PHILIPS

Manual

AC-millivoltmeter
PM2454 B

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I. Introduction

GENERAL

The Philips AC millivoltmeter PM 2454 B is a sensitive and accurate measuring instrument suitable for floating measurements from 50 µV up to 300 V in the frequency range from 10 Hz up to 12 MHz.
The instrument can be powered, either directly by mains or by means of an accumulator.
By this, and the very great bandwidth and sensitivity the instrument has a width range of applications, e.g. measurements on LF and HF amplifiers, carrier-wave telephony, electro-acoustical as well for measurements on transducers and measuring-transformers, etc.

The d.c. output, moreover, makes it possible to employ the instrument as an a.c./d.c. converter.
The instrument has a great indicating speed, a high temperature stability and is quickly ready for use.
The 12 measuring ranges of 1 mV up to 300 V fsd overlap so that a high reading accuracy is obtained. The moving-coil instrument is provided with a mirror scale with the ranges 0 - 30 and 0 - 100 as well as dB scale from -20 dB... + 2 dB (total span - 80 dB... + 52 dB).

By means of the measuring-probe PM 9336 the input impedance can be changed from 1 MΩ//30 pF except capacity measuring cable (100 pF) into 10 MΩ/11 pF to permit measurements on very high ohmic circuits.

II. Technical data

Properties expressed in numerical values with tolerances are guaranteed by the factory.
Numerical values without tolerances serve only for information and represent the properties of an average instrument.

II-1 ELECTRICAL.

Measuring range : 50 µV... 300 V divided into 12 ranges from 1 mV... 300 V (fsd.)

dB Measuring range : - 80 dB... + 52 dB (12 ranges)
0 dB = 1 mW into 600 Ω, 0,775 V

Frequency range : 10 Hz... 12 MHz

Input impedance : direct 1 MΩ//33 pF
with PM 9336: 10 MΩ//11 pF

Accuracy : Frequency

40 Hz	- 400 kHz	± 1% of reading, ± 1% fsd.
10 Hz	- 40 Hz	± 3% of reading, ± 1% fsd.
400 kHz	- 2 MHz	± 2% of reading, ± 1% fsd.
2 MHz	- 6 MHz	± 2% of reading, ± 3% fsd.
6 MHz	- 12 MHz	± 4% of reading, ± 4% fsd.

Note: By application of probe PM 9336 the accuracy will decrease 3% of reading.

Pre-deflection : < 3 scale divisions (with open or short-circuited input)
Influence on accuracy:
10% pointer deflection ≤ 0.45%
30% pointer deflection ≤ 0.15%

Temperature range	: 0 ... + 45°C
Temperature coëfficient	: ≤ 1°/oo/°C
Effect of mains voltage variations	: A mains voltage variation of 10% causes an additional measuring error of 1°/oo
Rectifying circuit for the meter section	: Average value rectifier
Meter scale	: Mirror scale with knife-edge pointer Calibrated in rms values of sinusoidal input voltages Linear division from 0 ... 103 and 0 ... 325 dB sclae from - 20 dB ... + 2 dB.
Overload protection	: In the ranges 1 mV to 300 mV: 300 V for frequencies between 10 Hz and 10 kHz 10 V for frequencies above 10 kHz Other ranges: 300 V for frequencies between 10 Hz and 12 MHz
Max. permissible voltage (all ranges)	: Between Hi and Lo 400 V d.c. Between Lo and housing 500 V d.c. or 500 V_{pp}
Common mode rejection ratio (between Lo and housing)	: In the 1 mV range Frequency 10 Hz ... 1 kHz > 140 dB 1 kHz ... 10 kHz > 130 dB 10 kHz ... 100 kHz > 120 dB Note: These values decrease with 10 dB/range in the higher ranges.
Impedance between Lo and housing	: 1 GΩ//1.4 nF
d.c. Output	: Output resistance 1 kΩ Output voltage 1 V short circuit proof.
Accuracy d.c. output	: Frequency 40 Hz - 400 kHz ± 1% of reading, ± 1% fsd. 10 Hz - 40 Hz ± 3% of reading, ± 1% fsd. 400 kHz - 2 MHz ± 2% of reading, ± 1% fsd. 2 MHz - 6 MHz ± 2% of reading, ± 3% fsd. 6 MHz - 12 MHz ± 4% of reading, ± 4% fsd.
Supply	: Mains voltage 110 V or 220 V ± 10% Additional adaption by 18 V is possible Mains frequency 48 - 60 Hz Externally d.c. supply 4 - 6 V Current consumption at 5 V: approx. 150 mA
Long-term stability	: At min. 90 operating days 1°/oo of fsd. on the average

II-2 MECHANICAL.

Dimensions	: Height 145 mm Width 236 mm Depth 298 mm
Weight	: Approx. 3.5 kg

III. Accessories

III-1 SUPPLIED AS PART OF THE EQUIPMENT.

- Measuring cable
- Fuse 250 mA d.a.
- Manual

III-2 OPTIONALLY AVAILABLE.

- Measuring probe (10:1) PM 9336
- Measuring cable BNC-BNC PM 9074
  Length 1 m Impedance 50 Ω
- Measuring cable BNC-BNC PM 9075
  Length 1 m. Impedance 75 Ω
- Measuring cable BNC-BNC PM 9076
  Length 1 m. Impedance 135 Ω

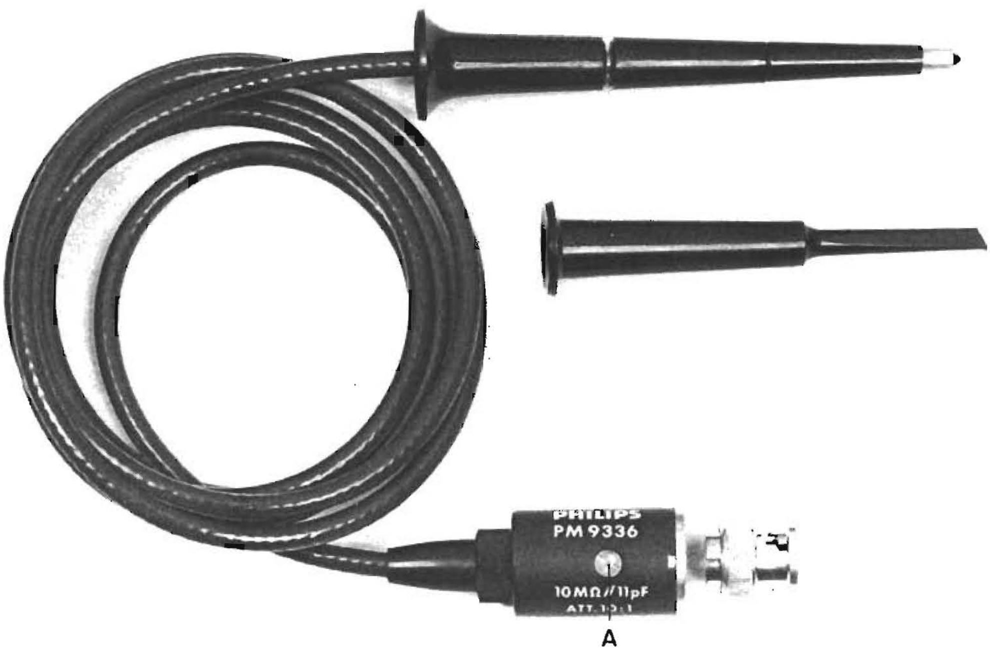


Fig. 1. Measuring probe PM 9336

IV. Principle of operation

The test voltage connected to the "INPUT" socket is supplied to the input attenuator. This is a capacitively compensated and fully screened voltage divider with a proportion of 1 : 1 or 1000 : 1. The output of the attenuator is connected to the input of the impedance transformer consisting of a feedback two-stage amplifier.

The main attenuator following it is an ohmic voltage divider operating in steps of 10 dB and ensuring a constant and low impedance for the preamplifier.

The latter consists of two amplifier stages with a high input impedance and a low output impedance. The amplifier stage supplies the voltage for the rectifier circuit following it, the rectifiers of which are included in the feedback network of an amplifier. The rectified current, which is proportional with the input voltage, flows through a test resistor.

The voltage drop across this resistor is measured differentially by means of a d.c. amplifier supplying the current for the test instrument. This amplifier also supplies the voltage for the d.c. output.

A reference voltage supplied by a calibrating-voltage generator which only works if supplied from the mains is applied to a test spot at the rear of the unit. With the aid of this voltage the unit can be calibrated in the 100 mV range. Furthermore this voltage renders it possible to adjust the attenuator probe; this should be done in the 10 mV range. The unit can be fed from the mains or from accumulators that have to be connected between points 4 and 1 (+ to 4) of BU4; points 1 and 2 of BU4 must be connected with the plug.

A DC-DC converter ensures that the d.c. supply voltage is converted into the required, stable + 15 V and - 15 V voltages supplying the test amplifier.

Furthermore the DC-DC converter ensures a good separation between the test amplifier and the supply source.

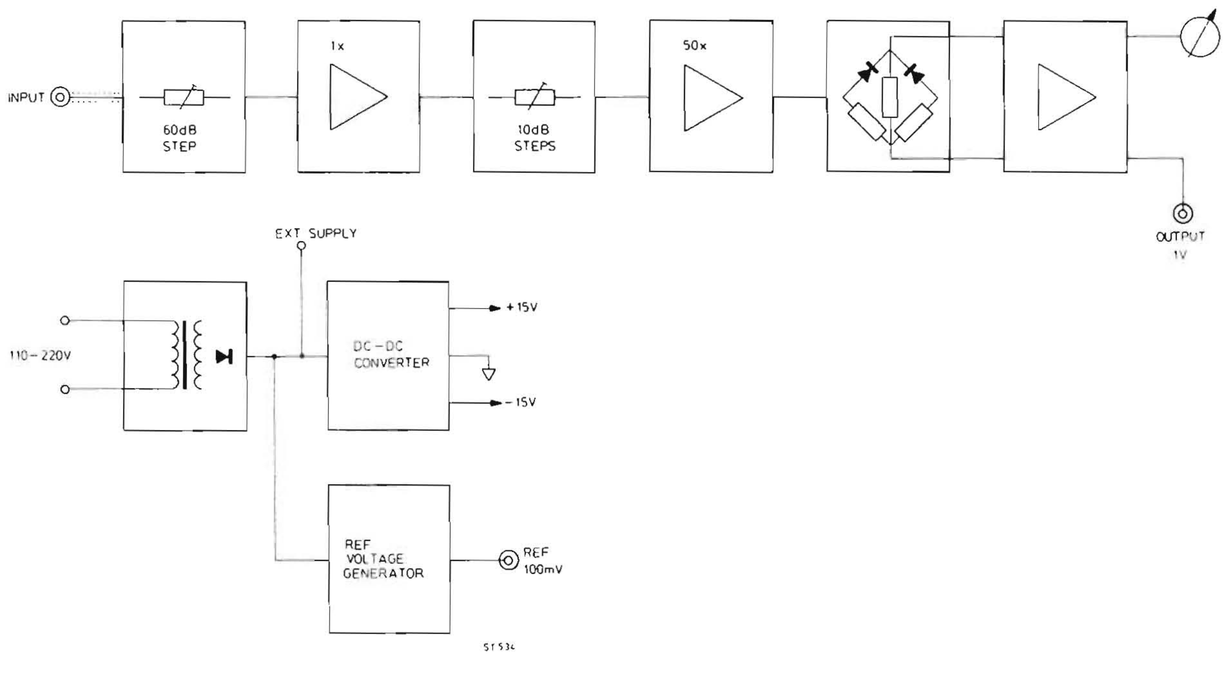


Fig. 2. Block diagram

V. Installation

V-1. MAINS SUPPLY.

Before the instrument is connected to the mains, check that the instrument is set to the lead voltage by means of slide switch SK 1.

- Mains voltages between 99 V and 121 V set SK 1 to 110 V
- Mains voltages between 198 V and 242 V set SK 1 to 220 V
- If necessary, connect the transformer windings as shown in fig. 3.

The instrument is set to 220 V in the factory.

V-2. FUSE.

Make sure that only fuses with the required current rating and of the specified type are used.
The use of repaired fuses and the short-circuiting of fuse holders is prohibited.
The rating of the mains fuse at the rear of the instrument should be 250 mA delayed action.

V-3. EARTHING.

The instrument should be connected to a protective earth in accordance with the local safety regulation. This can be effected via the 3-core means lead. The mains plug should only be inserted in a socket outlet provided with a protective contact, the protective action of which is not cancelled by the use of an extension card or device without protective conductor.

V-4. BATTERY OPERATION.

The instrument can also be powered by means of an accumulator.

- Connect a voltage from 4 - 6 V to BU4 by means of a 5-pole connector.
  + to pin 4
  - to pin 1

Warning: Wrong connected polarity will destroy IC 201.

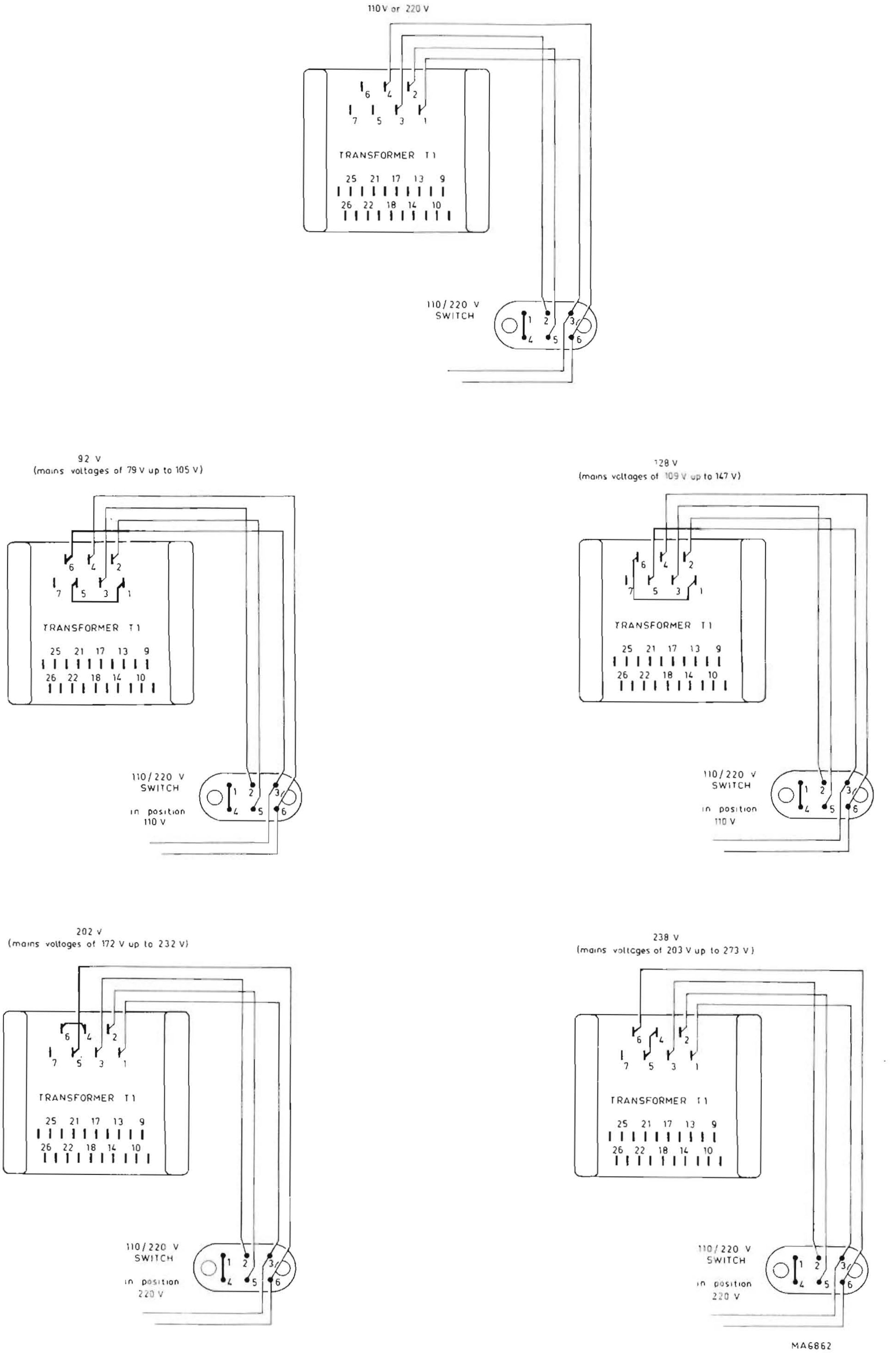


Fig. 3. Adaption of the mains transformer

VI. Operation

VI-1. MECHANICAL ZEROSETTING.

- Place the meter in a horizontal position and check the zero-setting of the meter.
- If necessary correct the setting by means of plastic screw "A", fig. 4.

VI-2. SWITCHING ON.

The instrument is ready for use after connection to the mains and earthing.
It is switched on by means of switch POWER ON (SK 2).
A warming-up time of approximately 30 min. should be observed to obtain full accuracy.

VI-3. CALIBRATION.

VI-3.1 Instrument.

- Select measuring range 100 mV
- Connect the shield of the measuring cable (Lo) to BU3 at the rear
- Put the signal lead (Hi) to the measuring spot "REF" at the rear
- Adjust the meter to 100 scale divisions with potentiometer "CAL" (R 224).

VI-3.2 Measuring probe PM 9336.

- Before adjusting, the instrument should be calibrated as described above
- Select measuring range 10 mV
- Connect the "earthlead" of the probe to BU3
- Put the signal lead (Hi) to the measuring spot "REF"
- Adjust the probe by means of adjusting screw "A", fig. 1.

VI-4. MEASURING.

- Select the correct measuring range with range selector SK 101
- Connect the test voltage to coaxial socket "INPUT" (BU1) with the delivered measuring cable.

Notes:

- By means of the 10:1 measuring probe PM 9336 the input impedance can be increased from 1 MΩ// 30 pF (except capacity of the cable: 100 pF) to 10 MΩ// 11 pF.
  This permits of carrying out measurements on very high-ohmic circuits.
- In case of measurements in the lowest range, (1 mV) it may occur that h.f. interference signals will influence the results.
  Therefore it is advised to shield the measurement circuit.

VI-5. D.C. OUTPUT (BU5 and BU6).

The instrument is provided with a floating d.c. output. The Lo is directly connected to the shield of the "INPUT" connector BU1.
The output voltage is proportional to the input voltage and is 1 V at full scale deflection, irrespective of the selected measuring range.
The impedance of the d.c. output is approx. 1 kΩ.

VI-6. ERRORS DUE TO DISTORTION.

Although the meter indicates the mean value of the full-wave rectified voltage, the scale of the instrument is calibrated in rms values of sinewave voltages. As a result measuring errors will arise when measuring non-sinusoidal voltages.
The values of these depend on the coëfficient of non-lineair distortion.

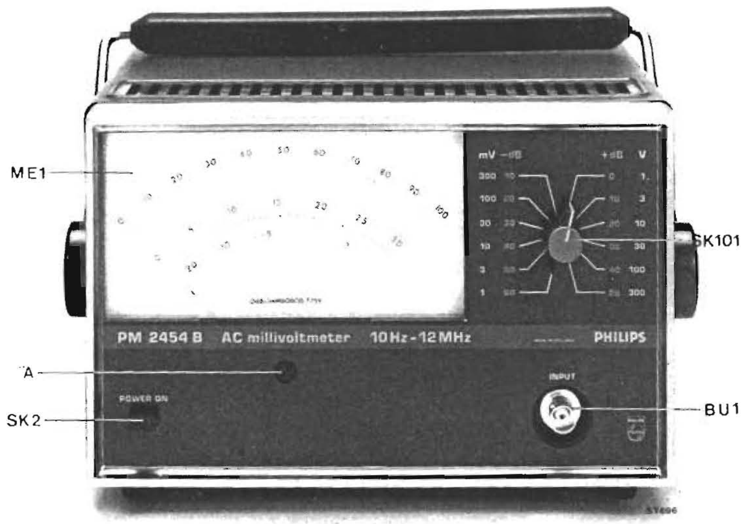


Fig. 4. Front view

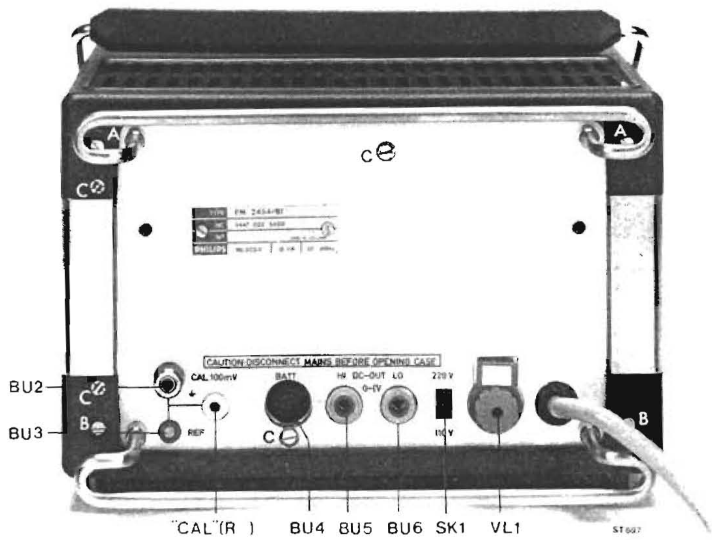


Fig. 5. Rear view

VII. Circuit description

VII-1. MEASURING SECTION.

Input circuit, Fig. 6.

The test voltage connected to BU1 is supplied to the impedance transformer stage via C101 and SK101/1f and SK101/2r (direct input) or via SK101/1f; R101 ... R104; C103 ... C106 and SK101/2r (via the high ohmic, frequency-independent 1000 : 1 attenuator).
In both cases the input capacitance is equalised by means of C102, so that a possible probe (PM 9336) can be used in every test area.

Impedance transformation circuit, Fig. 7.

This circuit consists of a two-stage amplifier (TS101 and TS102), the output signal of which is fully fed back. Thus a stable single amplifier with a low output impedance is obtained.

For the protection of the field effect transistor TS101 two protective diodes GR102 and GR104 are provided which in the reverse direction are connected between the input and GR101 and GR103 respectively.
If the input voltage exceeds the zener voltage of GR101 or GR102 or GR104 will become conductive, as a result of which the voltage on the gate of TS101 is limited.
The current through the diodes is limited by the impedance of the input circuit R106 - R108 and C111.
In the voltage divider that follows now and that consists of SK101/3r, R117 ... R126 and R128 ... R132 the test voltage is attenuated in steps of 10 dB. C118 and C119 prevent the frequency-response curve from rising.

Amplifier, Fig. 8.

This consists of two feedback circuits, viz. TS103 with TS104 and TS105 with TS106.
A d.c. feedback from nodal point R154 and R144 via R133 to the base of TS103 is wired across the whole assembly.
The amplification of the first circuit is determined by R140 and R141 and that of the second circuit by R137 and R142.
The RC network R135 and C122 blocks oscillations from the first circuit.

AC-DC converter, Fig. 9.

This converter contains the amplifier stages TS107 and TS109 with TS110 coupled by the emitter-follower TS108.
Test resistor R158 is included in the feedback network together with the rectifier circuit.
TS109 and TS110 together constitute an amplifier stage in cascode arrangement. Thus feedback from the output signal to the input of this amplifier stage is avoided.

By means of a differential amplifier (TS115 ... TS118) the operating point of TS110 is compared with the voltage obtained from potentiometer R187, see Fig. 10. A possible deviating voltage is amplified and fed back to the base of TS107, so that the voltage is corrected. The voltage on the collector of TS110 has been chosen so that it is equal to the emitter voltage plus half the knee voltage of GR106 and GR107; consequently the latter diodes can never become conductive on account of a voltage difference between the collector of TS110 and the emitter of TS107. To prevent the a.c. signal from the collector of TS110 from being fed back to the base of TS107 via the differential amplifier, C152 has been applied across this amplifier. As a result of this the variable-gain amplifier behaves as an integrator with a time constant governed by C152 and R196. The property of this integrator is that it passes on signal with frequencies below $f = \frac{1}{2\pi . RC}$ after amplification, but attenuates signals strongly if their frequency is higher.

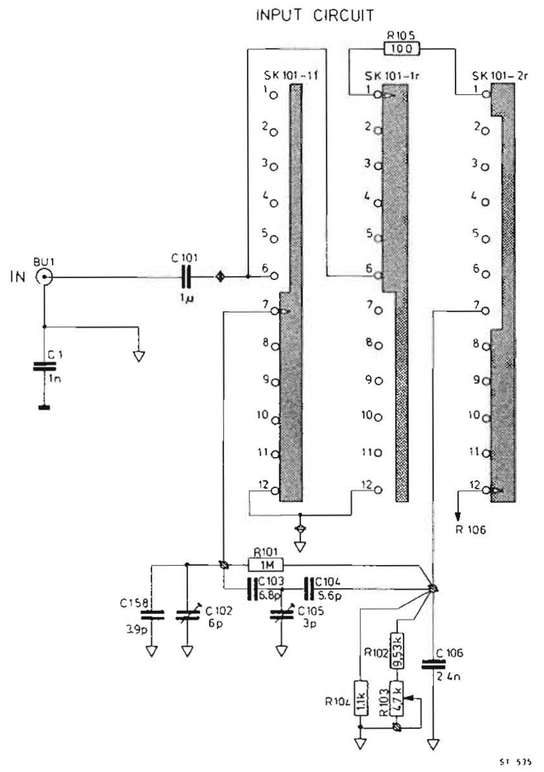


Fig. 6. Input circuit

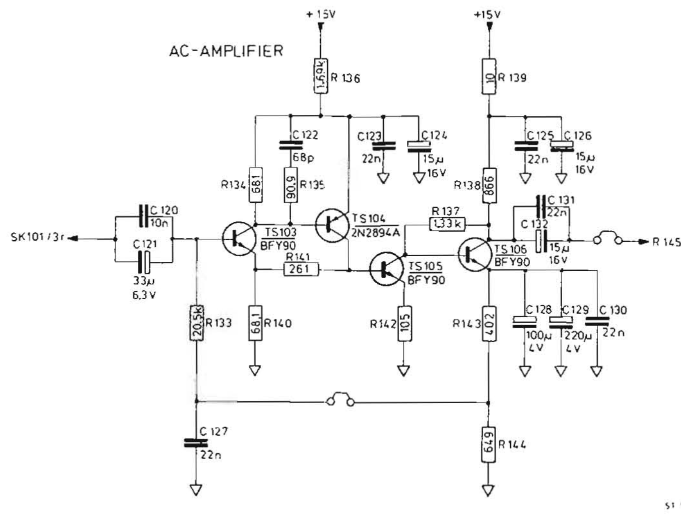


Fig. 8. AC Amplifier

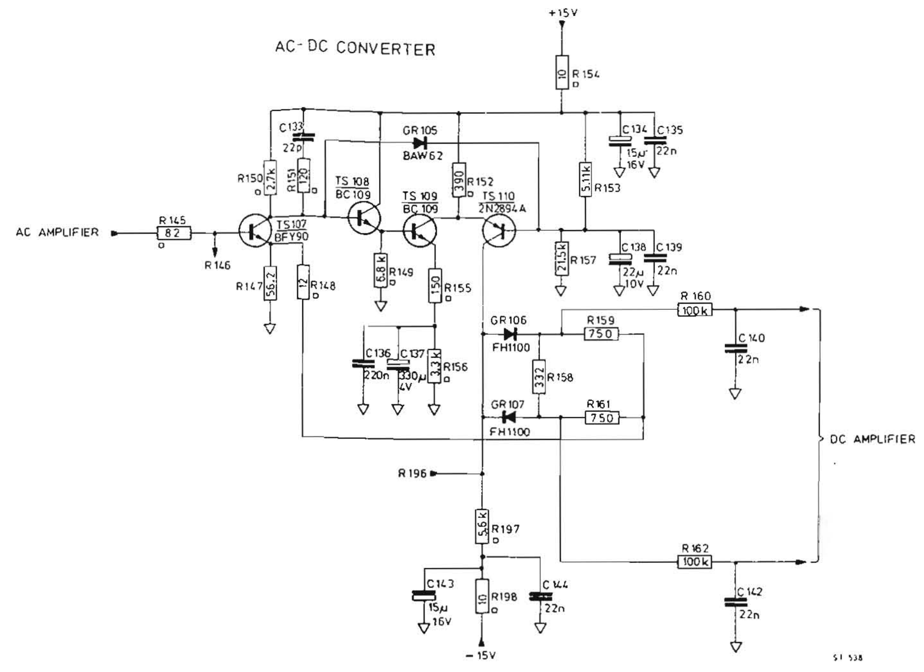


Fig. 9. AC-DC Converter

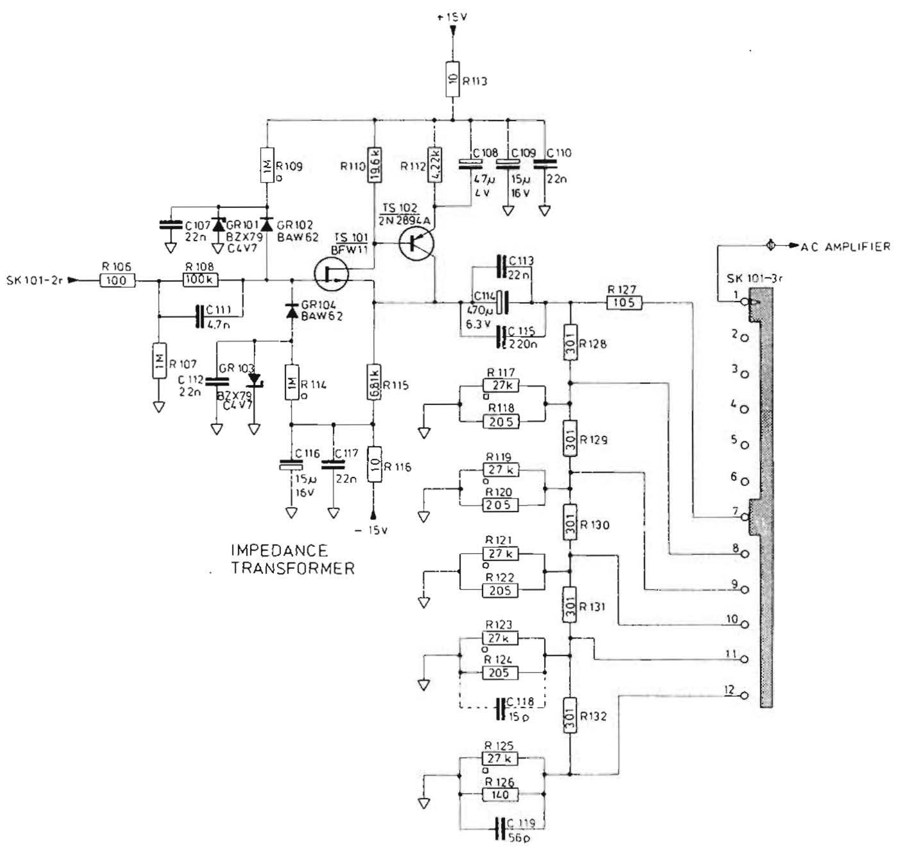


Fig. 7. Impedance transformation circuit

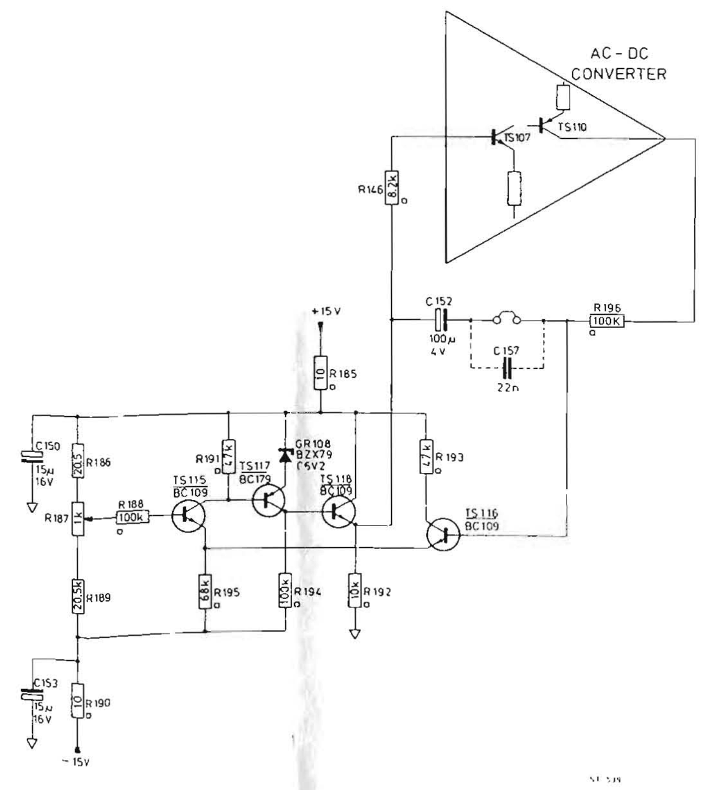


Fig. 10. Feedback circuit

DC amplifier, Fig. 11.

The rectified voltage applied across test resistor R158 is taken up via resistors R160 and R162 supplied to the d.c. amplifier via R163 and R164.
R160 - R162 and C140 ... C142 constitute a low pass filter.

The d.c. amplifier consists of three d.c. coupled stages. The first stage is formed by the FET pair TS111 and TS111'. The use of this pair of FET's ensures a stable zero point and a very low input current. The output signal of the first stage is applied to the junction of R166, TS111 and R168, TS111'. This signal drives the second stage consisting of the transistors TS112 and TS113.

VII-2. SUPPLY SECTION.

Mains section, Fig. 12.

The two primary windings S1 and S1' of TS1 can be connected in series or parallel by means of SK1.
For series-connection it applies that the mains voltage is 220 V.
For parallel connection the mains voltage is 110 V.

By connecting S2 in forward or reverse direction the unit can be made suitable for mains voltages of 238, 128, 202 and 92 V. The output voltage of TS1 is rectified by GR201, smoothed by C202 and stabilised by the circuit TS201; GR203; R204 and R205. The latter circuit functions as follows: if the voltage on the cathode of GR203 exceeds the zener voltage, this cathode will become conductive. The base of TS201 is driven, o collector current equal to hFe (IGR203 - $\frac{VBE}{R205}$) will start flowing and will increase the voltage drop across R202, so that the voltage rise across GR203 is counteracted.

If points 1 and 2 of BU4 are interconnected, this circuit no longer functions. The additional current then released can be used for charging an accumulator box via the resistors R201 and R203; the accumulator must be connected to BU4.

DC-DC converter, Fig. 13.

This converter consists of an astable multivibrator driving the base of TS205 via the emitter-follower TS204.

If TS205 is conductive, an energy equal to $\frac{1}{2}Li^2$ will be stored in the core of T201. If TS205 is driven out of conduction, this energy will be shifted to the buffer capacitors C206, C211 and C212 via GR208, GR209 and GR210. These capacitors will be charged to a voltage that will be higher according as the energy that is shifted greater. If the voltage on C206 exceeds the zener voltage of GR207, the collector current of TS206 will decrease, so that the voltage divider R212 and R213 is less affected; the voltage on the junction of R212 and R213 decreases. This lower voltage affects the astable multivibrator so that the time during which TS205 is driven into conduction is shortened. Consequently the energy stored in the core of T201 drops, so that the voltage across C206 and hence across C211 and C212, is reduced. The functioning of the astable multivibrator is as follows, see Fig. 14. It is assumed that the voltage at the junction of R212 and R213 and the collector of TS206 is a.Ub.

Let us assume that the multivibrator flops over, as a result of which TS202 becomes conductive. C204 will charge itself via R210 and the base emitter diode of TS202 to a value of Ub. The voltage across C203 was Ub. C203 will show a tendency to charge itself via R208, GR207 and TS202 from -aUb to +Ub. The voltage on the base of TS203 will therefore vary from -aUb→+Ub. At the moment when C203 has been charged to 0.6 V, TS203 is driven into conduction. The collector voltage of TS203 becomes zero. C203 will charge itself to a Ub via R207 and the base emitter diode of TS203. TS202 is driven out of conduction via C204.
C204 will show a tendency to charge itself from -Ub to +aUb via R209, GR206 and TS203. The voltage on the base of TS202 will consequently vary from -Ub → +aUb. At the moment when C204 has been charged to 0.6 V TS202 is driven into conduction and the entire process is repeated.

VII-3. REFERENCE VOLTAGE GENERATOR, Fig. 15.

This circuit only functions if the unit is supplied from the mains. The generator contains a four-scaler, IC201 which receives its input signal from the astable multivibrator of the d.c./d.c. converter. The output of the divider drives the chopper transistor TS207 which is connected inversely. TS207 transforms the d.c. voltage of the reference diode GR211 into a square-wave voltage which is so divided by R222 ... R225 that this voltage, if connected to the 100 mV range and with a well adjusted sensitivity of the amplifier, ensures full deflection of the test system. The supply voltage for GR212 is stabilised by means of R220 and GR211.

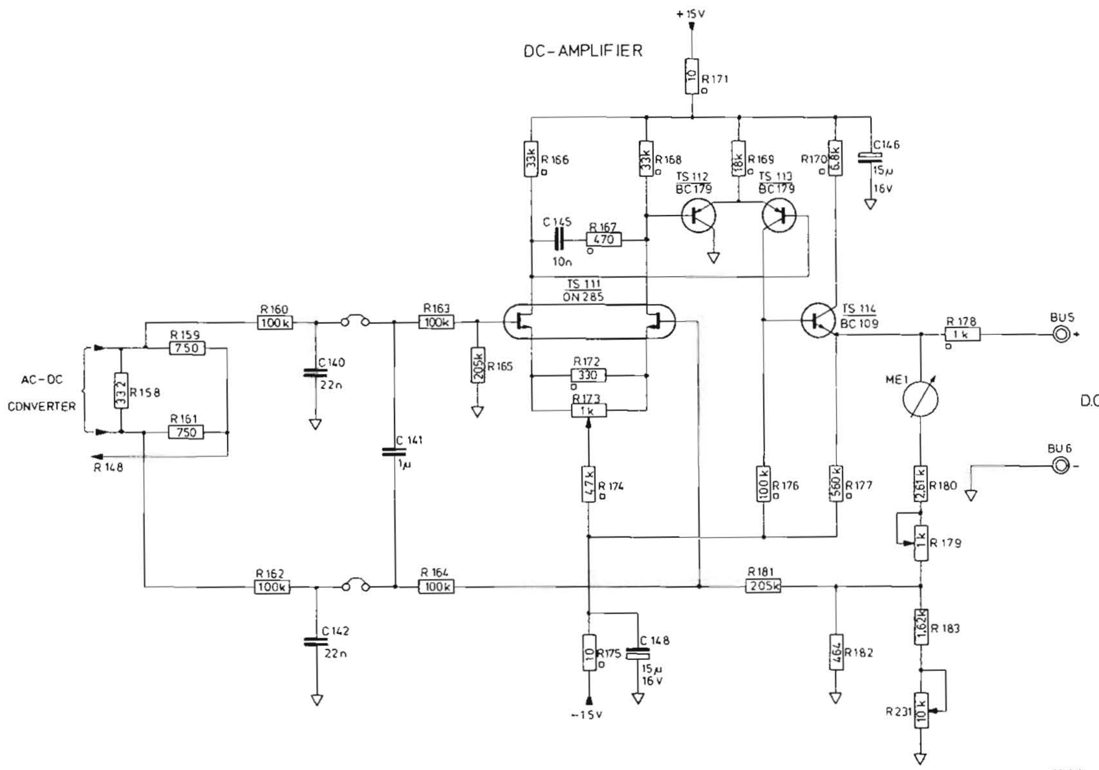


Fig. 11. DC Amplifier

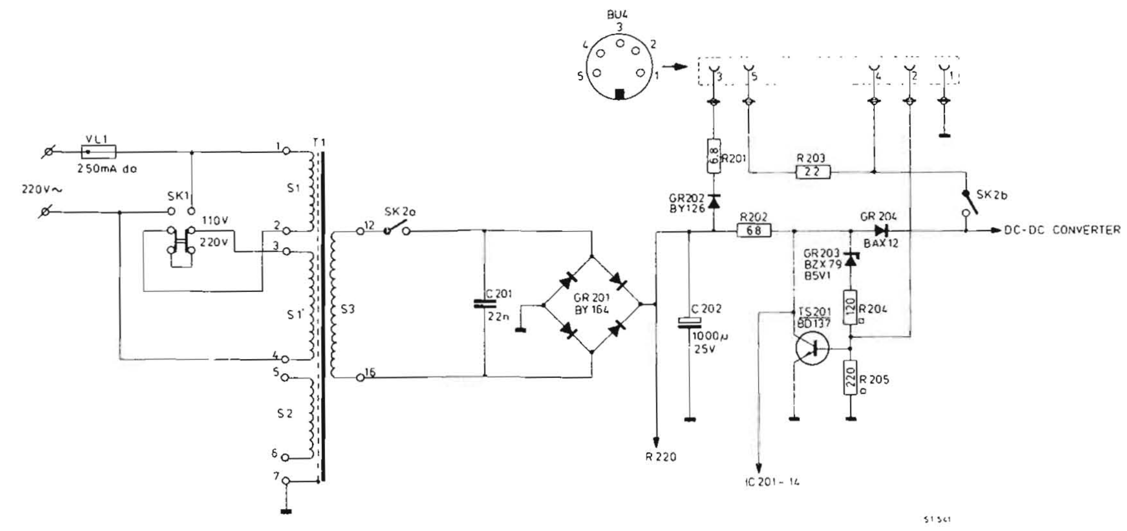


Fig. 12. Mains section

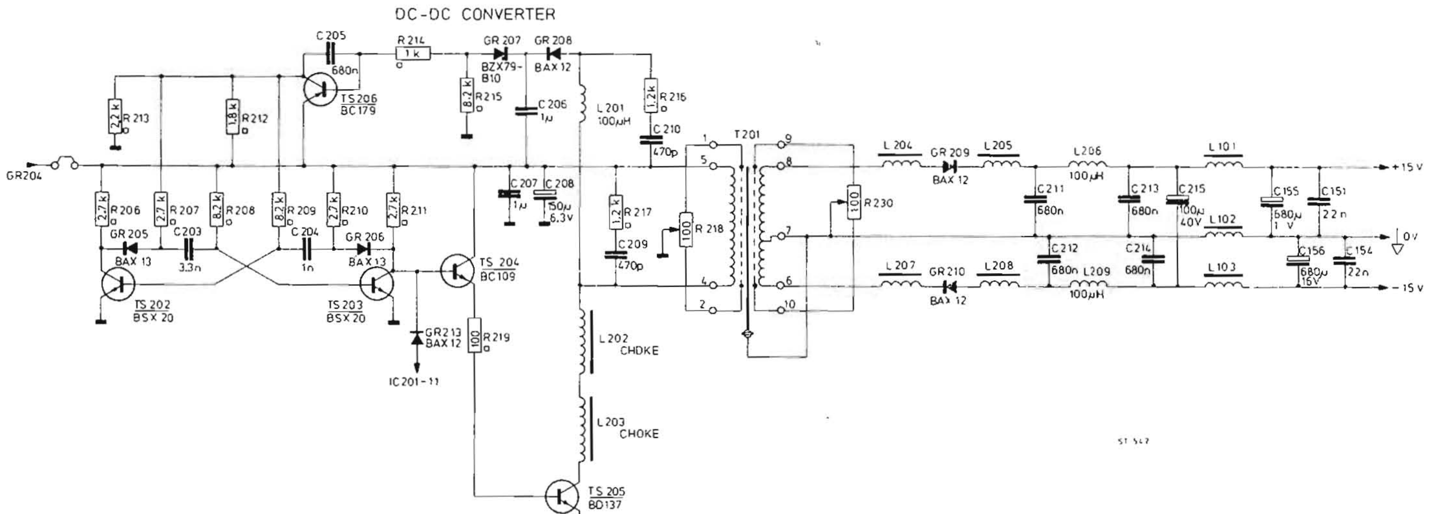
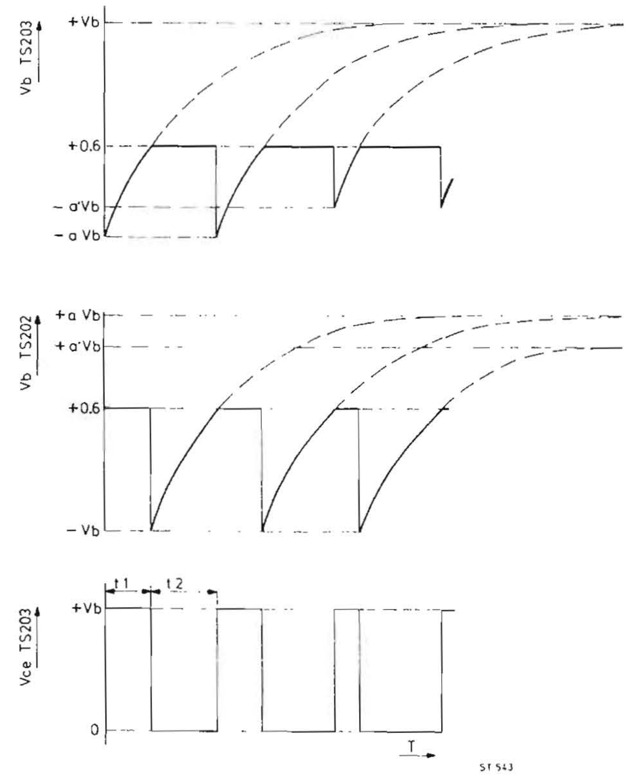


Fig. 13. DC-DC Converter



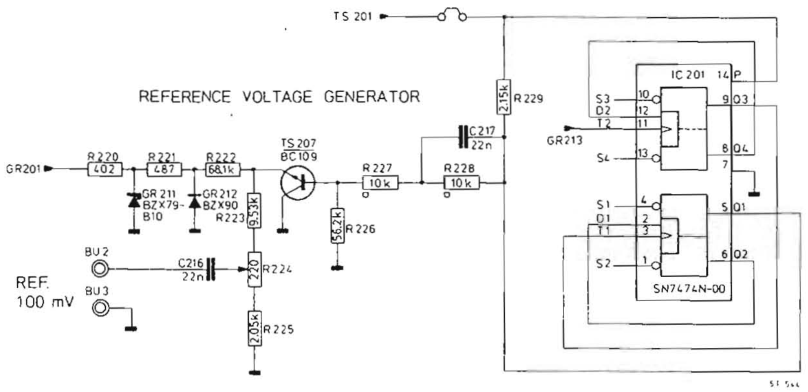


Fig. 15. Reference voltage generator

Fig. 14. Waveform diagram astable multivibrator

VIII. Access

The opening of parts, or removal of covers, is likely to expose live conductors. The instrument should therefore be disconnected from all voltage sources before any opening of parts or removal of covers is started.

During and after dismantling, bear in mind that capacitors in the instrument may still be charged even if it has been separated from all voltage sources.

USE A WELL-FITTING CROSSHEAD SCREW-DRIVER TO DISMANTLE THE INSTRUMENT TO PREVENT THE CROSS-SLOTTED SCREWS FOR DAMAGE.

VIII-1.DISMANTLING.

1. Top cover
   - Remove both screws "A" (Fig. 17)
   - Lift the cover at the rear and slide it backwards from the unit.

2. Bottom cover
   - Remove both screws "B" (Fig. 17)
   - Lift the cover at the rear and slide it backwards from the unit.

IX. Maintenance and servicing

AC millivoltmeter PM 2454 B requires no maintenance because the instrument contains no components which are subject to wear.

However, to ensure reliable and faultless operation, the instrument should not be exposed to moisture, heat, corrosive vapours and excessive dust.

IX-1. SERVICE HINTS.

If service work must be performed, the following points should be taken into account to avoid damage of the instrument.

- In case of measurements on a switched-on instrument proceed carefully to avoid short-circuits by means of measuring clips or measuring hooks.
- For soldering use absolutely acid-free soldering tin.
- For all soldering work on the printed circuit boards, use a miniature soldering iron (35 W max.) with a thin-cleaner or a vacuum soldering iron.
- On the printed wiring boards jumpers are introduced at the conductor side; they can be used to interrupt circuits in order to test the functioning of the corresponding circuit.
- To check the power supply unit (U2A) the rest of the instrument may be simulated by a resistor of 1 kΩ between + 12 V and ⏚, and - 12 V and ⏚ . These resistors may be put into the connector BU201.
- The d.c. settings of the instrument given on the circuit diagram are measured with the input short circuited. These values represent an average instrument.

X. Checking and adjusting

X-1. GENERAL.

The tolerances stated in this chapter correspond to the factory data; they apply when the instrument is re-adjusted completely. Such data may differ from these given in chapter II. Technical Data.

To calibrate this instrument only reference voltages and measuring equipment with the required accuracy should be applied.

Before calibration, a warming-up time of approximately 30 minutes should be taken into account.

X-2. SURVEY OF ADJUSTING ELEMENTS.

The next table gives a survey of the adjustments and checking procedure.

For a complete adjustment adhere to the sequence of point 3 of this chapter.

Adjusting unit	Fig.	Adjustment or final adjustment	Required measuring or auxiliary instrument	Adjust according to chapter X sub-point
R231		Calibrating the instrument		3.7
R103		Frequency-independent voltage divider	LF generator precision LF milli-voltmeter	3.8
R187		Operating point of TS110	Voltmeter, for instance PM 2403	3.4
R173		Zero point DC amplifier	Voltmeter, for instance PM 2403	3.5
R179		DC output	LF generator, precision LF millivoltmeter. Voltmeter, for instance PM 2421	3.7
R218/R230		Suppression of interference voltage	HF scope, for instance PM 3450	3.6
R224		Reference voltage	LF generator, precision LF millivoltmeter	3.9
C102/103		Frequency-independent voltage divider	LF generator, precision LF millivoltmeter. Probe PM 9336	3.8

X-3. ADJUSTING PROCEDURE.

X-3.1 Mechanical zero-setting.

- Check with the unit switched off whether the mechanical zero adjustment of the pointer is correct. Deviations can be corrected by means of the correction screw. The unit should be placed horizontal in this case.

X-3.2 Supply voltages.

- The value adjusted by means of voltage selector SK1 must correspond with the local mains voltage. If necessary the value adjusted by means of the voltage selector can be augmented or reduced by 18 V (see Fig. 3).
- The mains fuse must have a current value of 250 mA, delayed action.
- The supply voltages are + 15 V and - 15 V with respect to 0
  Test points + 15 V: BU201/1
  0 V: BU201/2
  - 15 V: BU201/3

X-3.3 Power consumption and stabilisation of the DC-DC converter.

- Interconnect points 1 and 2 of BU4.
- Connect a 5 V d.c. voltage between points 4 and 1 of BU4 (positive to point 4).
- Switch on SK2, the current consumption must be less than 160 mA.
- Increase the voltage to 6 V.
- Measure the voltage across C155; it should range between 15 V and 16 V.
- Reduce the voltage to 4 V; the voltage drop across C155 must be smaller than 1.2 V.

X-3.4 Adjusting the operating point of TS110.

- Remove the tin from the interconnection spot parallel to C157 (5).
- Measure the collector voltage of TS110 via a 10 k resistor.
- Test pin A with respect to ⏚ . See Fig. 20.
- Adjust this voltage to + 120 mV with the aid of potentiometer R187. Then interconnect the interconnection spot again.

X-3.5 Zero-setting d.c. amplifier.

- Set SK101 to position 300 mV.
- Measure the voltage on the d.c. output.
- Adjust this voltage to 0 V by means of potentiometer R173.
- Set SK101 to position 10 mV.
- The pre-deflection must be less than 2 sd.

X-3.6 Adjusting the interference voltage suppression.

- Connect a 1 k resistor parallel to capacitor C1 (Fig. 23).
- Monitor the interference voltage across C1 by means of a HF scope.
- Connect the scope earth to the instrument cabinet.
- Adjust potentiometer R230 so as to be inclined approximately 30° from fully anticlockwise.
- Adjust the voltage across C1 to a minimum value by means of potentiometer R218.
- Check whether this value is reduced if R238 is turned.
- Repeat this for R218.

X-3.7 Adjusting the d.c. output.

- Set SK101 to position 30 mV.
- Connect a voltage of 31.6 mV ± 0.2%; 1 kHz to BU1.
- Adjust the test system to 100 sd by means of R231.
- Measure the voltage on the d.c. output BU5 and BU6.
- Adjust the voltage to 1 V ± 0.2% by means of R179.

X-3.8 Adjusting the frequency-independent voltage divider.

- Set SK101 to position 10 V.
- Connect a voltage of 10 V ± 0.2%; 400 Hz to BU1.
- Adjust the test system to 100 sd by means of R103.
- Increase the frequency to 50 kHz.
- Adjust the test system to 100 sd by means of C105.
- Set SK101 to position 100 mV.
- Connect a voltage of 1 V ± 0.2% to BU1 via a PM 9336 probe.
- Note down the deflection of the test system.
- Increase the frequency to 50 kHz.
- Adjust the system to the value noted by means of the trimming potentiometer in the probe.
- Set SK101 to position 1 V.
- Connect a voltage of 10 V ± 0.2%, 200 Hz to BU1 via the probe now adjusted.
- Note down the deflection of the test system.
- Increase the frequency to 50 kHz.
- Adjust the system to the latter value by means of C102.

X-3.9 Adjusting the reference voltage generator.

- Set SK101 to position 100 mV.
- Interconnect BU1 to the test spot BU3 at the rear of the unit, screening to earth.
- Adjust the test system to 100 sd by means of R224.

X-3.10 Final check.

After the above adjustments, the instrument must comply with the specifications given in the table below.

Position SK101	Supply		Indication in sd test system	D.C. Output
10 mV	10 mV;	10 kHz	100 ± 1.5%	1 V ± 1.5%
30 mV	31.6 mV;	10 kHz	100 ± 1.5%	1 V ± 1.5%
100 mV	100 mV;	10 kHz	100 ± 1.5%	1 V ± 1.5%
100 mV	100 mV;	400 kHz	100 ± 1.5%	1 V ± 1.5%
100 mV	100 mV;	10 Hz	100 ± 3.5%	1 V ± 3.5%
100 mV	100 mV;	2 MHz	100 ± 2 %	1 V ± 2.5%
100 mV	100 mV;	6 MHz	100 ± 4 %	1 V ± 4 %
100 V	100 mV;	12 MHz	100 ± 7 %	1 V ± 7 %
1 V	1 V;	10 KHz	100 ± 1.5%	1 V ± 1.5%
1 V	1 V;	12 MHz	100 ± 7 %	1 V ± 7 %
3 V	3.16 V;	10 kHz	100 ± 1.5%	1 V ± 1.5%
10 V	10 V;	10 kHz	100 ± 1.5%	1 V ± 1.5%

Note: Accuracy of the voltage supplied: ± 0.5%.

XI. List of parts

XI-1. MECHANICAL.

Item	Fig.	Qty.	Ordering number	Description
1	16	2	5322 447 94068	Top and bottom cover
2	16	1	5322 460 64003	Ornamental strip
3	16	2	5322 535 74367	Spindle for handle
4	16	1	5322 520 34138	Bearing bush, left
5	18	1	5322 520 34139	Bearing bush, right
6	16	2	5322 498 74003	Cab for handle
7	16	1	5322 498 54032	Handle assembly
8	-	1	5322 532 54209	Coppling piece
9	16	1	5322 460 64002	Ornamental frame
10	16	1	5322 456 14029	Text plate
11	16	1	5322 414 64039	Knob for SK101
12	16	1	5322 414 74019	Cab for knob
13	-	1	5322 535 74394	Spindle
14	19	1	5322 535 94637	Extension spindle
15	16	1	5322 414 24883	Knob
16	19	1	5322 492 64337	Retaining spring.

XI-2. MISCELLANEOUS.

Item	Fig.	Ordering number	Description	Manufacturer
17	16	5322 344 64055	Meter 4E 125 25 μA ME1	
18	16	5322 267 10008	Terminal BU1	Suhner UG657/U
19	17	5322 535 80523	Contact piece BU2	
20	17	5322 268 10031	Contact pin BU3	
21	17	5322 237 44008	Connector 5 pol. BU4	Hirschman Mab 5
22	17	5322 267 30231	Terminal BU5	
23	17	5322 267 30231	Terminal BU6	
24	19	5322 264 44009	Connector housing	AMP 163691-1
25	-	4822 268 10107	Contact pin strip	AMP 163690-6
26	17	5322 277 20014	Slide switch SK1	
27	19	5322	Connector 6 pol. BU201	AMP 163680-6
28	19	5322 276 10272	Switch assembly SK2	
29	16	5322 273 64036	Switch assembly SK101	
30	18	5322 146 14061	Mains transformer T1	
31	18	5322 142 64015	Converter transformer T201	
32	17	5322 256 40026	Fuse holder	
33	17	5322 321 14001	Mains cable	
34	17	5322 325 54029	Cable grommet	Heyman type SR-5P-4
35	18	5322 218 64039	Printed circuit board U2A	
36	18	5322 218 64038	Printed circuit board U1A	
37	20	5322 158 10052	HF choke L101	
38	20	5322 158 10052	HF choke L102	
39	20	5322 158 10052	HF choke L103	
40	22	5322 158 10243	Coil 100 μA L201	
41	22	5322 158 10052	HF choke L202	

Item	Fig.	Ordering number	Description	Manufacturer
42	22	5322 158 10052	HF choke L203	
43	22	4822 526 10011	Ferroxcube ring L204	
44	22	4822 526 10011	Ferroxcube ring L205	
45	22	5322 158 10243	Coil 100 µA L206	
46	22	4822 526 10011	Ferroxcube ring L207	
47	22	4822 526 10011	Ferroxcube ring L208	
48	22	5322 158 10243	Coil 100 µA L209	
49	-	5322 321 24168	Measuring cable	
50	-	4822 253 30013	Fuse 250 mA d.a.	

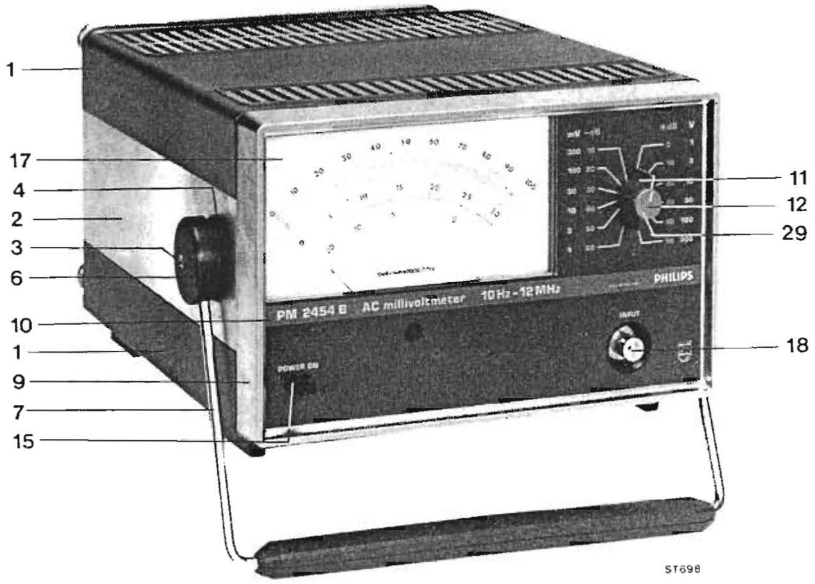


Fig. 16. Front view with item numbers

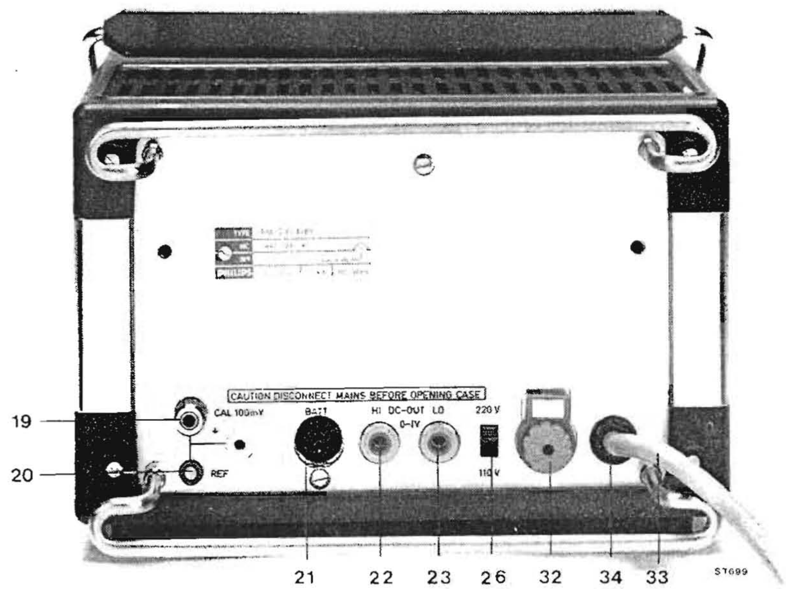


Fig. 17. Rear view with item numbers

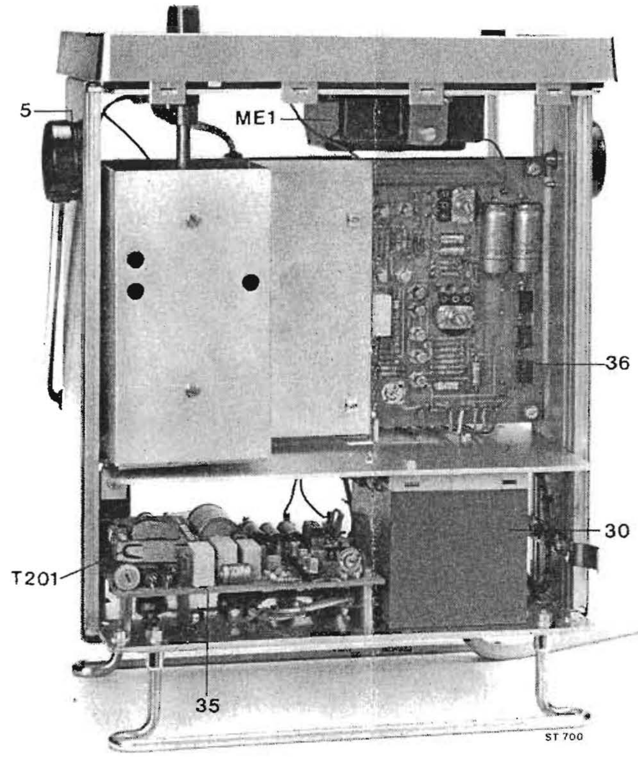


Fig. 18. Top view

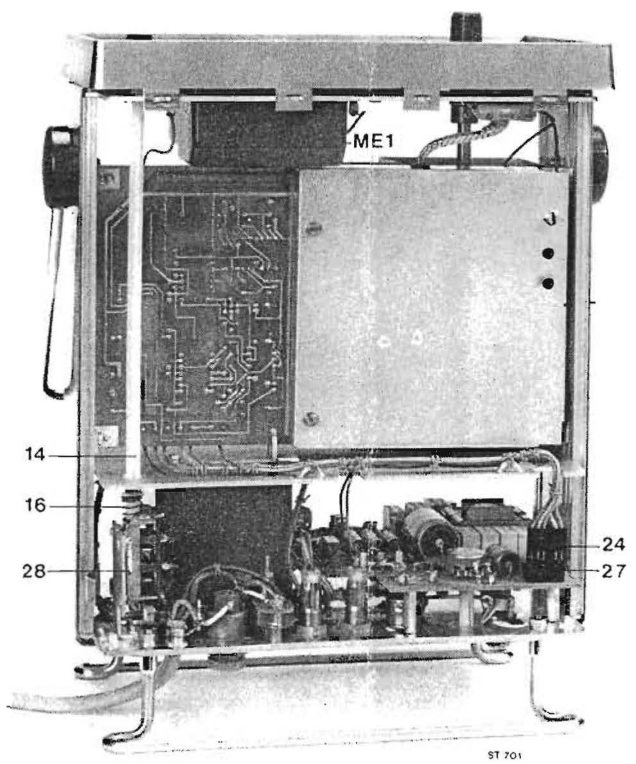


Fig. 19. Bottom view

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

SERVICE

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.

XI-3. ELECTRICAL.

XI-3.1 Resistors.

No.	Ordering number	Value	%	Series
R101	5322 116 54237	1 MΩ	1	MR54
R102	5322 116 54617	9.53 kΩ	1	MR25
R103	5322 101 20416	4.7 kΩ		Potentiometer
R104	5322 116 50842	1.1 kΩ	1	MR25
R105	5322 116 50268	100 Ω	1	MR30
R106	5322 116 50268	100 Ω	1	MR30
R107	5322 116 54237	1 MΩ	1	MR54
R108	5322 116 51123	100 kΩ	1	MR30
R110	5322 116 54641	19.6 kΩ	1	MR25
R112	5322 116 50729	4.22 kΩ	1	MR25
R113	5322 116 50452	10 Ω	1	MR25
R115	5322 116 54012	6.81 kΩ	1	MR25
R116	5322 116 50452	10 Ω	1	MR25
R118	5322 116 54767	205 Ω	0.25	MR24C
R120	5322 116 54767	205 Ω	0.25	MR24C
R122	5322 116 54767	205 Ω	0.25	MR24C
R124	5322 116 54767	205 Ω	0.25	MR24C
R126	5322 116 50865	140 Ω	0.25	MR24C
R127	5322 116 54472	105 Ω	1	MR25
R128	5322 116 50786	301 Ω	0.25	MR24C
R129	5322 116 50786	301 Ω	0.25	MR24C
R130	5322 116 50786	301 Ω	0.25	MR24C
R131	5322 116 50786	301 Ω	0.25	MR24C
R132	5322 116 50786	301 Ω	0.25	MR24C
R133	5322 116 54643	20.5 kΩ	1	MR25
R134	5322 116 54534	681 Ω	1	MR25
R135	5322 116 54466	90.9 Ω	1	MR25
R136	5322 116 54567	1.69 kΩ	1	MR25
R137	5322 116 50779	1.33 kΩ	1	MR25
R138	5322 116 54543	866 Ω	1	MR25
R139	5322 116 50452	10 Ω	1	MR25
R140	5322 116 54455	68.1 Ω	1	MR25
R141	5322 116 54502	261 Ω	1	MR25
R142	5322 116 54472	105 Ω	1	MR25
R143	5322 116 54519	402 Ω	1	MR25
R144	5322 116 54532	649 Ω	1	MR25
R147	5322 116 54446	56.2 Ω	1	MR25
R153	5322 116 54595	5.11 kΩ	1	MR25
R157	5322 116 50451	21.5 kΩ	1	MR25
R158	5322 116 54513	332 Ω	1	MR25
R159	5322 116 54536	750 Ω	1	MR25
R160	5322 116 54696	100 kΩ	1	MR25
R161	5322 116 54536	750 Ω	1	MR25
R162	5322 116 54696	100 kΩ	1	MR25
R163	5322 116 54696	100 kΩ	1	MR25
R164	5322 116 54727	205 kΩ	1	MR25
R165	5322 116 54696	100 kΩ	1	MR25
R173	5322 101 20241	1 kΩ		Potentiometer
R179	5322 100 10112	1 kΩ		Potentiometer
R180	5322 116 50671	2.61 kΩ	1	MR25

No.	Ordering number	Value	%	Series
R181	5322 116 54727	205 kΩ	1	MR25
R182	5322 116 50536	464 Ω	1	MR25
R183	5322 116 54565	1.62 kΩ	1	MR25
R186	5322 116 54643	20.5 kΩ	1	MR25
R187	5322 101 20241	1 kΩ		Potentiometer
R189	5322 116 54643	20.5 kΩ	1	MR25
R201	4822 112 41049	6.8 Ω	10	Carbon
R202	4822 112 41076	68 Ω	5	Carbon
R203	4822 112 41063	22 Ω	10	Carbon
R218	5322 101 14072	100 Ω		Potentiometer
R220	5322 116 54834	402 Ω	1	MR30
R221	5322 116 50508	487 Ω	1	MR25
R222	5322 116 54683	68.1 kΩ	1	MR25
R223	5322 116 54597	5.36 kΩ	1	MR25
R224	5322 116 14051	220 Ω		Potentiometer
R225	5322 116 50664	2.05 kΩ	1	MR25
R226	5322 116 54676	56.2 kΩ	1	MR25
R229	5322 116 50767	2.15 kΩ	1	MR25
R230	5322 101 14072	100 Ω		Potentiometer
R231	4822 101 30237	10 kΩ		Potentiometer.

XI-3.2 Capacitors.

No.	Ordering number	Value	%	V	Description
C1	5322 122 14003	1 nF	20	400	Ceramic
C101	4822 121 40117	1 μF	10	400	Polyester
C102	4822 125 60037	6 pF		500	Trimmer
C103	4822 122 31192	6.8 pF		500	Ceramic
C104	4822 122 31191	5.6 pF		500	Ceramic
C105	5322 125 64011	3 pF		500	Trimmer
C106	5322 123 34016	2.4 pF			Feed through cap.
C107	5322 122 30103	22 nF	-20 +100	40	Ceramic
C108	4822 124 20582	47 μF		4	Electrolytic
C109	4822 124 20467	15 μF		16	Electrolytic
C110	5322 122 30103	22 nF	-20 +100	40	Ceramic
C111	4822 120 11125	4.7 nF	-20 +50	500	Ceramic
C112	5322 122 30103	22 nF	-20 +100	40	Ceramic
C113	5322 122 30103	22 nF	-20 +100	40	Ceramic
C114	4822 124 20457	470 μF		6.3	Electrolytic
C115	4822 121 40232	0.22 μF	10	100	Polyester
C116	4822 124 20467	15 μF		16	Electrolytic
C117	5322 122 30103	22 nF	-20 +100	40	Ceramic
C118	4822 122 31197	15 pF	5	500	Ceramic
C119	4822 122 31206	56 pF	5	500	Ceramic
C120	4822 120 11134	10 nF	-20 +50	500	Ceramic
C121	4822 124 20452	33 μF		6.3	Electrolytic
C122	4822 122 31076	68 pF	2	63	Ceramic
C123	5322 122 30103	22 nF	-20 +100	40	Ceramic
C124	4822 124 20467	15 μF		16	Electrolytic
C125	5322 122 30103	22 nF	-20 +100	40	Ceramic
C126	4822 124 20467	15 μF		16	Electrolytic
C127	5322 122 30103	22 nF	-20 +100	40	Ceramic
C128	4822 124 20578	100 μF		4	Electrolytic
C129	4822 124 20581	220 μF		4	Electrolytic

No.	Ordering number	Value		%	V	Description
C130	5322 122 30103	22	nF	-20 +100	40	Ceramic
C131	5322 122 30103	22	nF	-20 +100	40	Ceramic
C132	4822 124 20467	15	µF		16	Electrolytic
C133	4822 122 31063	22	pF		63	Ceramic
C134	4822 124 20467	15	µF		16	Electrolytic
C135	5322 122 30103	22	nF	-20 +100	40	Ceramic
C136	4822 121 40232	0.22	µF	10	100	Polyester
C137	4822 124 20448	330	µF		4	Electrolytic
C138	4822 124 20459	22	µF		10	Electrolytic
C139	5322 122 30103	22	nF	-20 +100	40	Ceramic
C140	5322 122 30103	22	nF	-20 +100	40	Ceramic
C141	5322 121 40197	1	µF	10	100	Polyester
C142	5322 122 30103	22	nF	-20 +100	40	Ceramic
C143	4822 124 20467	15	µF		16	Electrolytic
C144	5322 122 30103	22	nF	-20 +100	40	Ceramic
C145	4822 122 30043	10	nF	10	100	Ceramic
C146	4822 124 20467	15	µF		16	Electrolytic
C148	4822 124 20467	15	µF		16	Electrolytic
C150	4822 124 20467	15	µF		16	Electrolytic
C151	5322 122 30103	22	nF	-20 +100	40	Ceramic
C152	4822 124 20578	100	µF		4	Electrolytic
C153	4822 124 20467	15	µF		16	Electrolytic
C154	5322 122 30103	22	nF	-20 +100	40	Ceramic
C155	4822 124 20523	680	µF		16	Electrolytic
C156	4822 124 20523	680	µF		16	Electrolytic
C157	5322 122 30103	22	nF	-20 +100	40	Ceramic
C158	4822 120 11043	3.9	pF		500	Ceramic
C201	5322 122 30103	22	nF	-20 +100	40	Ceramic
C202	4822 124 20529	1000	µF		25	Electrolytic
C203	4822 122 30099	3.3	nF	10	100	Ceramic
C204	4822 122 31175	1	nF	10	100	Ceramic
C205	5322 121 40233	0.68	µF	10	100	Polyester
C206	5322 121 40197	1	µF	10	100	Polyester
C207	5322 121 40197	1	µF	10	100	Polyester
C208	4822 124 20454	150	µF		6.3	Electrolytic
C209	4822 122 31177	470	pF	10	100	Ceramic
C210	4822 122 31177	470	pF	10	100	Ceramic
C211	5322 121 40197	0.68	µF	10	100	Polyester
C212	5322 121 40197	0.68	µF	10	100	Polyester
C213	5322 121 40197	0.68	µF	10	100	Polyester
C214	5322 121 40197	0.68	µF	10	100	Polyester
C215	4822 124 20488	100	µF		40	Electrolytic
C216	5322 122 30103	22	nF	-20 +100	40	Ceramic
C217	5322 122 30103	22	nF	-20 +100	40	Ceramic.

XI-3.3 Transistors.

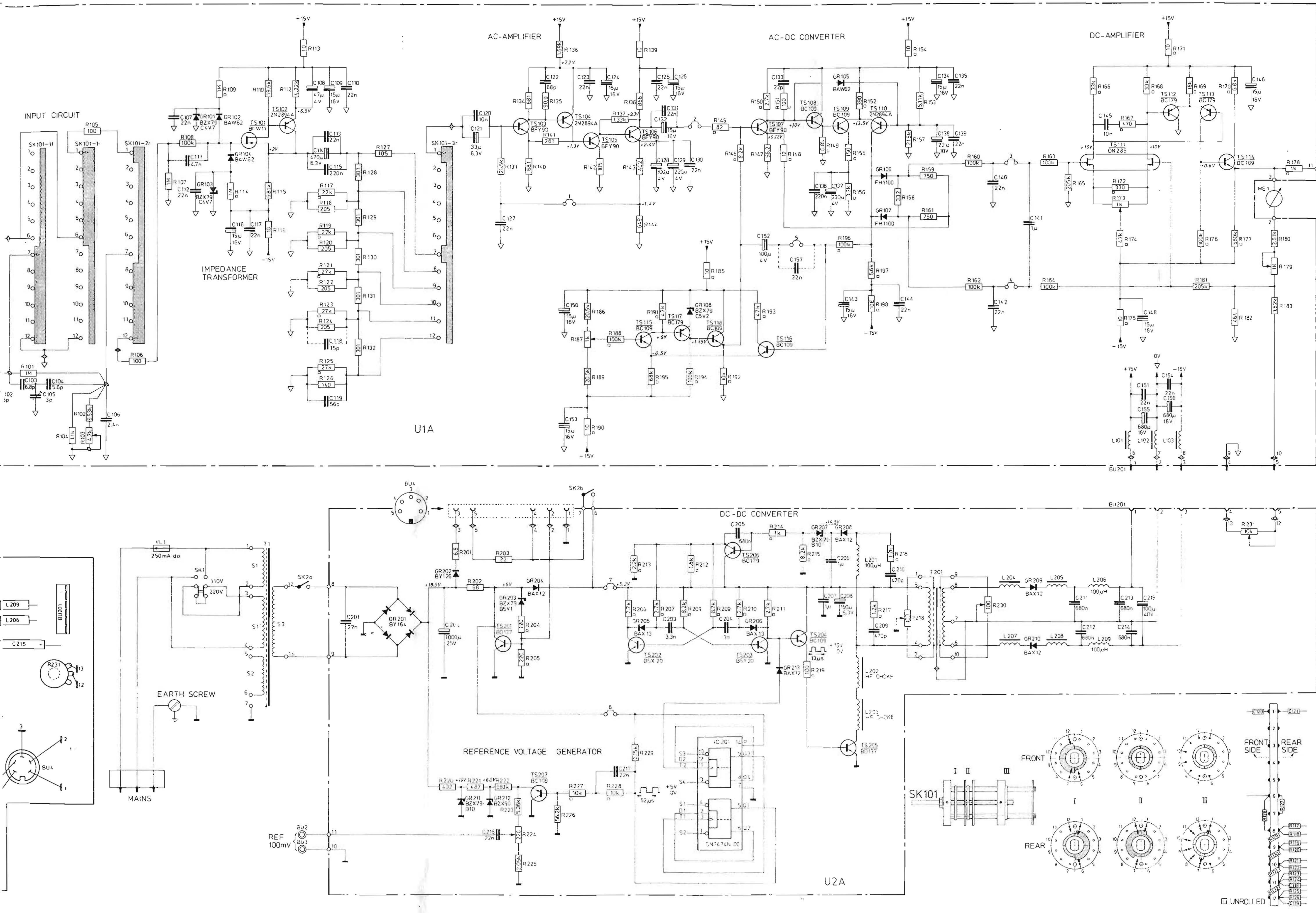
No.	Ordering number	Type
TS101	5322 130 40408	BFW 11
TS102	5322 130 44127	2N2894A
TS103	5322 130 40493	BFY 90
TS104	5322 130 44127	2N2894A
TS105	5322 130 40493	BFY 90
TS106	5322 130 40493	BFY 90
TS107	5322 130 40493	BFY 90
TS108	5322 130 40144	BC 109 C
TS109	5322 130 40144	BC 109 C
TS110	5322 130 44127	2N2894A
TS111	5322 130 40702	ON 285
TS112	5322 130 40453	BC 179
TS113	5322 130 40453	BC 179
TS114	5322 130 40144	BC 109 C
TS115	5322 130 40144	BC 109 C
TS116	5322 130 40144	BC 109 C
TS117	5322 130 40453	BC 179
TS118	5322 130 40144	BC 109 C
TS201	5322 130 40664	BD 137
TS202	5322 130 40417	BSX 20
TS203	5322 130 40417	BSX 20
TS204	5322 130 40144	BC 109 C
TS205	5322 130 40664	BD 137
TS206	5322 130 40453	BC 179
TS207	5322 130 40144	BC 109 C

XI-3.4 Diodes.

No.	Ordering number	Type	
GR101	5322 130 30773	BZX 79-C4 V7	
GR102	5322 130 30613	BAW 62	
GR103	5322 130 30773	BZX 79-C4 V7	
GR104	5322 130 30613	BAW 62	
GR105	5322 130 30613	BAW 62	
GR106	5322 130 34062	FH 1100	Fairchild
GR107	5322 130 34062	FH 1100	Fairchild
GR108	5322 130 30766	BZX 79-C6 V2	
GR201	5322 130 30414	BY 164	
GR202	5322 130 30192	BY 126	
GR203	5322 130	BZX 79-B5 V1	
GR204	5322 130 30424	BAX 12	
GR205	5322 130 40182	BAX 13	
GR206	5322 130 40182	BAX 13	
GR207	5322 130 34257	BZX 79-B10	
GR208	5322 130 30424	BAX 12	
GR209	5322 130 30424	BAX 12	
GR210	5322 130 30424	BAX 12	
GR211	5322 130 34297	BZX 79-B10	
GR212	5322 130 34298	BZX 90	
GR213	5322 130 30424	BAX 12	

XI-3.5 Integrated circuits.

No.	Ordering number	Type
IC201	5322 209 84165	SN7474N-oo


INPUT CIRCUIT
IMPEDANCE TRANSFORMER
AC-AMPLIFIER
AC-DC CONVERTER
DC-AMPLIFIER
DC OUT
U1A
DC-DC CONVERTER
REFERENCE VOLTAGE GENERATOR
EARTH SCREW
MAINS
REF 100mV
U2A
SK101
FRONT
REAR
FRONT SIDE
REAR SIDE
III UNROLLED

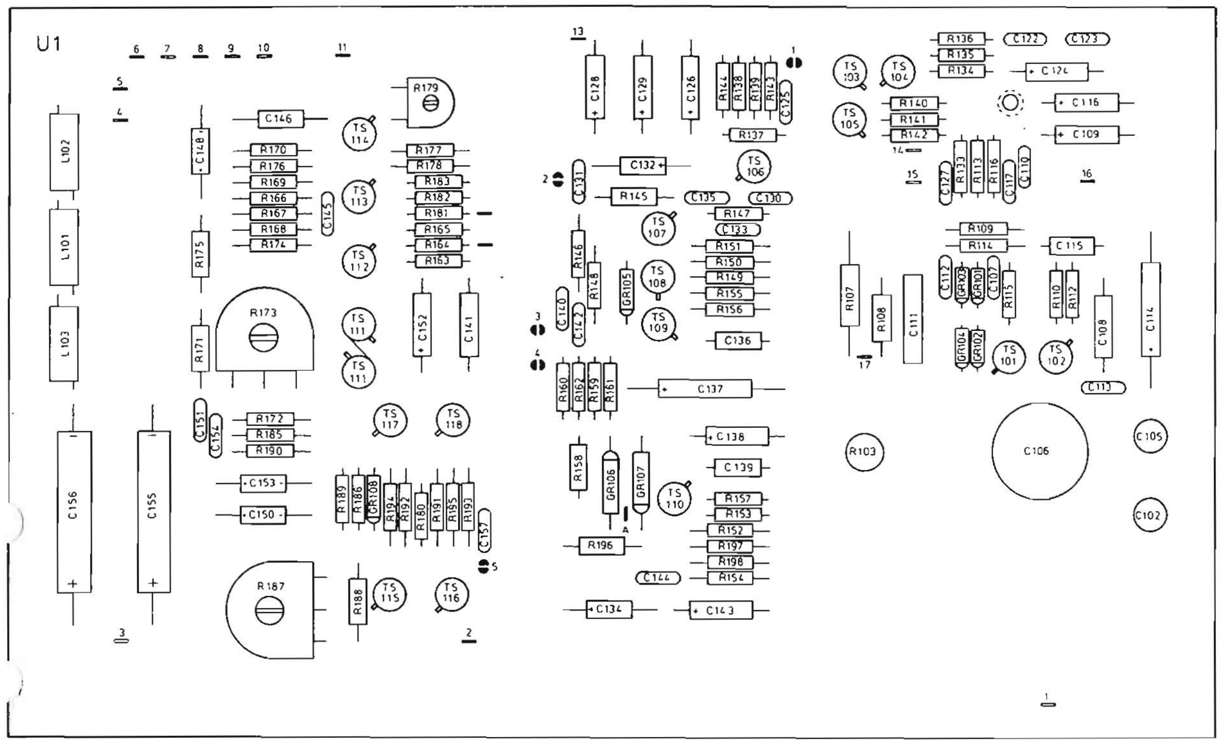
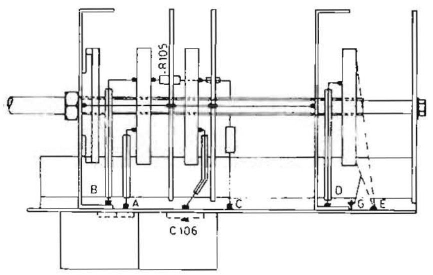


Fig. 20. Printed circuit board U1



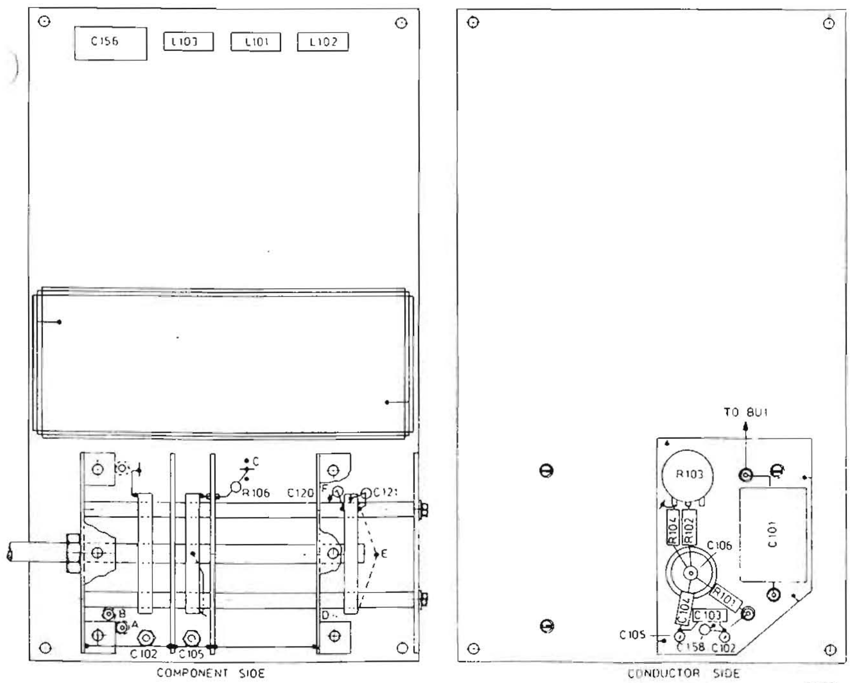


Fig. 21. Printed circuit board U1 with SK101

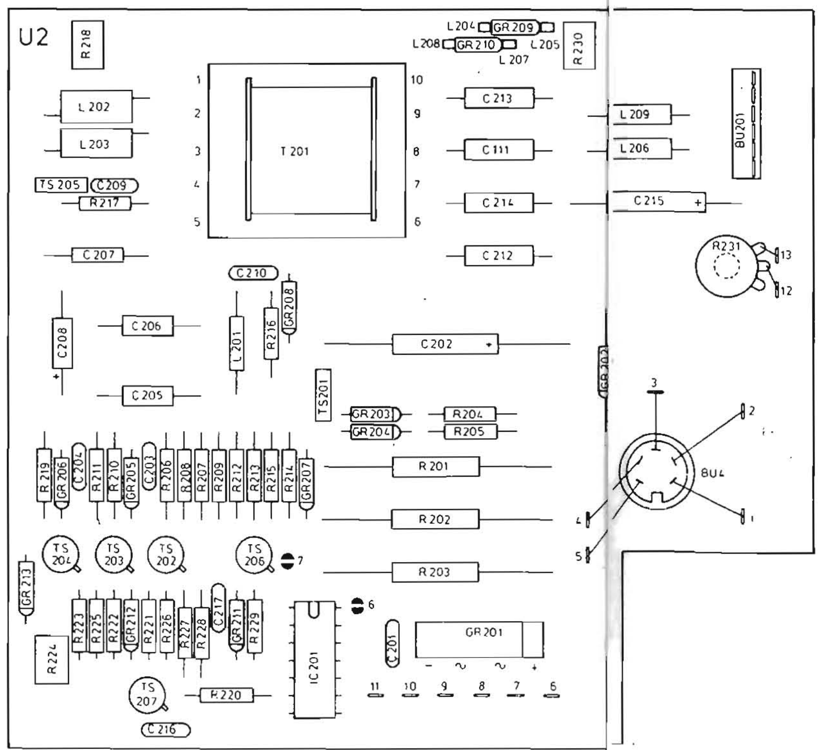
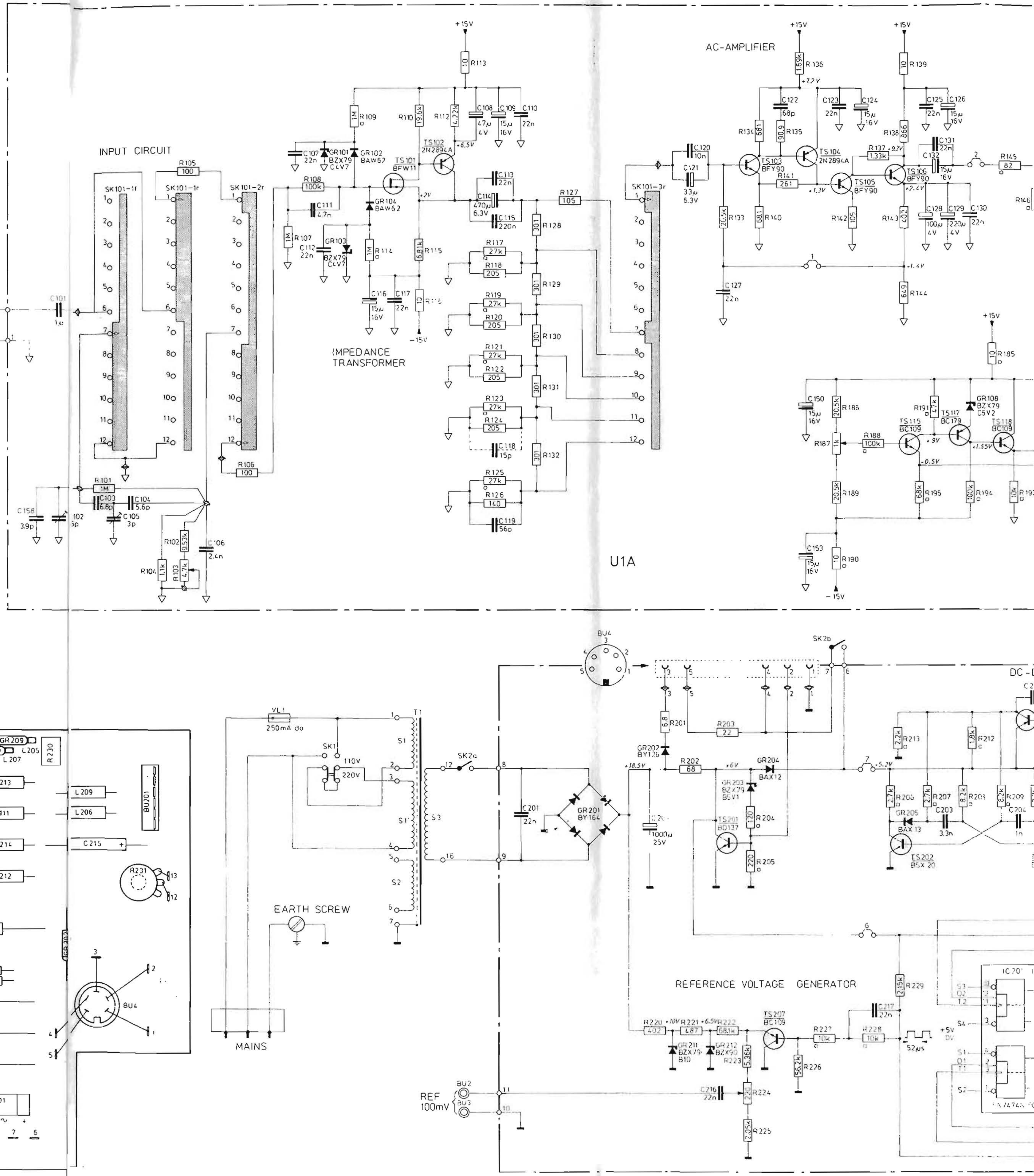


Fig. 22. Printed circuit board U2



QUALITY REPORTING

CODING SYSTEM FOR FAILURE DESCRIPTION

The following information is meant for Philips service workshops only and serves as a guide for exact reporting of service repairs and maintenance routines on the workshop charts.
For full details reference is made to Information G1 (Introduction) and Information Cd 689 (Specific information for Test and Measuring Instruments).

LOCATION

□□□□
Unit number
e.g. 000A or 0001 (for unit A or 1; not 00UA or 00U1)

or: Type number of an accessory (only if delivered with the equipment)
e.g. 9051 or 9532 (for PM 9051 or PM 9532)

or: Unknown/Not applicable
0000

CATEGORY

□
0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

COMPONENT/SEQUENCE NUMBER

□□□□□□
Enter the identification as used in the circuit diagram, e.g.:

GR1003	Diode GR1003
TS0023	Transistor TS23
IC0101	Integrated circuit IC101
RO....	Resistor, potentiometer
CO....	Capacitor, variable capacitor
BO....	Tube, valve
LA....	Lamp
VL...	Fuse
SK....	Switch
BU....	Connector, socket, terminal
TO....	Transformer
LO....	Coil
XO....	Crystal
CB....	Circuit block
RE....	Relay
ME....	Meter, indicator
BA....	Battery
TR....	Chopper

Parts not identified in the circuit diagram:

990000	Unknown/Not applicable
990001	Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002	Knob (incl. dial knob, cap, etc.)
990003	Probe (only if attached to instrument)
990004	Leads and associated plugs
990005	Holder (valve, transistor, fuse, board, etc.)
990006	Complete unit (p.w. board, h.t. unit, etc.)
990007	Accessory (only those without type number)
990008	Documentation (manual, supplement, etc.)
990009	Foreign object
990099	Miscellaneous

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730101

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Test and Measuring Instruments Dept.
Eindhoven - Netherlands