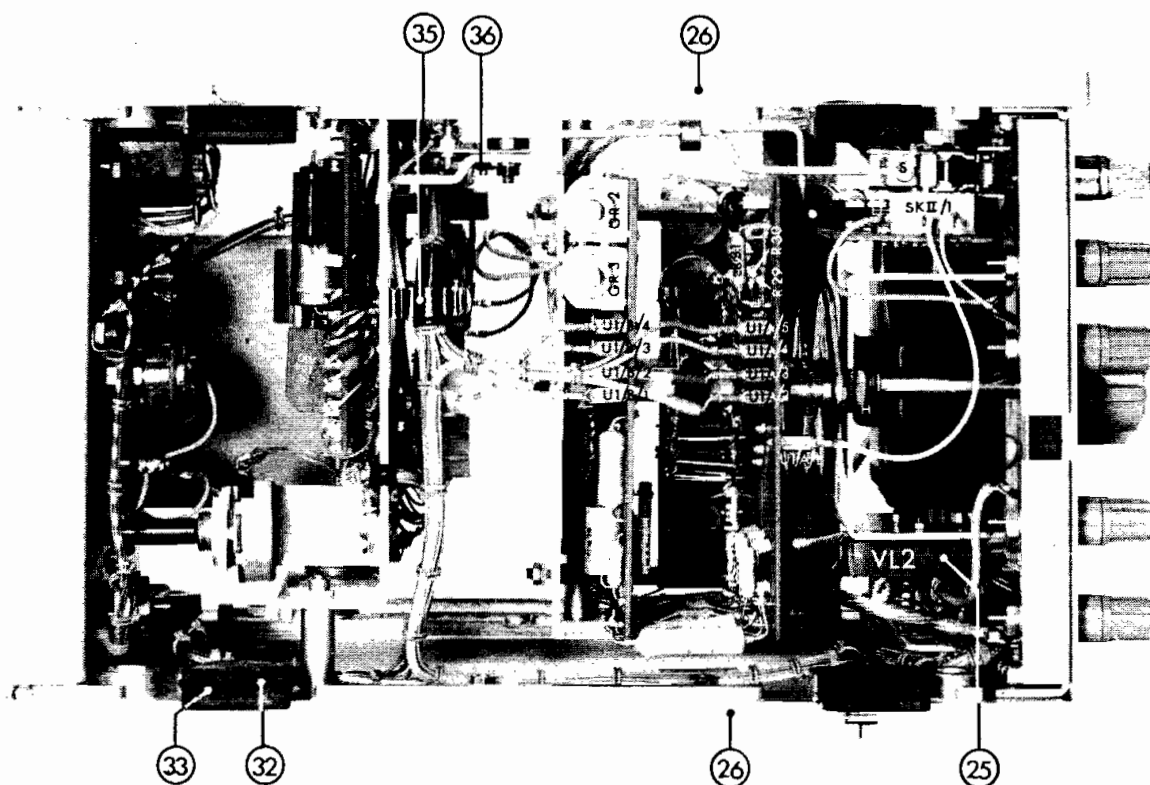


Fig. 17. Bottom view

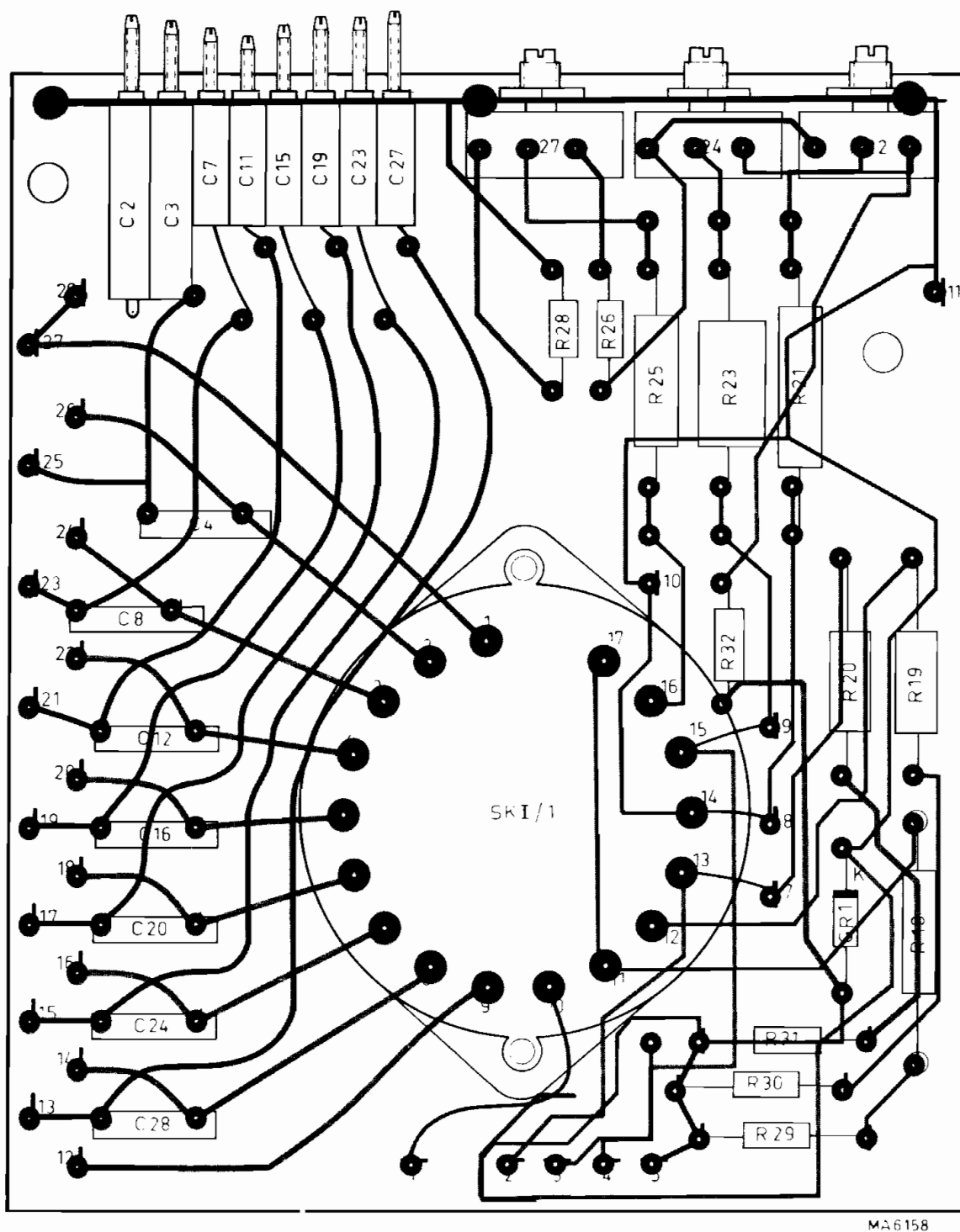


Fig. 18. Printed wiring board U1/A

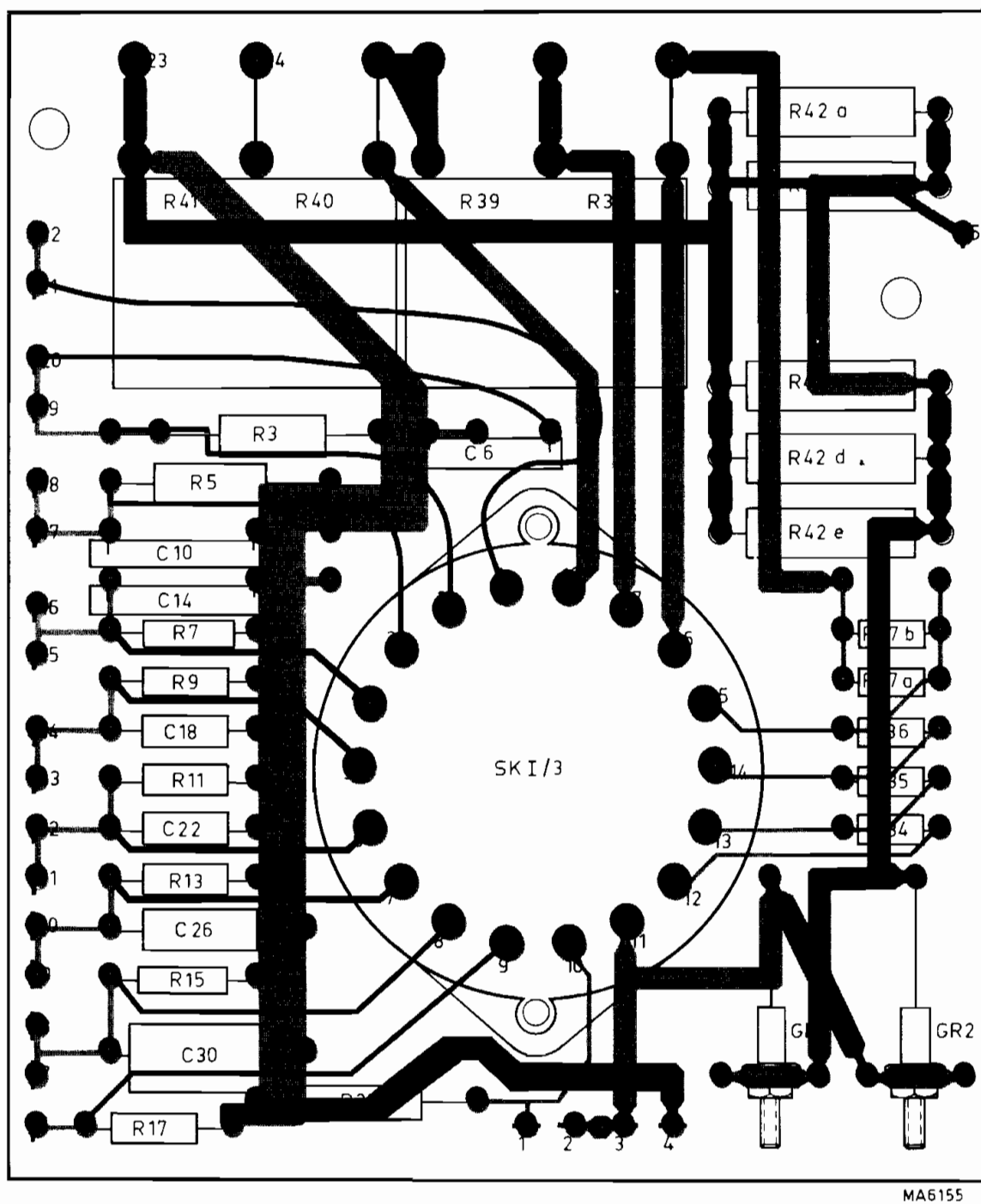


Fig. 19. Printed wiring board U1/B

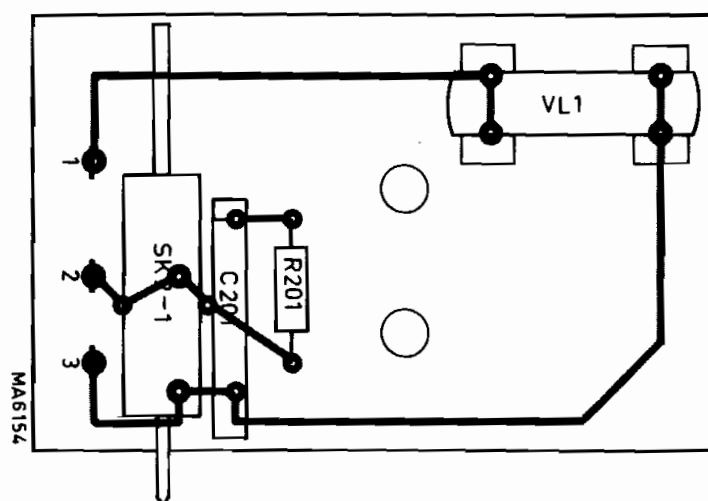


Fig. 20. Printed wiring board U2

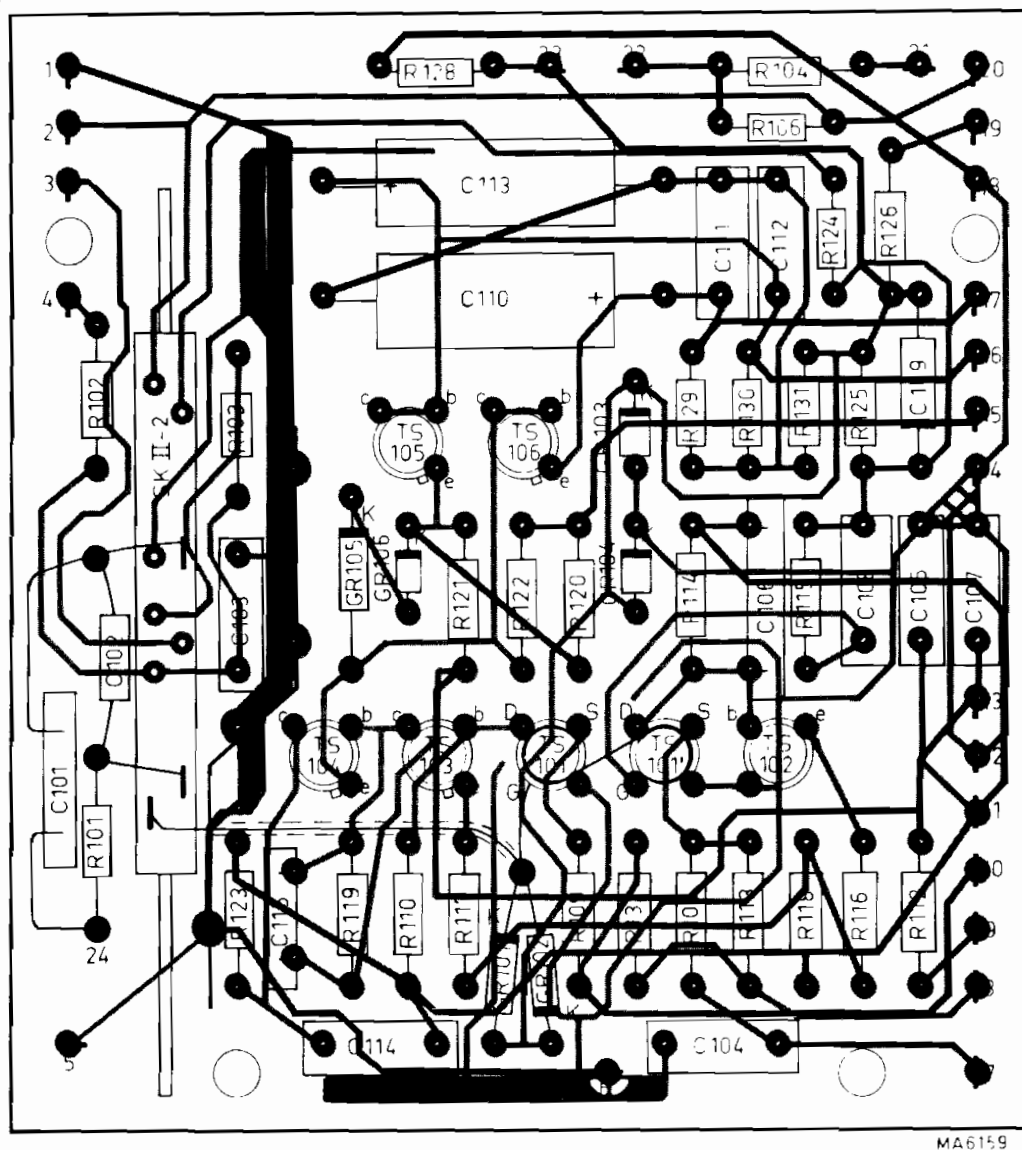


Fig. 21. Printed wiring board U3

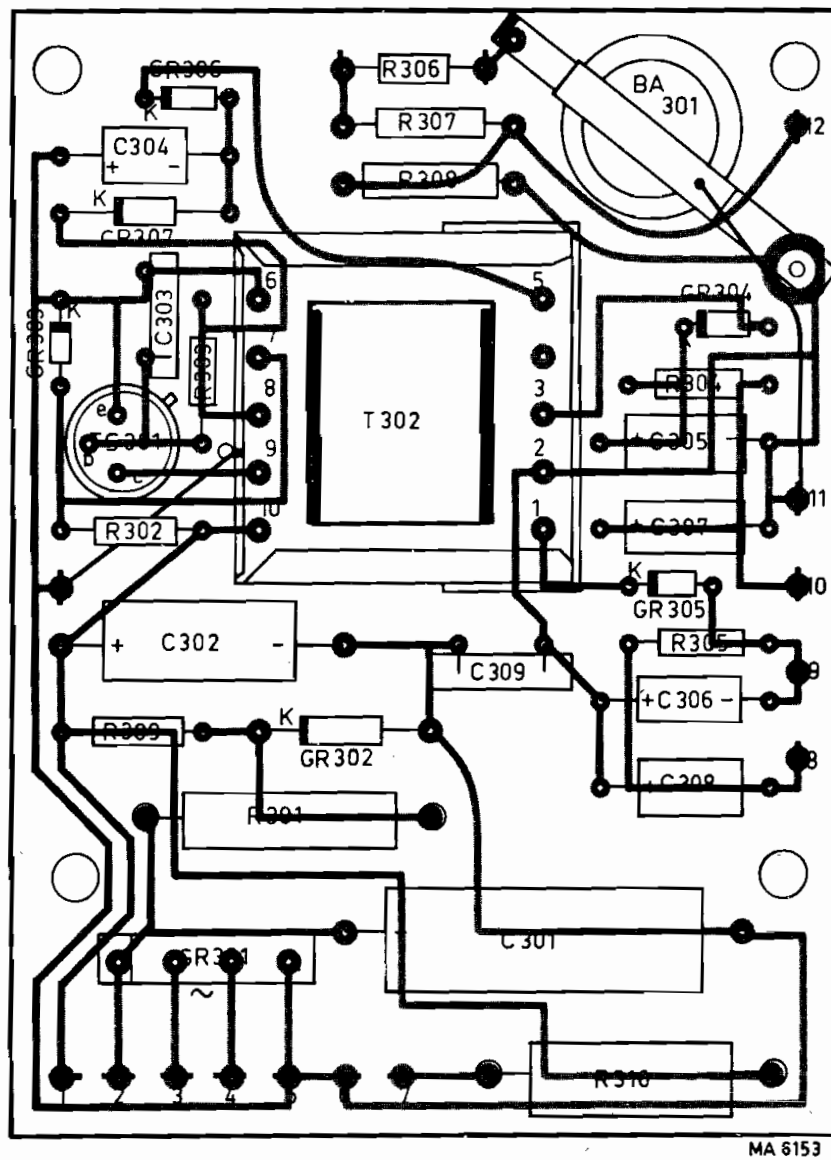
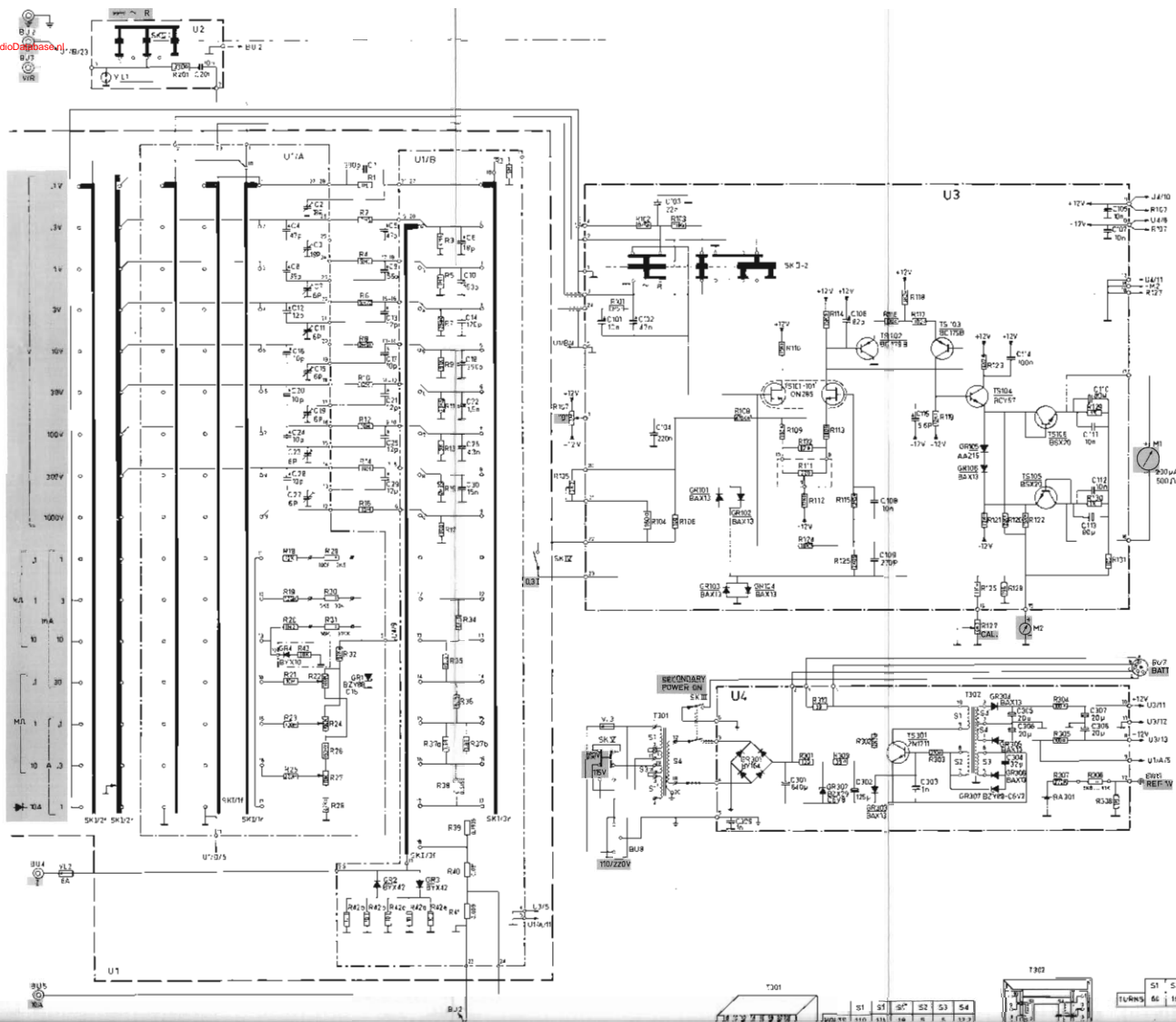


Fig. 22. Printed wiring board U4



51	52	53	54
55	56	57	58

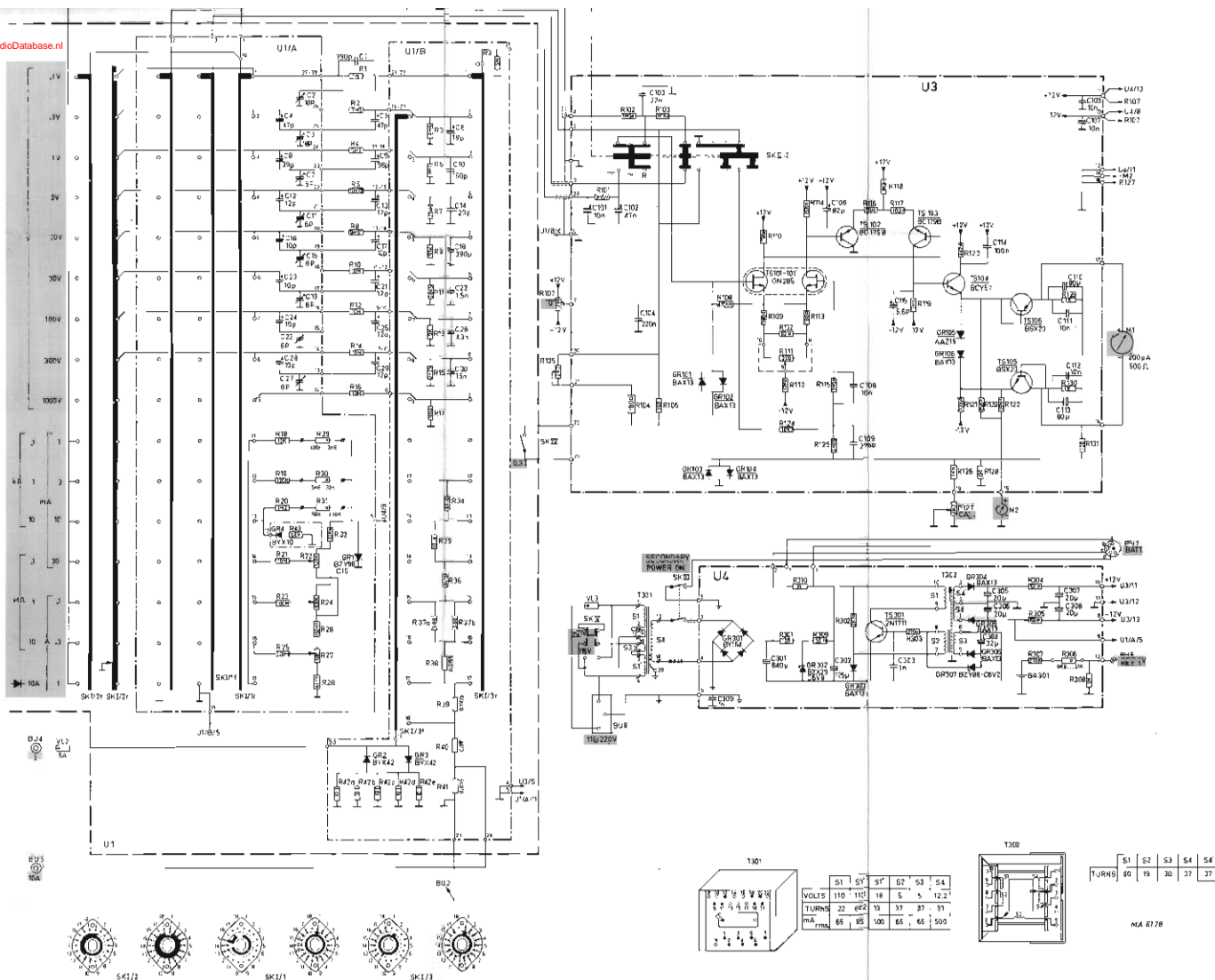


Fig. 23. Circuit diagram PM 2404