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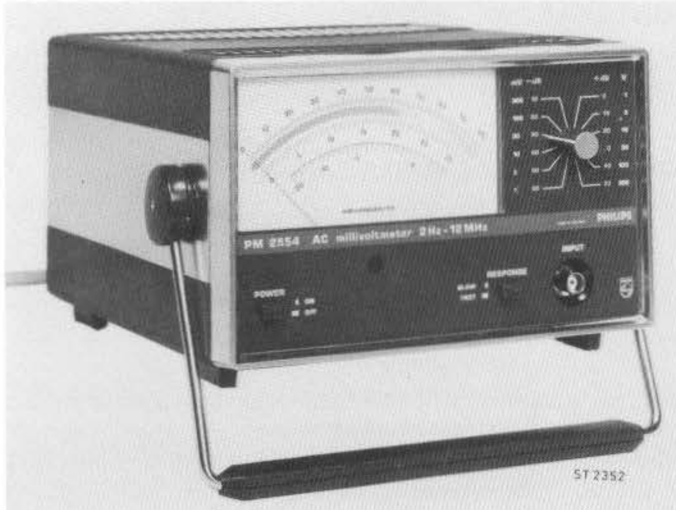

Instruction Manual

AC-millivoltmeter
PM2554

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SERVICE DATA

NOTE:

The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

LIST OF FIGURES

1. INTRODUCTION

The Philips AC millivoltmeter PM 2554 is a sensitive and accurate measuring instrument suitable for floating measurements from 50 µV up to 300 V in the frequency range from 2 Hz up to 12 MHz.
The instrument can be powered by mains.
By 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 as for measurements on transducers and measuring-transformers, etc.

The d.c. or a.c. output choosen by an internal jumper, makes it possible to employ the instrument as an a.c./d.c. converter or as an a.c. amplifier.
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 f.s.d. 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.

2. 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.

2.1. Electrical

Measuring range	50 µV...300 V divided into 12 ranges from 1 mV...300 V (f.s.d.)
dB Measuring range	−80 dB...+ 52 dB (12 ranges) 0 dB = 1 mW into 600 Ω, 0.775 V
Frequency range	2 Hz...12 MHz
Input impedance	direct 1 MΩ // 33 pF with PM 9336: 10 MΩ // 11 pF
Accuracy	Frequency

Frequency		Accuracy
10 Hz	– 400 kHz	± 1% of reading, ± 1% f.s.d.
2 Hz	– 10 Hz	± 3% of reading, ± 1% f.s.d.
400 kHz	– 2 MHz	± 2% of reading, ± 1% f.s.d.
2 MHz	– 6 MHz	± 2% of reading, ± 3% f.s.d.
6 MHz	– 12 MHz	± 4% of reading, ± 4% f.s.d.

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

Pre-deflection	< 3 scale divisions (terminating resistance ⩽ 500 Ω) 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	Additional 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 scale from −20 dB...+ 2 dB
Overload protection	In the ranges 1 mV to 300 mV: 300 V for frequencies between 2 Hz and 10 kHz 10 V for frequencies above 10 kHz Other ranges: 300 V for frequencies between 2 Hz and 12 MHz
Max. permissible voltage (all ranges)	Between Hi and Lo 400 Vd.c. Between Lo and housing 500 Vd.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
Output	D.c. or a.c. output (choosen by internal jumper)
D.C. output	Output resistance 1 kΩ Output voltage 1 V short-circuit proof
A.C. output	Output impedance 600 Ω in serial with 47 μF Output voltage 50 mV short-circuit proof
Accuracy d.c. output	Frequency 10 Hz – 400 kHz ± 1% of reading, ± 1% f.s.d. 2 Hz – 10 Hz ± 3% of reading, ± 1% f.s.d. 400 kHz – 2 MHz ± 2% of reading, ± 1% f.s.d. 2 MHz – 6 MHz ± 2% of reading, ± 3% f.s.d. 6 MHz – 12 MHz ± 4% of reading, ± 4% f.s.d.
Supply	Mains voltage: 90 V...132 V or 180 V...265 V, 50/60 Hz.

Long-term stability	At min. 90 operating days 1°/oo of f.s.d. on the average.

2.2. Mechanical

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

3. ACCESSORIES

3.1. Supplied as part of the equipment.

- Measuring cable for voltages above 3 mV and frequencies below 100 kHz
- Manual.

3.2. Optionally available.

- Measuring probe (10:1) PM 9336 (fig. 1 page 22)
- 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

4. PRINCIPLE OF OPERATION

Blockdiagram fig. 2 (page 22)

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 pre-amplifier

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 a.c. output and the rectifier circuit, 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.
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.
The equipment power supply voltage is stabilized to ensure that variations in mains supply voltage do not influence the display.

5. INSTALLATIONS

Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see section: EARTHING).

5.1. Mains supply and fuse

Before inserting the mains plug into a mains socket, make sure that the instrument is set to local mains voltage. The instrument is wired for operation from a 180 V...265 V, 50/60 Hz mains voltage.

5.1.1. Adapting of the mains voltage

Adaption of the instrument for other mains voltages is possible by altering the wiring of the mains transformer (see fig. 3 page 26)

To adapt the mains voltage proceed as follows:

- Remove the top cover by removing the two screws A (see fig. 5 page 26)
- Change the wiring of the transformer according to figure 3 page 26

The PM 2554 is suitable for mains voltages of 90 V...132 V and 180 V...265 V, 50/60 Hz.

5.2. Fuse

Make sure that only fuses with the required current rating and of the specified types are used. The use of repaired fuses and the short-circuiting of fuse holders is prohibited.

The rating of the mains fuse of the instrument should be: 50 mA d.a. for 180 V...265 V
100 mA d.a. for 90 V...132 V

5.3. 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 mains 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.

5.4. Rackmounting

The PM 2554 can be mounted in a 19" rack by using a mounting-set as shown in fig. 22 page 27. This set is not delivered by Philips.

6. OPERATION

6.1. Mechanical zerosetting

- Place the meter in a horzontal position and check the zero-setting of the meter.
- If necessary correct the setting by means of plastic screw "A", fig. 4 (page 26)

6.2. 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 (S 2).
A warming-up time of approximately 30 min. should be observed to obtain full accuracy.

6.3. Calibration

6.3.1. Instrument

- Select measuring range 100 mV
- Put the signal lead (Hi) to the connector X4 at the rear
- Adjust the meter to 100 scale divisions with potentiometer "CAL" (R 80).

6.3.2. Measuring probe PM 9336

- Before adjusting, the instrument should be calibrated as described above
- Select measuring range 10 mV
- Put the signal lead (Hi) to the connector X4 at the rear
- Adjust the probe by means of adjusting screw "A", fig. 1 (page 22).

6.4. Measuring

- Select the correct measuring range with range selector S 101
- Connect the test voltage to coaxial socket "INPUT" (X1) 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.
- *Do not use the delivered measuring cable for measuring voltages below 3 mV, and/or with a frequency above 100 kHz.*
- *In case of measurements of voltages in the lowest range, (1 mV) or with high frequencies (above 1 MHz) it may occur that h.f. interference signals respectively the standing wave ratio will influence the results.*
  Therefore it is advised to shield the measurements circuit.
- *For measurements at low frequencies, switch SLOW-FAST (S 102) should be set in position SLOW to obtain a proper reading.*
  As a result the indicating speed of the meter will be reduced and the pointer deflection will become more stable.

6.5. Output (X2 and X3)

The instrument is provided with a floating output.
The Lo is directly connected to the shield of the "INPUT" connector X1.
By means of an internal jumper or a d.c. output or an a.c. output is selected.
(see fig. 16 page 42).

6.5.1. D.C. output

The output voltage is proportional to the input voltage and is 1 V at full scale deflection, irrespective of the selected measuring range.
The output resistance is approx. 1 kΩ.

6.5.2. A.C. output

The output voltage is proportional to the input voltage and is 50 mV at full scale deflection, irrespective of the selected measuring range.
The output impedance is approx. 600 Ω in serial with 47 μF.

6.6. Errors due to disortion.

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 voltage.

The values of these depend on the coëfficient of non-lineair distortion.

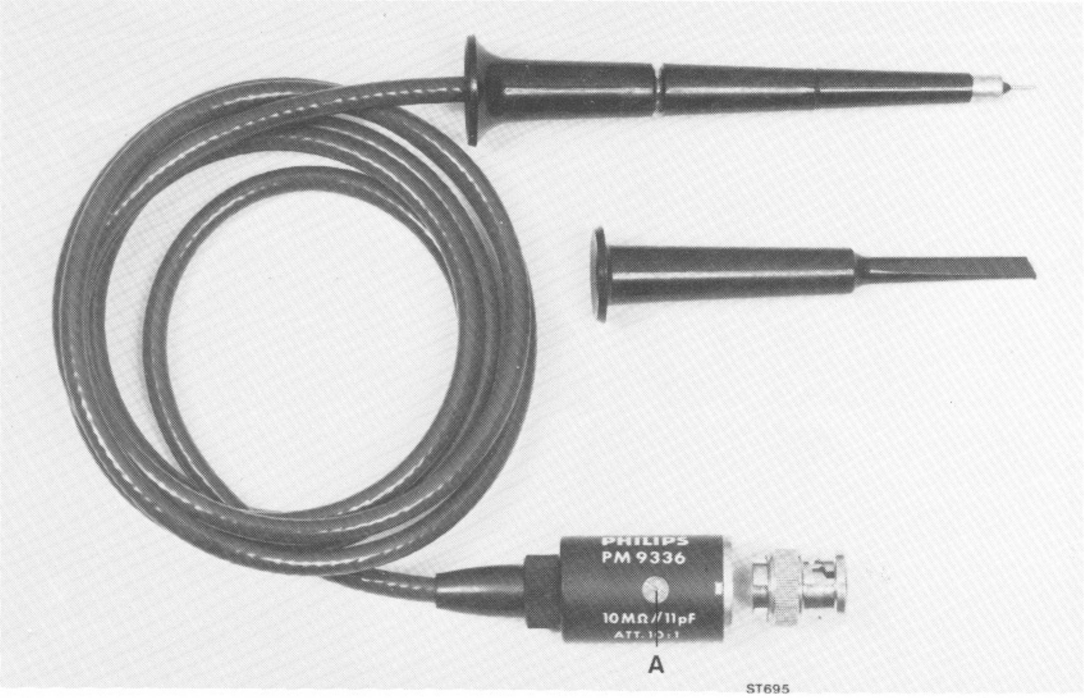

PHILIPS
PM 9336
10 MΩ // 11pF
A
ST695

Fig. 1.

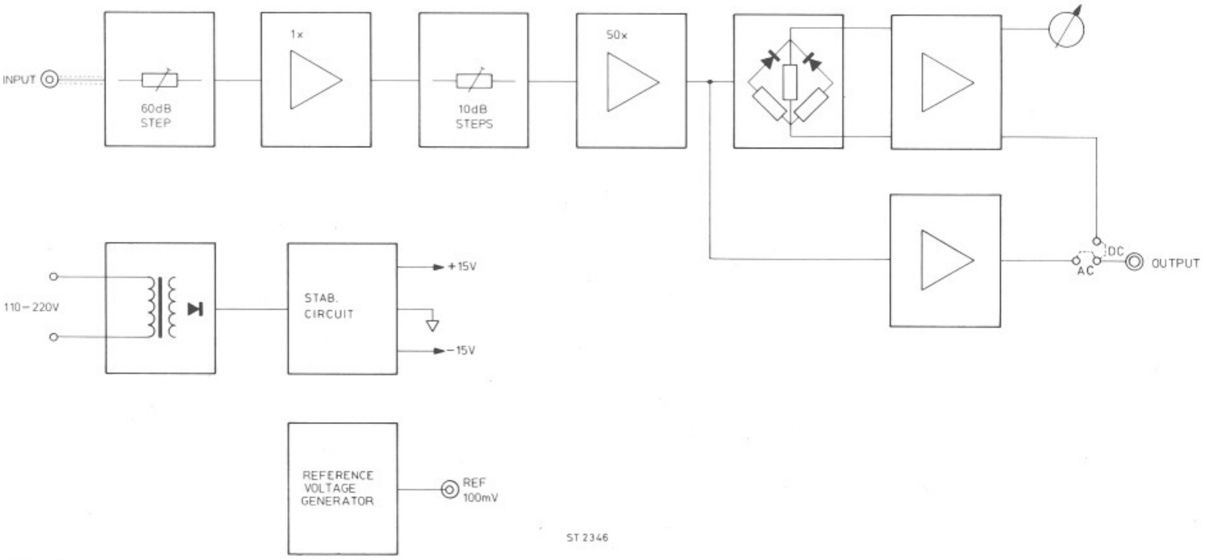

INPUT
60dB
STEP
1x
10dB
STEPS
50x
DC
AC
OUTPUT
110–220V
STAB.
CIRCUIT
+15V
–15V
REFERENCE
VOLTAGE
GENERATOR
REF
100mV
ST 2346

Fig. 2.

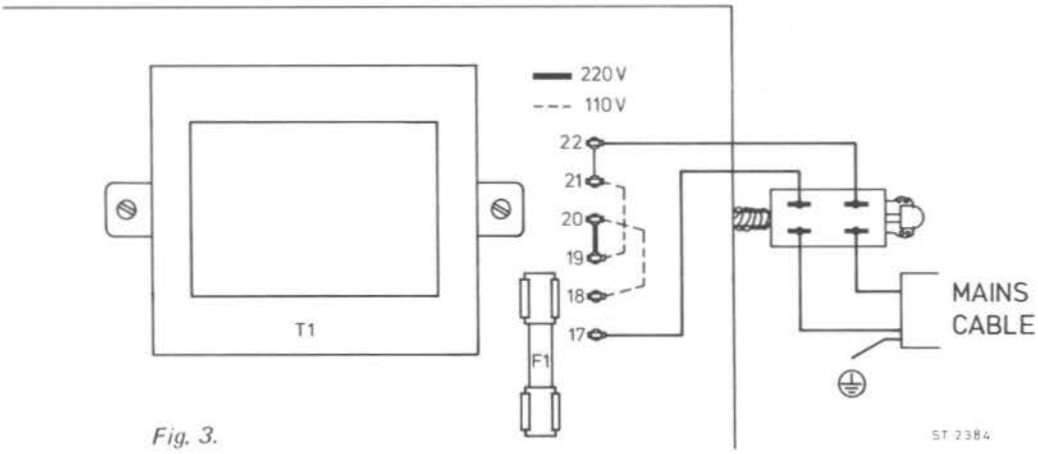


Fig. 3.

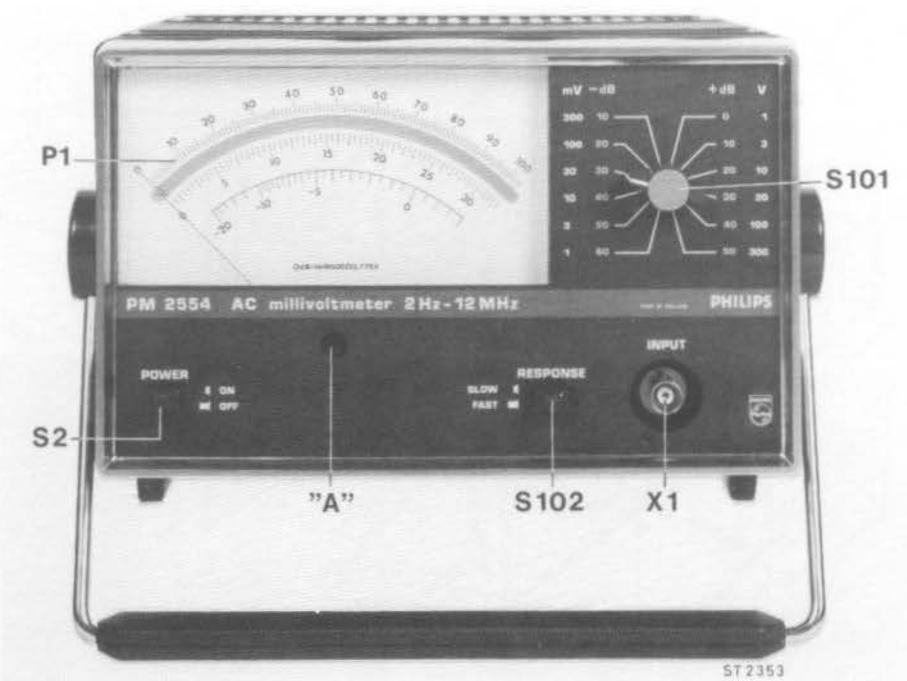


Fig. 4.

Fig. 5.

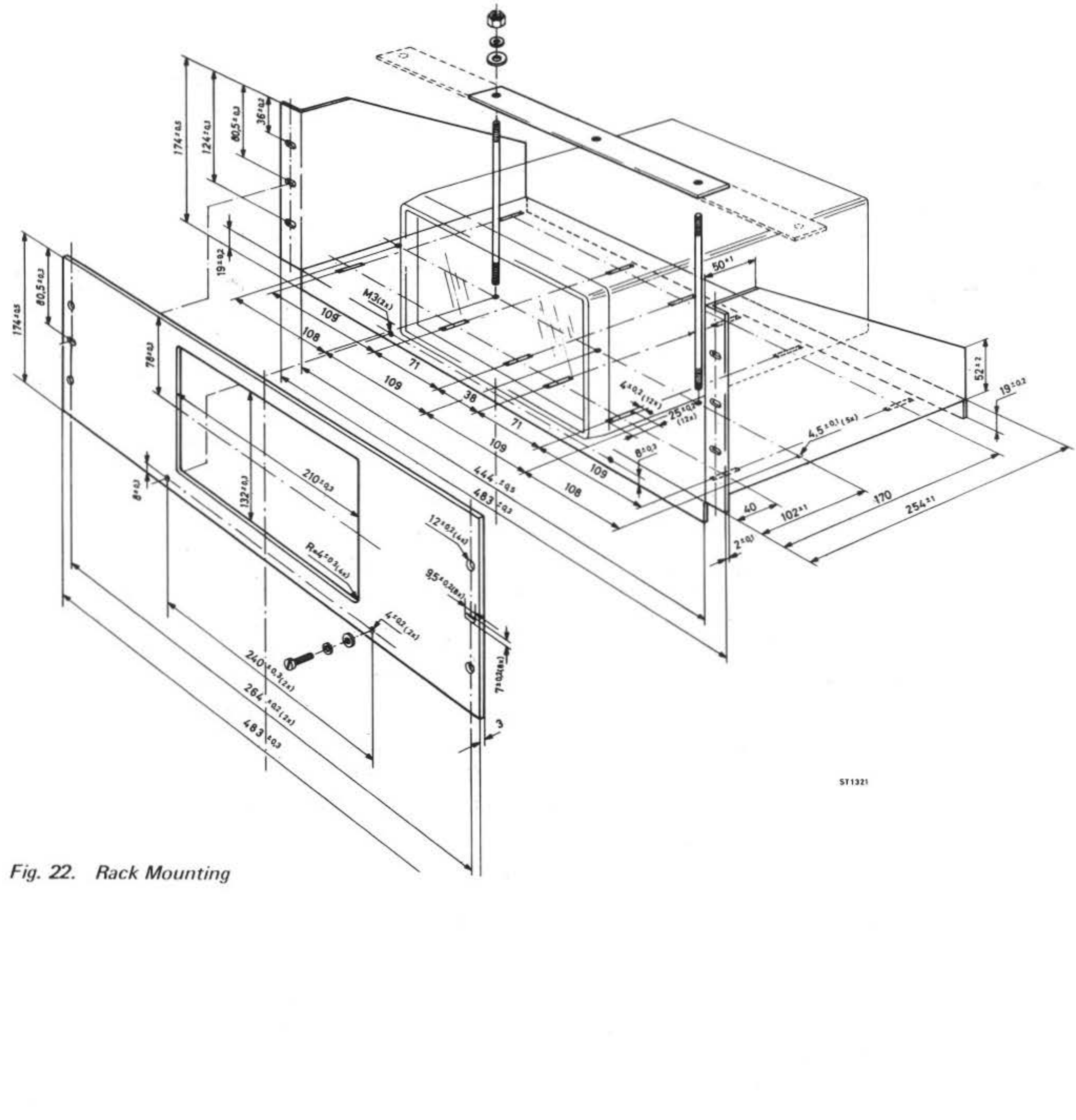


Fig. 22. Rack Mounting

7. CIRCUIT DESCRIPTION

7.1. Measuring section

Input circuit, fig. 6

The test voltage connected to X1 is supplied to the impedance transformer stage via C1 and S 101/1f and S 101/2r (direct input) or via S 101/1f; R1...R4; C4...C6; C50...C56 and S 101/2r (via high ohmic, frequency-independent 1000:1 attenuator).
In both cases the input capacitance is equalised by means of C3, 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 V5 and V6, 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 V5 two protective diodes V2 and V4 are provided which in the reverse direction are connected between the input and V1 and V3 respectively.
If the input voltage exceeds the zener voltage of V1,or V2 or V4 will become conductive, as a result of which the voltage on the gate of V5 is limited.
The current through the diodes is limited by the impedance of the input circuit R 106–R 7 and C8. In the voltage divider that follows now and that consists of S 101/3r, R 119...R 126 and R 128...R 132 the test voltage is attenuated in steps of 10 dB. C 118 and C 119 prevent the frequency-response curve from rising.

Amplifier, fig. 8

This consists of two feedback circuits, viz. V7 with V8 and V9 with V10.
A d.c. feedback from nodal point R40 and R41 via R31 to the base of V7 is wired across the whole assembly.
The amplification of the first circuit is determined by R34 and R35 and that of the second circuit by R38 and R37.
The RC network R33 and C22 blocks oscillations from the first circuit.

AC–DC converter, fig. 9, 10

This converter contains the amplifier stages V12 and V15 with V16 coupled by the emitter-follower V14 and the current source V18.
Test resistor R65 is included in the feedback network together with the rectifier circuit.
V15 and V16 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 A2 the operating point of V16 compared with the voltage obtained from voltage divider R58 – R59. A possible deviating voltage is amplified and fed back to the base of V12 so that the voltage is corrected. The voltage on the collector of V16 has been chosen so that it is equal to the emitter voltage plus half the knee voltage of V19 and V20; consequently the latter diodes can never become conductive on account of a voltage difference between the collector of V16 and the emitter of V12.
To prevent the a.c. signal from the collector of V16 from being fed back to the base of V12 via the differential amplifier, C33 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 C33 and R56. 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.

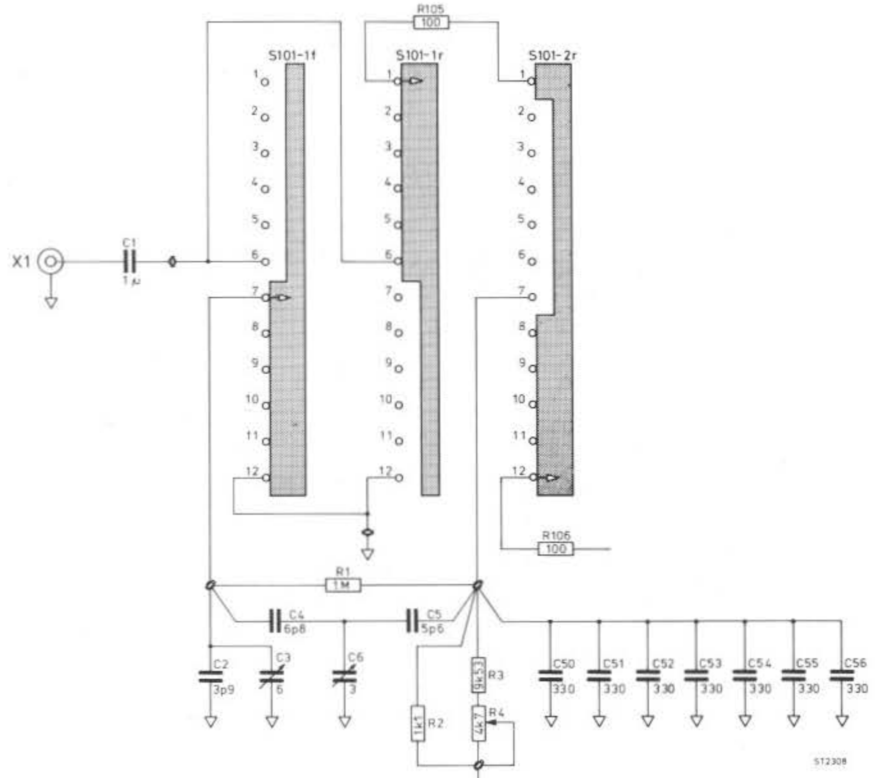


Fig. 6. Input circuit.

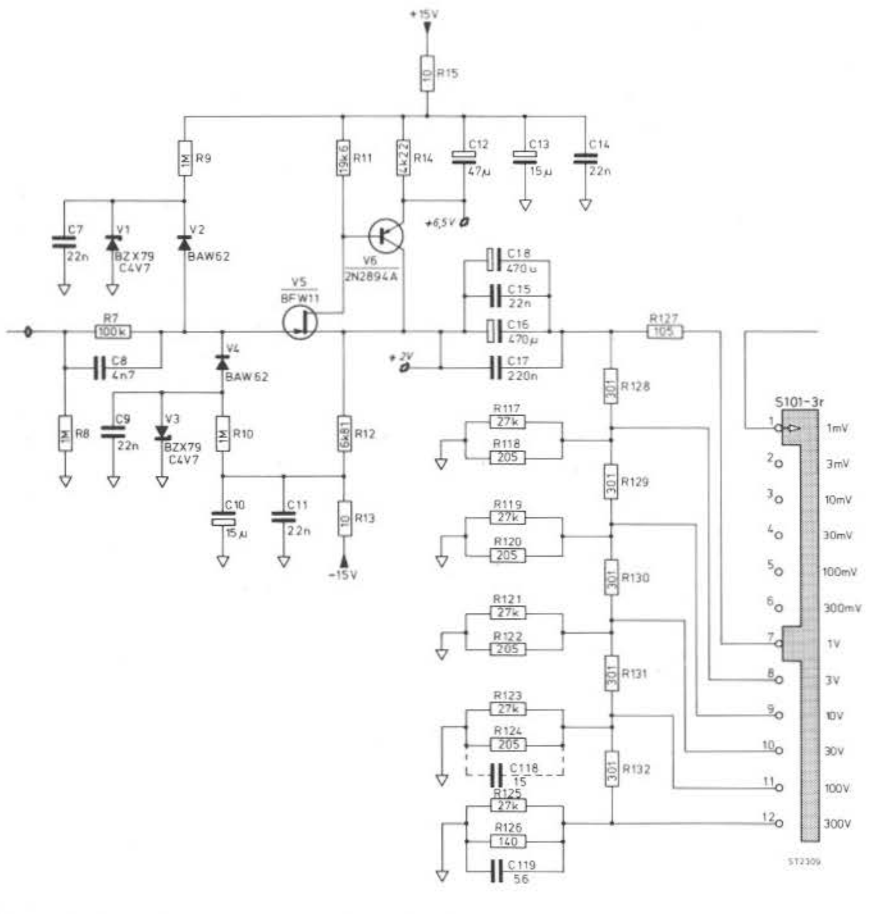


Fig. 7. Impedance transformation circuit

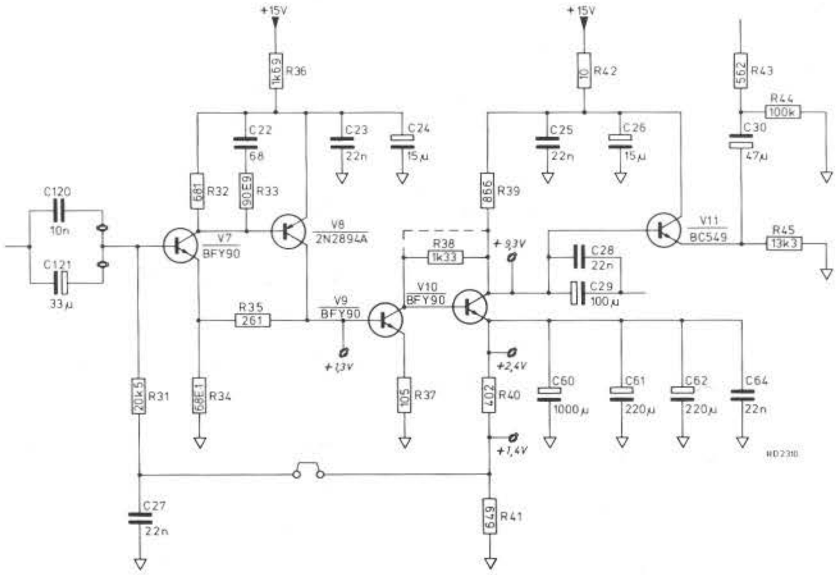
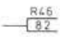


Fig. 8. AC Amplifier



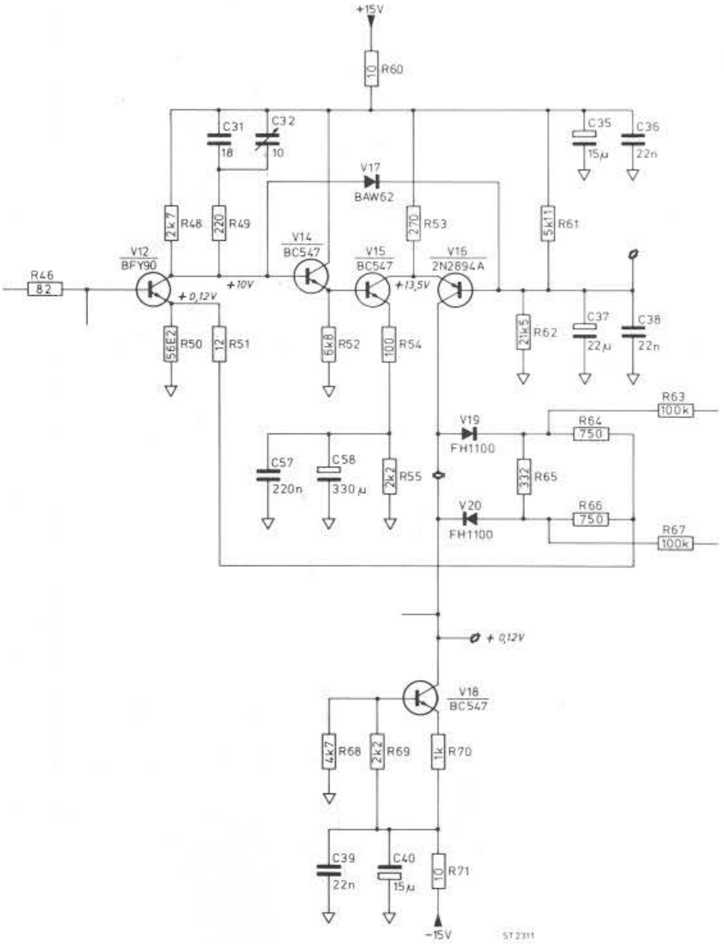


Fig. 9. AC - DC Converter

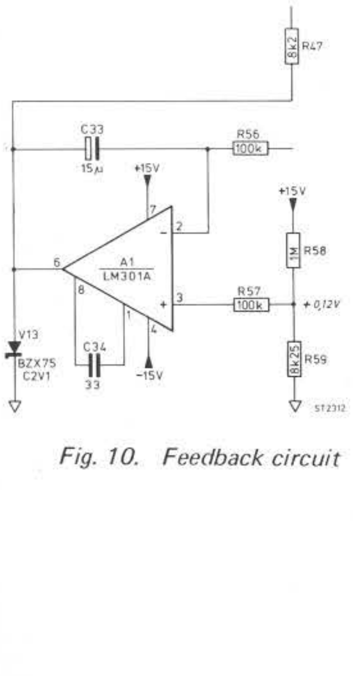


Fig. 10. Feedback circuit

DC amplifier, fig. 11

The dc voltage which appears over the measuring resistor R65 is fed via resistors R63 and R67 which, together with the resistors R27 and R73 determine the amplification factor (X1) for dc signals. The ripple voltage at the output of the amplifier A2 is suppressed by the capacitors C45 and C42 and the resistor R73.
Owing to the circuit arrangement by which capacitors C45 and 42 can be switched using S 102 the ripple suppression is also effective at very low frequencies. At the same time the meter response is damped so that unwanted virbration of the meter needle is reduced. The offset voltage for A2 is determined by resistor R91.

7.2. Supply section, fig. 12

The two primary windings S1 and S2 of transformer T1 can be connected in series or in parallel by connecting together the appropriate soldering pins.

For mains voltages between 180 and 265 volts the windings must be connected in series and for voltages between 90 and 132 volts in parallel.

The output of T1 is rectified by V21 and smoothed by C46.

The current source consisting of V23–26 and R84 delivers the current for the equipment and at the same time provides a stabilized supply voltage via zener diodes V24 and V25.

The adjusting current for V23 is delivered by the current source consisting of V22–25 and R83.

R82 is the starting resistor for both current sources.

7.3. Reference voltage generator, fig. 13

The generator consists of a CMOS circuit with a time constant determined by R85 and C47. The supply voltage for this circuit is further stabilized by means of zener diode V27, resulting in the square wave at the output (pin 10) being extremely stable.

This voltage is applied to a potential divider consisting of resistors R86 to 89 and a proportion of it is applied to reference output X4.
Applying this voltage to the 100 mV range enables the instrument to be calibrated.

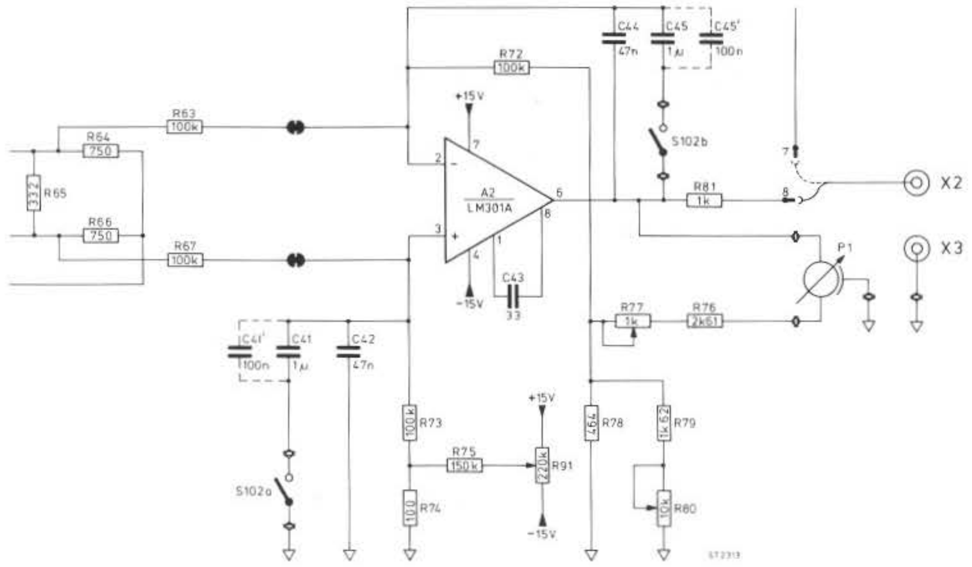


Fig. 11. DC Amplifier

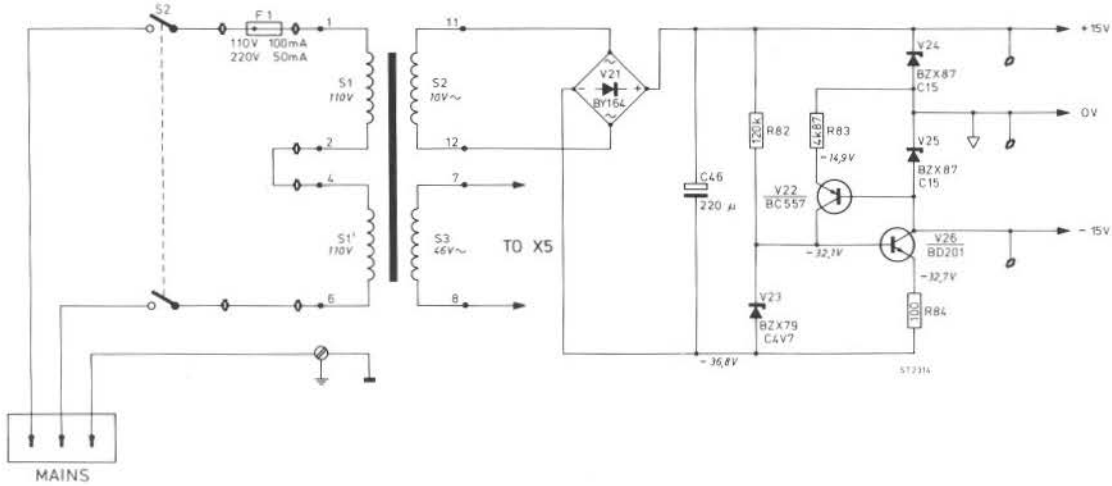


Fig. 12. Mains section

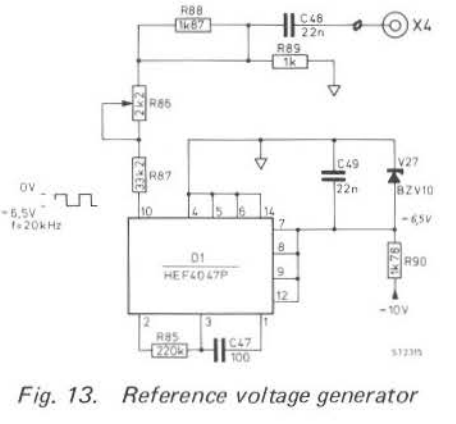


Fig. 13. Reference voltage generator

8. 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 CORSS-SLOTTED SCREWS FOR DAMAGE.

8.1. Dismantling

1. Top cover
   - Remove both screws "A" (fig. 5)
   - Lift the cover at the rear and slide it backwards from the unit.
2. Bottom cover
   - Remove both screws "B" (fig. 5)
   - Lift the cover at the rear and slide it backwards from the unit.

9. MAINTENANCE AND SERVICING

AC millivoltmeter PM 2554 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.

9.1. 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.
- The dc settings of the instrument given on the circuit diagram are measured with the input short circuited. These values represent an average instrument.

10. CHECKING AND ADJUSTING

10.1. General

The tolerances stated in this chapter correspond to the factory data; they apply when the instrument is read-justed completely. Such data may differ from these given in chapter 2. 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.

10.2. 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 10 sub-point
R80	18	Calibrating the instrument		3.4
R4	19	Frequency-independent voltage divider	LF generator precision LF millivoltmeter	3.5
R91	18	Zero point DC amplifier	Voltmeter, for instance PM 2403	3.3
R77	18	DC output	LF generator, precision LF millivoltmeter. Voltmeter, for instance PM 2421	3.4
R86	18	Reference voltage	LF generator, precision LF millivoltmeter	3.6
C3/C6	18	Frequency-independent voltage divider	LF generator, precision LF millivoltmeter. Probe PM 9336	3.5

10.3 Adjusting procedure

10.3.1. 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.

10.3.2. Supply voltages

- The value adjusted by means of the wiring of T1 (see fig. 3) must correspond with the local mains voltage
- The mains fuse must have a current value of 50 mA d.a. (90 V...132 V) or 100 mA d.a. (180 V...265 V)
- The supply voltages are + 15 V and – 15 V with respect to 0

  Test points + 15 V: cathode V24
  0 V: cathode V25
  – 15 V: anode V25

10.3.3. Zero-setting d.c. amplifier

- Set S 101 to position 300 mV
- Measure the voltage on the d.c. output
- Adjust this voltage to 0 V by means of potentiometer R91
- Set S 101 to position 1 mV
- The pre-deflection must be less than 3 scale devisions (sd.)

10.3.4. Adjusting the d.c. output

- Set S 101 to position 30 mV
- Connect a voltage of 31.6 mV ± 0.2%; 1 kHz to X1
- Adjust the test system to 100 sd by means of R80
- Measure the voltage on the d.c. output X2 and X3
- Adjust the voltage to 1 V ± 0.2% by means of R77

10.3.5. Adjusting the frequency-independent voltage divider

- Set S 101 to position 10 V
- Connect a voltage of 10 V ± 0.2% 400 Hz to X1
- Adjust the test system to 100 sd by means of R4
- Increase the frequency to 50 kHz
- Adjust the test system to 100 sd by means of C6
- Set S 101 to position 100 mV
- Connect a voltage of 1 V ± 0.2% to X1 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 S 101 to position 1 V
- Connect a voltage of 10 V ± 0.2%, 200 Hz to X1 via the probe now adjusted
- Noted down the deflection of the test system
- Increase the frequency to 50 kHz
- Adjust the system to the latter value by means of C3.

10.3.6. Adjusting the reference generator

- Set S 101 in position 100 mV
- Apply a voltage of 100 mV ± 0.2% 1 kHz to X1
- Adjust the test system to 100 sd by means of R80
- Interconnect X1 and X4
- Adjust the test system to 100 sd by means of R86

10.3.7. Ripple suppression

(Only necessary if C41 or C45 has to be replaced)

- Set S 101 in position 1 V
- Set S 102 in position slow
- Connect a voltage of 0.9 V 2 Hz to X1
- The total swing of the needle should be smaller than 0.5 sd
- If necessary add a capacitor of 0.1 μF in parallel with R41 or R45

10.3.8. Final check

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

Position S 101	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 ± 1.5%	1 V ± 1.5%
100 mV	100	mV	2 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 mV	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%

— In case of a to high indication at 2 Hz C60 should be increased or C16 should be decreased.

10.3.7. Ripple suppression
(Only necessary if C41 or C45 has to be replaced)

- Set S 101 in position 1 V
- Set S 102 in position slow
- Connect a voltage of 0.9 V 2 Hz to X1
- The total swing of the needle should be smaller than 0.5 sd
- If necessary add a capacitor of 0.1 μF in parallel with R41 or R45

10.3.8. Final check

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

Position S 101	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 ± 1.5%	1 V ± 1.5%
100 mV	100	mV	2 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 mV	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%
— In case of a to high indication at 2 Hz C60 should be increased or C16 should be decreased.

11. LIST OF PARTS

11.1 Mechanical

Item	Fig.	Qty.	Ordering number	Description
1	14	1	5322 447 94068	Top and bottom cover
2	14	2	5322 460 64003	Ornamental strip
3	14	2	5322 535 74367	Spindle for handle
4	14	1	5322 520 34138	Bearing bush, left
5	17	1	5322 520 34139	Bearing bush, right
6	14	1	5322 498 74003	Cab for handle
7	14	1	5322 498 54032	Handle assey
8	14	1	5322 460 64002	Ornamental frame
9	16	1	5322 414 64039	Knob for S 101
10	14	1	5322 414 74019	Cab for knob
11	14	1	5322 526 44136	Insulating bush
12	17	1	5322 405 94159	Clip
13	16	1	5322 532 54209	Coppling piece
14	14	1	5322 535 74394	Spindle
15	17	1	5322 535 94637	Extension spindle
16	16	1	5322 532 64119	Bush
17	16	2	5322 462 44175	Foot
18	17	1	5322 492 64337	Retaining spring
19	15	4	5322 462 44121	Foot

11.2 Miscellaneous

Item	Fig.	Qty.	Ordering number	Description
20	16	1	4822 253 30003	Fuse 50 mA da 5 x 20
21	14	1	5322 344 64055	Measuring system
22	17	1	5322 276 14085	Fast-Slow switch
23	17	1	4822 276 10554	Mains switch
24	16	1	5322 273 64036	Range switch
25	16	1	5322 146 24186	Mains transformer
26	14	1	5322 267 14022	HF-Con BNC
27	15	1	5322 267 30231	Connector Hi
28	15	1	5322 267 30231	Connector Lo
29	15	1	5322 267 30231	Connector REF
30	15	1	5322 267 54072	Connector 8–P
31	–	1	5322 320 14093	Measuring cable
32	16	2	4822 253 30006	Fuse 100 mA da 5 x 20
33	14	2	5322 414 14011	Push botton knob
34	15	1	5322 321 14001	Mains cable
35	15	1	5322 325 50101	Cable grommet
36	16	1	5322 462 44362	Protective cover

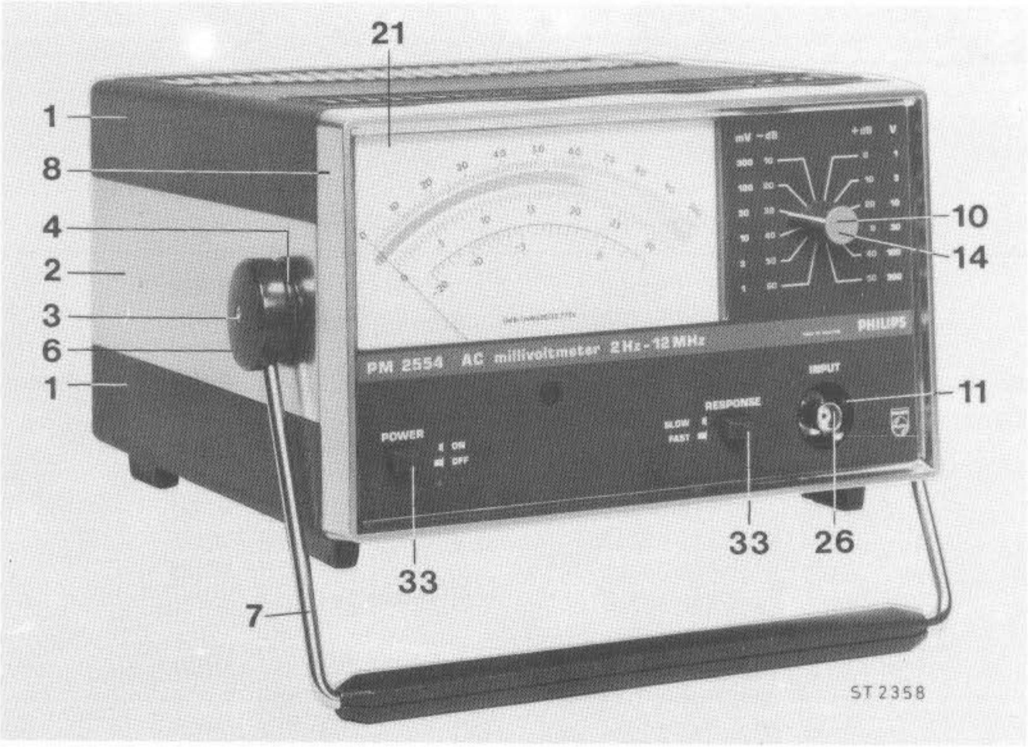


Fig. 14. Front view with item numbers

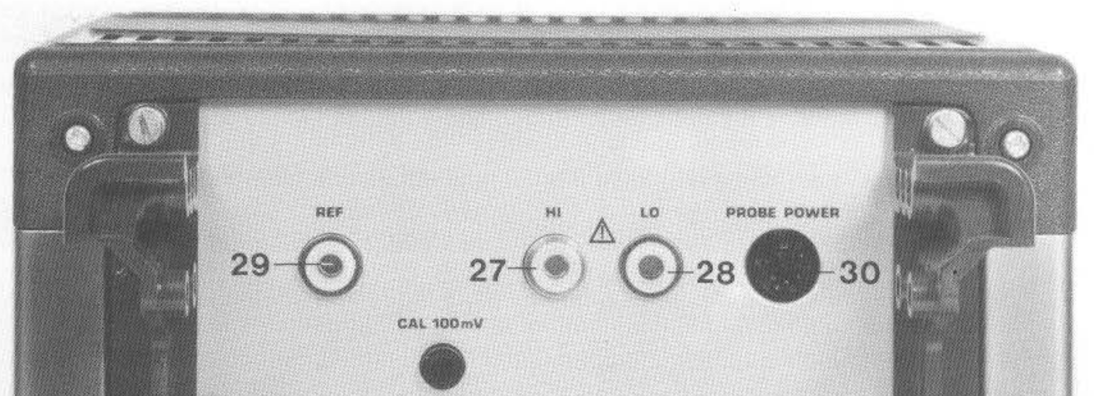


Fig. 15. Rear view with item numbers

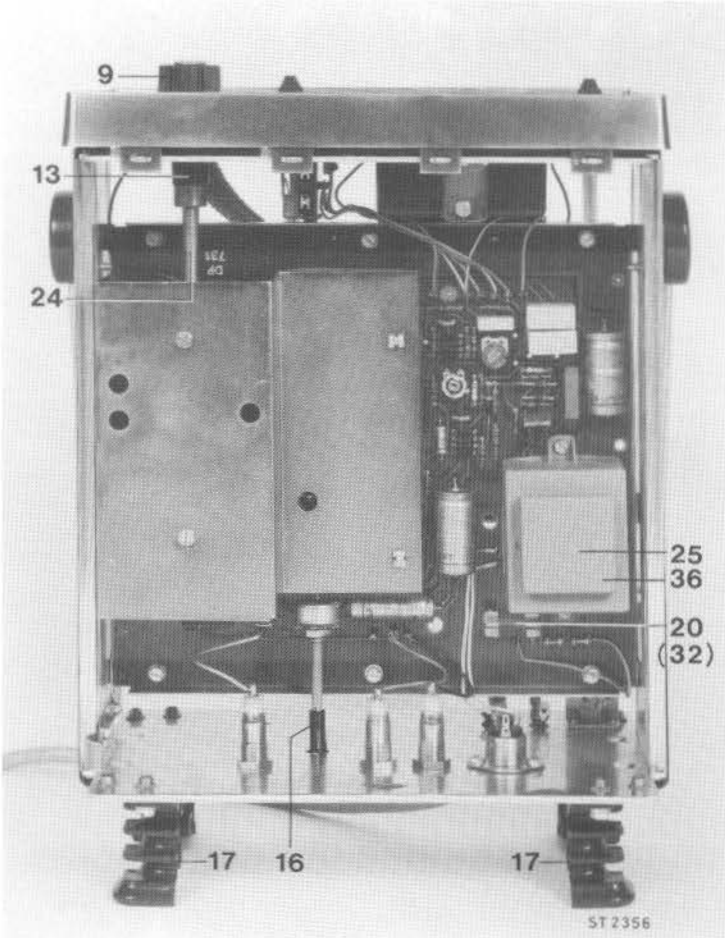


Fig. 16. Top view

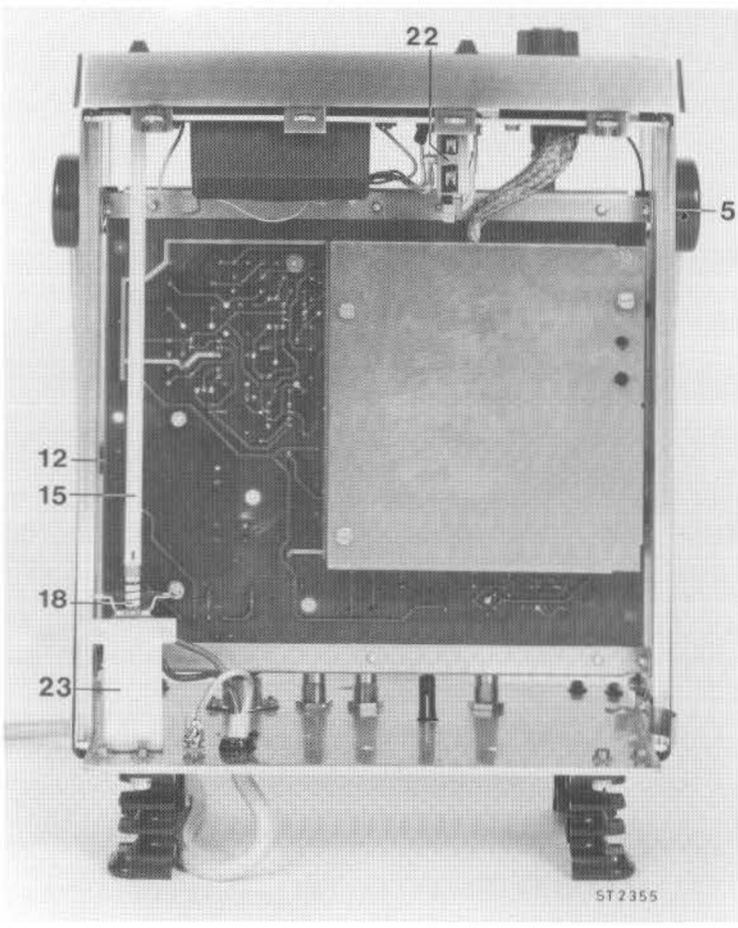


Fig. 17. Bottom view

11.3. Electrical

11.3.1. Resistors *

No.	Ordering number	Value (Ω)	%	Series
R 1	5322 116 54188	1 M	1	MR30
R 2	5322 116 54554	1,1 k	1	MR25
R 3	5322 116 54617	9,53 k	1	MR25
R 4	4822 101 20416	4,7 k	20	0.1W Potentiometer
R 7	4822 116 51123	100 k	1	MR30
R 8	5322 116 54188	1 M	1	MR30
R 11	5322 116 54641	19,6 k	1	MR25
R 12	5322 116 54012	6,81 k	1	MR25
R 13	5322 116 50452	10	1	MR25
R 14	5322 116 50729	4,22 k	1	MR25
R 15	5322 116 50452	10	1	MR25
R 31	5322 116 54643	20,5 k	1	MR25
R 32	5322 116 54534	681	1	MR25
R 33	5322 116 54466	90,9	1	MR25
R 34	5322 116 54455	68,1	1	MR25
R 35	5322 116 54502	261	1	MR25
R 36	5322 116 54567	1,69 k	1	MR25
R 37	5322 116 54472	105	1	MR25
R 38	5322 116 54561	1,33 k	1	MR25
R 39	5322 116 54543	866	1	MR25
R 40	5322 116 54519	402	1	MR25
R 41	5322 116 54532	649	1	MR25
R 42	5322 116 50452	10	1	MR25
R 43	5322 116 54009	562	1	MR25
R 44	5322 116 54696	100 k	1	MR25
R 45	5322 116 54627	13,3 k	1	MR25
R 50	5322 116 54446	56,2	1	MR25
R 57	5322 116 54696	100 k	1	MR25
R 58	5322 116 54188	1 M	1	MR30
R 59	5322 116 54558	8,25 k	1	MR25
R 61	5322 116 54595	5,11 k	1	MR25
R 62	5322 116 50451	21,5 k	1	MR25
R 63	5322 116 54696	100 k	1	MR25
R 64	5322 116 54536	750	1	MR25
R 65	5322 116 54513	332	1	MR25
R 66	5322 116 54536	750	1	MR25
R 67	5322 116 54696	100 k	1	MR25
R 72	5322 116 54696	100 k	1	MR25
R 73	5322 116 54696	100 k	1	MR25
R 74	5322 116 54469	100	1	MR25

* Carbon resistors CR25 5% –0,125 W are not mentioned in this list

No.	Ordering number	Value (Ω)	%	Series	
R 76	5322 116 50671	2,61 k	1	MR25	
R 77	4822 100 10037	1 k	20	0,05W	Potentiometer
R 78	5322 116 50536	464	1	MR25	
R 79	5322 116 54565	1,62 k	1	MR25	
R 80	5322 101 24138	10 k	20	MR25	
R 81	5322 116 54549	1 k	1	MR25	
R 83	5322 116 50509	4,87 k	1	MR25	
R 84	5322 116 54469	100	1	MR25	
R 86	4822 100 10029	2,2 k	20	0,05W	Potentiometer
R 87	5322 116 50482	33,2 k	1	MR25	
R 88	5322 116 50728	1,87 k	1	MR25	
R 89	5322 116 54549	1 k	1	MR25	
R 90	5322 116 50729	4,22 k	1	MR25	
R 91	4822 100 10088	220 k	20	0,05W	Potentiometer
R 105	5322 116 54852	100	1	MR30	
R 106	5322 116 54852	100	1	MR30	
R 118	5322 116 54767	205	0,25	MR24C	
R 120	5322 116 54767	205	0,25	MR24C	
R 122	5322 116 54767	205	0,25	MR24C	
R 123	4822 110 63145	27 k	5	CR25	
R 124	5322 116 54767	205	0,25	MR24C	
R 126	5322 116 50865	140	0,25	MR24C	
R 127	5322 116 54472	105	1	MR25	
R 128	5322 116 55038	301	0,25	MR24C	
R 129	5322 116 55038	301	0,25	MR24C	
R 130	5322 116 55038	301	0,25	MR24C	
R 313	5322 116 55038	301	0,25	MR24C	
R 132	5322 116 55038	301	0,25	MR24C	

11.3.2. Capacitors

No.	Ordering number	Value (F)	%	V	Description
C 1	4822 121 40117	1 μ	10	400	Polyester
C 2	4822 122 31217	3,9 p	0,25pF		Ceramic
C 3	4822 125 60037	6		500	Trimmer
C 4	4822 122 31192	6,8 p	0,25pF	500	Ceramic
C 5	4822 122 31191	5,6 p	0,25pF	500	Ceramic
C 6	5322 125 64011	3 p		500	Trimmer
C 7	4822 122 30103	22 n	−20+80	40	Ceramic
C 8	5322 121 44225	4,7 n	10	630	Polyester
C 9	4822 122 30103	22 n	−20+80	40	Ceramic
C 10	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 11	4822 122 30103	22 n	−20+80	40	Ceramic
C 12	4822 124 20461	47 μ	−10+50	10	Electrolytic
C 13	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 14	4822 122 30103	22 n	−20+80	40	Ceramic
C 15	4822 122 30103	22 n	−20+80	40	Ceramic
C 16	4822 124 20457	470 μ	−10+50	6,3	Electrolytic
C 17	4822 121 40232	220 n	10	100	Polyester
C 18	4822 124 20457	470 μ	−10+50	6,3	Electrolytic
C 22	4822 122 31076	68 p	2	100	Ceramic
C 23	4822 122 30103	22 n	−20+80	40	Ceramic
C 24	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 25	4822 122 30103	22 n	−20+80	40	Ceramic
C 26	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 27	4822 122 30103	22 n	−20+80	40	Ceramic
C 28	4822 122 30103	22 n	−20+80	40	Ceramic
C 29	4822 124 20462	100 μ	−10+50	10	Electrolytic
C 30	4822 124 20461	47 μ	−10+50	10	Electrolytic
C 31	4822 122 31061	18 p	2	100	Ceramic
C 32	4822 125 50062	10 p		250	Trimmer
C 33	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 34	4822 122 31067	33 p	2	100	Ceramic
C 35	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 36	4822 122 30103	22 n	−20+80	40	Ceramic
C 37	4822 124 20459	22 μ	−10+50	10	Electrolytic
C 38	5322 121 40308				Polyester
C 39	4822 122 30103	22 n	−20+80	40	Ceramic
C 40	4822 124 20467	15 μ	−10+50	16	Electrolytic
C 41	5322 121 40197	1 μ	10	100	Polyester
C 42	5322 121 44138	47 n	10	100	Polyester
C 43	4822 122 31067	33 p	2	100	Ceramic
C 44	5322 121 44138	47 n	10	100	Polyester
C 45	5322 121 40197	1 μ	10	100	Polyester
C 46	4822 124 20537	220 μ	−10+50	63	Electrolytic
C 47	4822 122 31081	100 p	2	100	Ceramic
C 48	4822 122 30103	22 n	−20+80	40	Ceramic

No.	Ordering number	Value (F)		%	V	Description
C 49	4822 122 30103	22	n	−20+80	40	Ceramic
C 50	4822 122 30055	330	p	−20+80	100	Ceramic
C 51	4822 122 30055	330	p	2	100	Ceramic
C 52	4822 122 30055	330	p	2	100	Ceramic
C 53	4822 122 30055	330	p	2	100	Ceramic
C 54	4822 122 30055	330	p	2	100	Ceramic
C 55	4822 122 30055	330	p	2	100	Ceramic
C 56	4822 122 30055	330	p	2	100	Ceramic
C 57	4822 121 40232	220	n	10	100	Polyester
C 58	4822 124 20465	330	μ	−10+50	10	Electrolytic
C 60	4822 124 20508	1000	μ	−10+50	4	Electrolytic
C 61	4822 124 20581	220	μ	−10+50	4	Electrolytic
C 62	4822 124 20515	2200	μ	−10+50	6,3	Electrolytic
C 64	4822 122 30103	22	n	−20+80	40	Ceramic
C 70	4822 122 31058	15	p	2	700	Ceramic
C 118	4822 122 31058	15	p	2	100	Ceramic
C 119	4822 122 31074	56	p	2	100	Ceramic
C 121	4822 124 20468	33	μ	−10+50	16	Electrolytic

11.3.3. Semiconductors

No.	Ordering number	Type
V 1	5322 130 34174	BZX79–C4V7
V 2	4822 130 30613	BAW62
V 3	5322 130 34174	BZX79–C4V7
V 4	4822 130 30613	BAW62
V 5	5322 130 40408	BFW11
V 6	5322 130 44127	2N2894A
V 7	5322 130 40493	BFY90
V 8	5322 130 44127	2N2894A
V 9	5322 130 40493	BFY90
V 10	5322 130 40493	BFY90
V 11	4822 130 40964	BC549
V 12	5322 130 40493	BFY90
V 13	5322 130 34049	BZX75–C2V1
V 14	4822 130 44257	BC547
V 15	4822 130 44257	BC547
V 16	5322 130 44127	2N2894A
V 17	4822 130 30613	BAW62
V 18	4822 130 44257	BC547
V 19	5322 130 34062	FH1100
V 20	5322 130 34062	FH1100
V 21	4822 130 30414	BY164
V 22	4822 130 44256	BC557
V 23	5322 130 34174	BZX79–C4V7
V 24	5322 130 34156	BZX87–C15
V 25	5322 130 34156	BZX87–C15
V 26	5322 130 44325	BD201 (TO220)
V 27	5322 130 34439	BZV10

11.3.4. Integrated circuits

No.	Ordering number	Type
D 1	5322 209 14125	HEF 4047BP
A 1	5322 209 84679	LM301AN
A 2	5322 209 84679	LM301AN

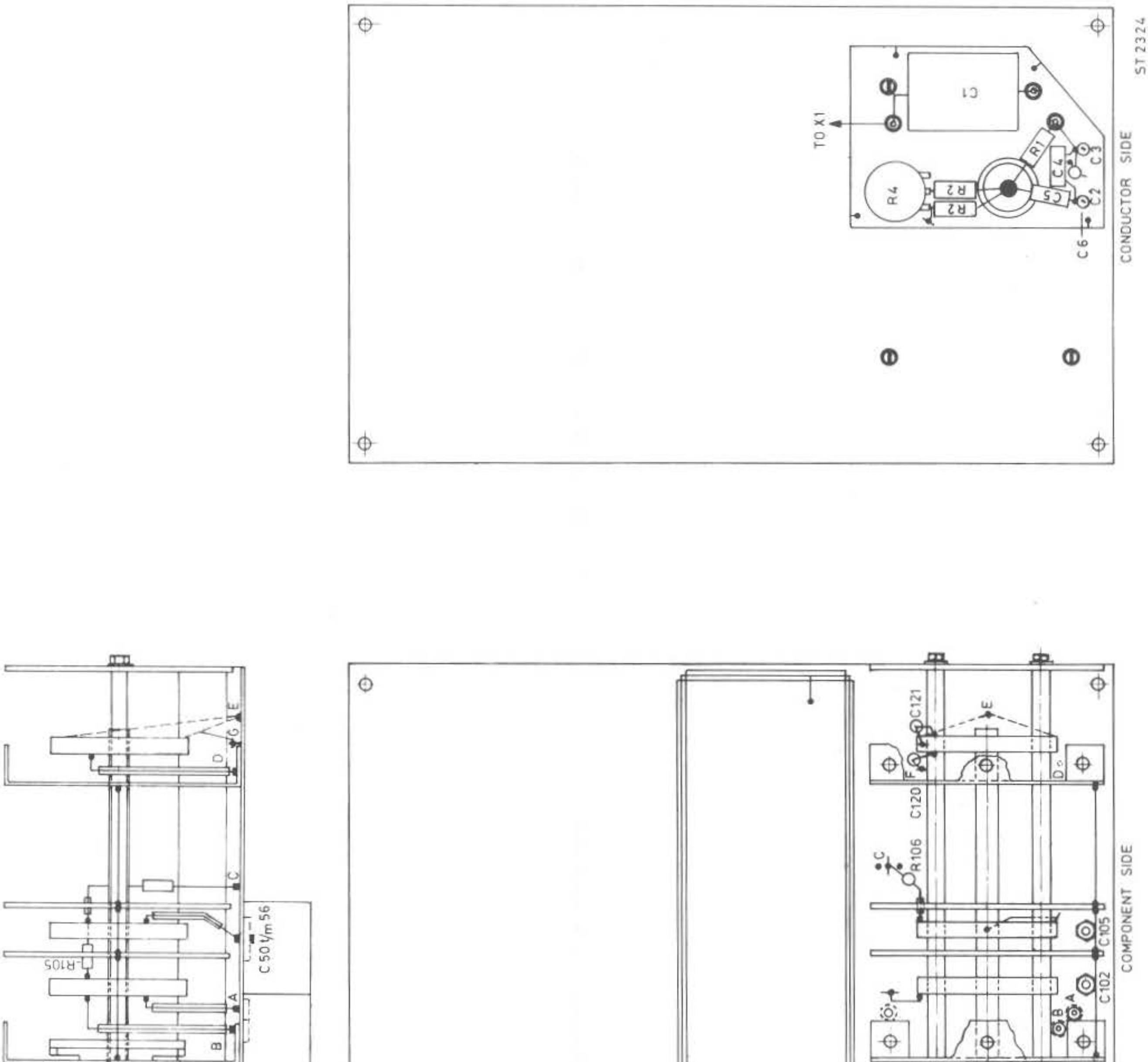


Fig. 20. Printed circuit board U1 with S 101

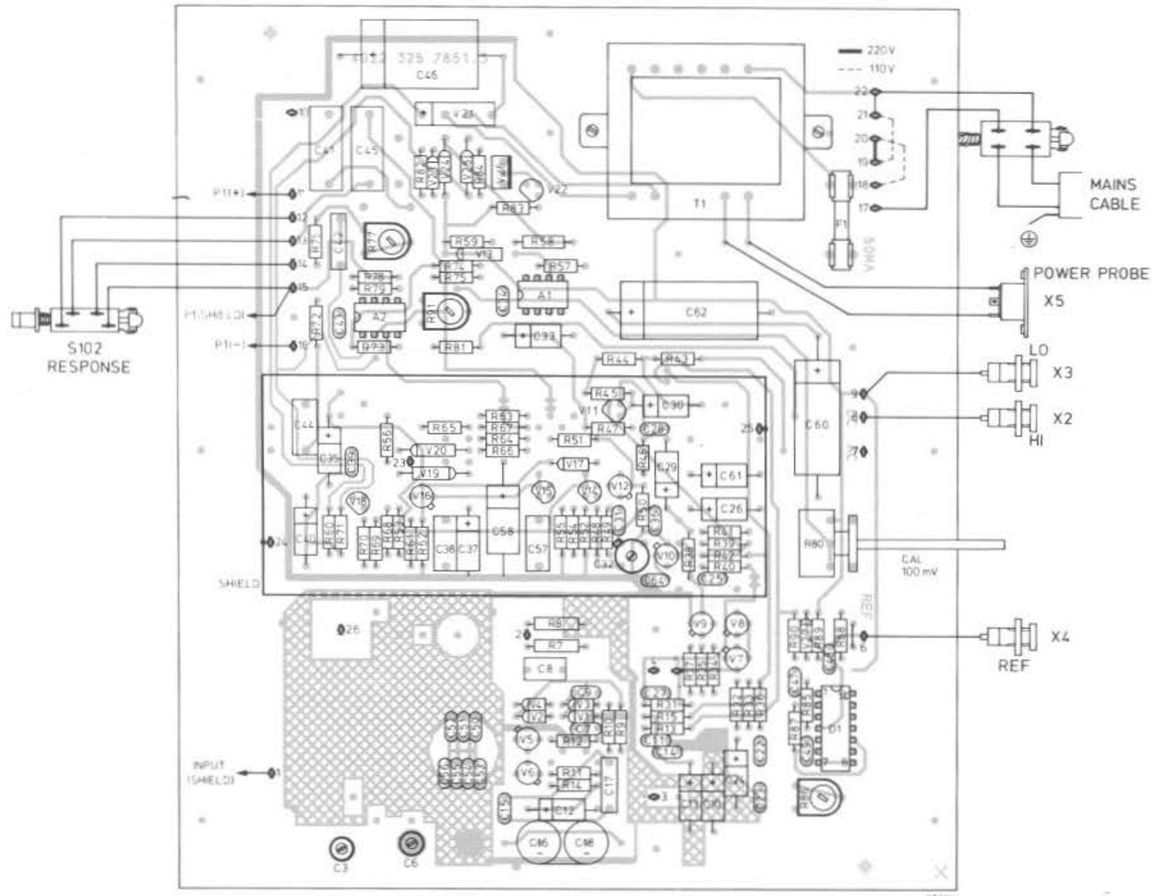


Fig. 18. Printed circuit board U1 Component side

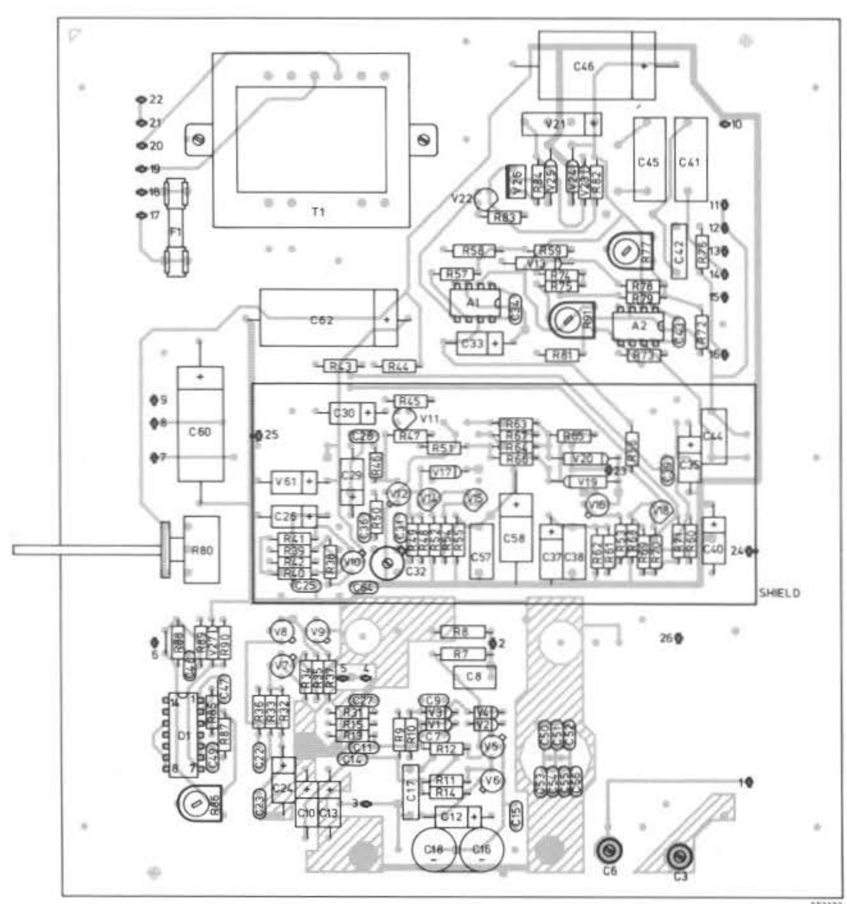
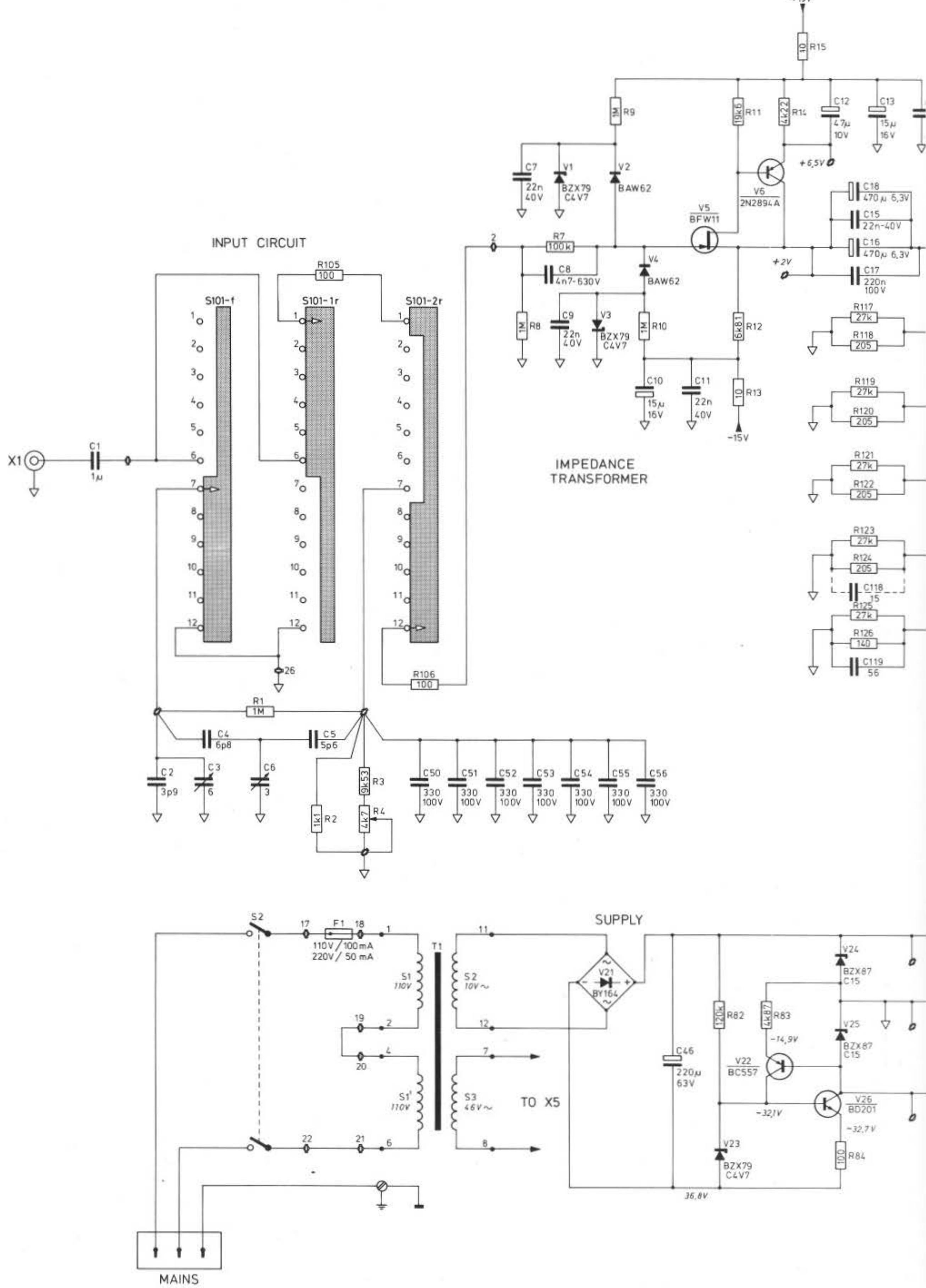
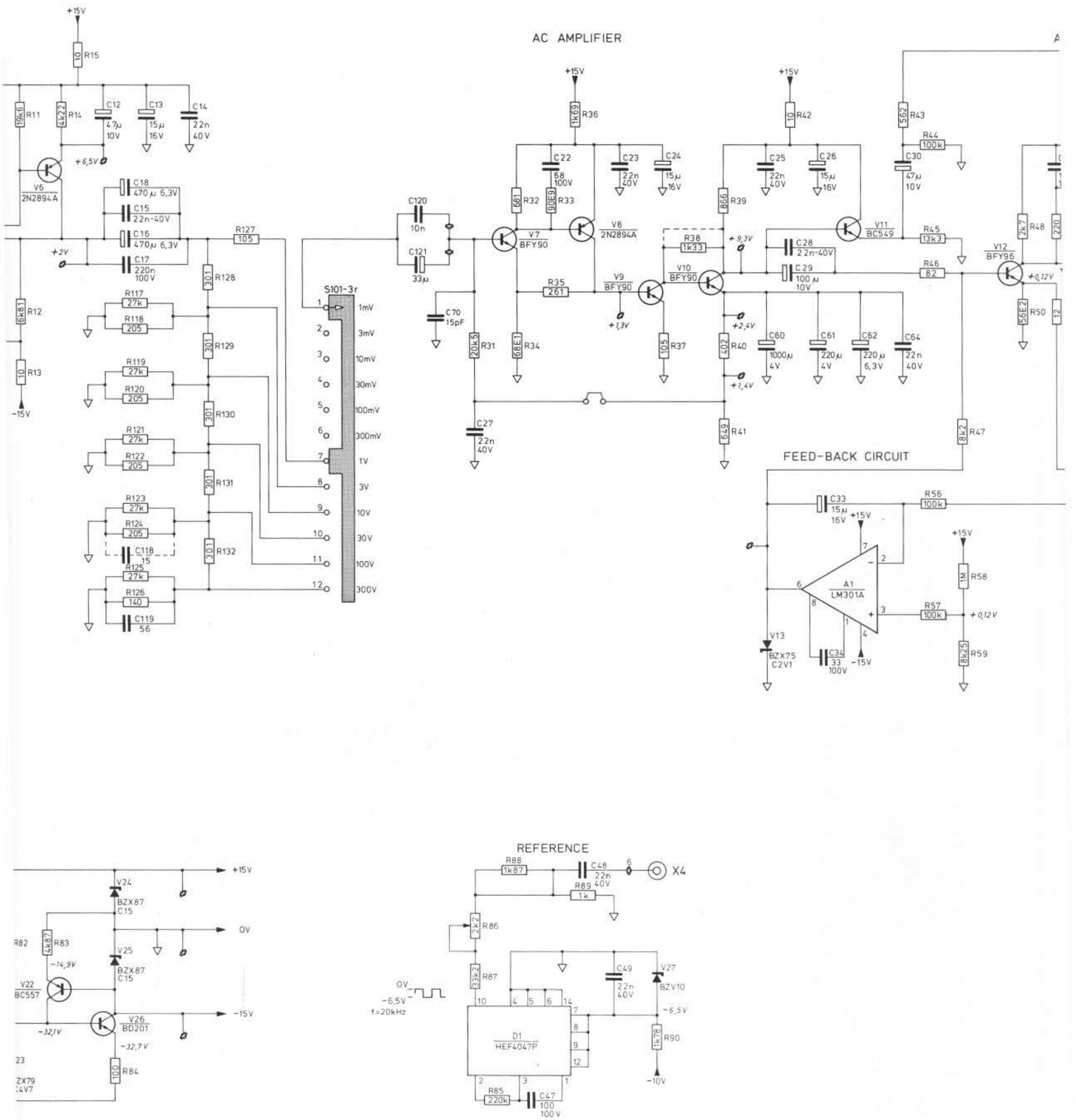


Fig. 19. Printed circuit board U1 Conductor side



INPUT CIRCUIT
IMPEDANCE TRANSFORMER
SUPPLY
MAINS
TO X5
+15V
-15V
+6,5V
+2V
X1
C1 1µ
S101-f
S101-1r
S101-2r
R105 100
R106 100
R1 1M
C4 6p8
C5 5p6
C2 3p9
C3 6
C6 3
R3 9k53
R2 1k1
R4 4k7
C50 330 100V
C51 330 100V
C52 330 100V
C53 330 100V
C54 330 100V
C55 330 100V
C56 330 100V
R15 10
R9 1M
R11 19k6
R14 4k22
C12 47µ 10V
C13 15µ 16V
C7 22n 40V
V1 BZX79 C4V7
V2 BAW62
V5 BFW11
V6 2N2894A
R7 100k
C8 4n7-630V
V4 BAW62
R8 1M
C9 22n 40V
V3 BZX79 C4V7
R10 1M
R12 6k81
R13 10
C10 15µ 16V
C11 22n 40V
C18 470µ 6,3V
C15 22n-40V
C16 470µ 6,3V
C17 220n 100V
R117 27k
R118 205
R119 27k
R120 205
R121 27k
R122 205
R123 27k
R124 205
C118 15
R125 27k
R126 140
C119 56
S2
F1
110V / 100mA
220V / 50 mA
T1
S1 110V
S1' 110V
S2 10V~
S3 46V~
V21 BY164
C46 220µ 63V
R82 120k
R83 4k87
V22 BC557
V23 BZX79 C4V7
V24 BZX87 C15
V25 BZX87 C15
V26 BD201
R84 100
-14,9V
-32,1V
-32,7V
36,8V



AC AMPLIFIER
FEED-BACK CIRCUIT
REFERENCE
+15V
-15V
0V
-10V
R15 10
R11 19k6
R14 4k22
C12 47μ 10V
C13 15μ 16V
C14 22n 40V
+6,5V
V6 2N2894A
C18 470μ 6,3V
C15 22n-40V
C16 470μ 6,3V
C17 220n 100V
+2V
R127 105
R12 6k81
R13 10
R117 27k
R118 205
R128 301
R119 27k
R120 205
R129 301
R121 27k
R122 205
R130 301
R123 27k
R124 205
C118 15
R131 301
R125 27k
R126 140
C119 56
R132 301
S101-3r
1mV
3mV
10mV
30mV
100mV
300mV
1V
3V
10V
30V
100V
300V
C120 10n
C121 33μ
C70 15pF
R31 20k5
C27 22n 40V
R36 1k69
C22 68 100V
R32 681
R33 90E9
V7 BFY90
V8 2N2894A
C23 22n 40V
C24 15μ 16V
R35 261
R34 68E1
V9 BFY90
+1,3V
R37 105
R42 10
C25 22n 40V
C26 15μ 16V
R39 866
R38 1k33
+9,3V
V10 BFY90
C28 22n-40V
C29 100μ 10V
+2,4V
R40 402
+1,4V
R41 649
C60 1000μ 4V
C61 220μ 4V
C62 220μ 6,3V
C64 22n 40V
V11 BC549
R43 562
R44 100k
C30 47μ 10V
R45 13k3
R46 82
R47 8k2
V12 BFY96
+0,12V
R48 2k7
R50 56E2
C33 15μ 16V
R56 100k
A1 LM301A
V13 BZX75 C2V1
C34 33 100V
R57 100k
R58 1M
R59 8k25
+0,12V
V24 BZX87 C15
V25 BZX87 C15
R82
R83 4k87
-14,9V
V22 BC557
-32,1V
V26 BD201
-32,7V
R84 100
R88 1k87
C48 22n 40V
X4
R89 1k
R86 2k2
R87 33k2
0V
-6,5V
f=20kHz
D1 HEF4047P
C49 22n 40V
V27 BZV10
-6,5V
R90 1k78
R85 220k
C47 100 100V

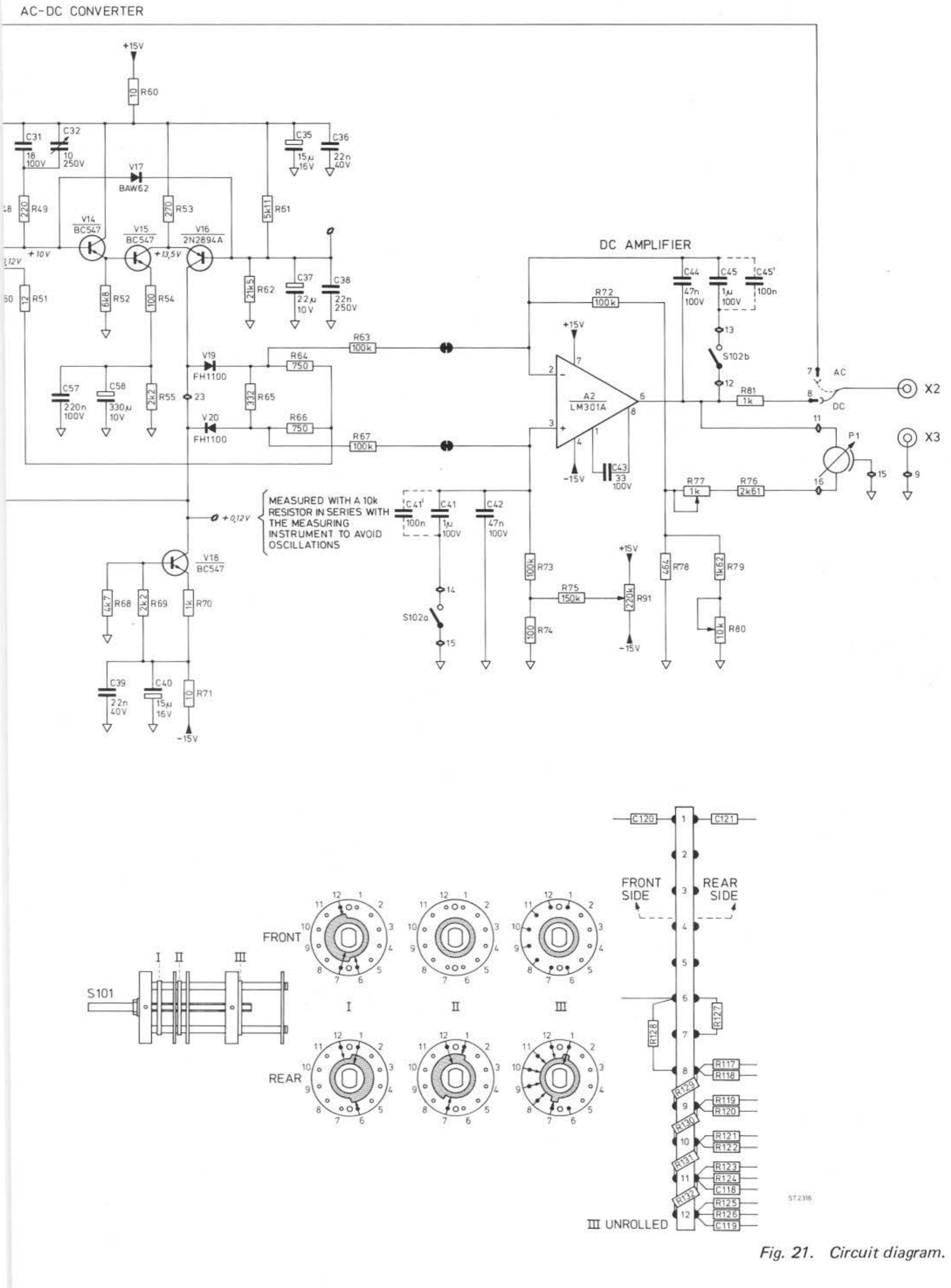


Fig. 21. Circuit diagram.