PHILIPS

Digital multimeter

PM 2423

9447 024 23011

9499 470 06311 730101/1/01

PHILIPS

Manual

Digital multimeter **PM2423**

9447 024 23011

9499 470 06311

730101/1/01

Contents

FIGURES

I. Introduction

The PM 2423 is a digital multimeter with a 3+1 digit display with a maximum reading of 1999.
The instrument can be employed for measuring:

- DC voltages of 1 mV up to 1000 V
- AC voltages of 1 mV up to 350 V_{rms}
- Resistances of 0,1 Ω up to 200 MΩ

The selection of the measuring ranges is effected automatically on the DC and AC voltage ranges and semi-automatically on the resistance range.
The polarity of the DC voltages and the position of the decimal point is indicated automatically.
Range and display hold is possible.
On account of the specifications, accuracy and construction the instrument is an ideal general-purpose multimeter for production lines or laboratories, for servicing as well as for education.

II. Technical data

Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer.
Numerical values without tolerances serve only for information and represent the properties of an average instrument.
The data mentioned below are guaranteed for six months at a temperature of 23 ^{o}C $\pm$10 ^{o}C and humidity below 85 %.

A. MEASURING RANGES

1. Direct voltages

Measuring range	4 ranges: 2 V, 20 V, 200 V and 1000 V end range
Resolution	1 mV on the 2 V range
Input impedance	1 MΩ on the 2 V range 10 MΩ on the 20 V up to the 1000 V range
Accuracy	$\pm$0.1 % of reading $\pm$1 digit
Response time	0,4 sec, without range switching
Maximum permissible voltage	DC 1000 V

2. Alternating voltages

Measuring range	4 ranges: 2 V, 20 V, 200 V and 350 V_{rms} end range
Resolution	1 mV_{rms} on the 2 V range

Input impedance	1 MΩ on all ranges
Frequency range	45 Hz to 20 kHz
Accuracy	±0,3 % of reading ±0,2 % of end range on the 2,20 and 200 V range ±0,5 % of reading ±0,5 % of end range on the 350 V range
Response time	2 secs without range switching
Maximum permissible voltage	AC 350 V_{rms}

3. Resistances

Measuring range	7 ranges: 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ and 200 MΩ end range
Resolution	0,1 Ω on the 200 Ω range
Test voltage	2 V at end range
Test current	

Range	Current
200 Ω	10 mA
2 kΩ	1 mA
20 kΩ	100 μA
200 kΩ	10 μA
2 MΩ	1 μA
20 MΩ	100 nA
200 MΩ	10 nA

Maximum permissible voltage between COM-OHM terminal	100 V DC or AC for 10 seconds
Accuracy	±0,5 % of reading ±1 digit on the 200 Ω up to the 200 kΩ range ±1 % of reading ±1 digit on the 2 MΩ range ±2 % of reading ±1 digit on the 20 MΩ range ±10 % of reading ±1 digit on the 200 MΩ range

B. GENERAL DATA

Operating system	Integrating system
Input terminals	Floating
Maximum display	1999 except on the DC 1000 V and AC 350 V range
Range switching	Automatic for DC and AC Automatic with manual Ω, kΩ and MΩ switching for resistance measurements
Measuring speed	2,5 measurements/sec.
Range switching time	400 msec./range
Common mode rejection	>60 dB at mains frequency
Series mode rejection	40 dB at mains frequency
Overrange indication	By indication (R) and continuous running of the display

Maximum permissible voltages	Between case - COM: 600 V d.c. continuous Between V - COM: 1000 V d.c. continuous 350 V_{rms} continuous Between COM - OHM: 100 V d.c. or a.c. for 10 seconds
Polarity indication	Automatic
Hold	Polarity, display and range holding is possible
Operating temperature range	0 °C to 50 °C
Mains voltage	220 V_{rms} ± 10 % freq. 50/60 Hz
Power consumption	approx. 11 VA

C. MECHANICAL DATA

Dimensions	Width 220 mm Height 75 mm Depth 214 mm
Weight	approximately 2 kg

III. Accessories

- Set of measuring leads
- Fuse 0.1 A, delayed action
- Vinyl cover
- Manual

Optionally available

- HT probe PM 9240

This probe is suitable for measuring direct voltages up to 30 kV.
Maximum measuring error: approximately 15 % (in conjunction with PM 2423) in the 2 V range, approximately 6 % (in conjunction with PM 2423) in all other ranges.
Input resistance: 991 MΩ in the 2 V range
1000 MΩ in all other ranges

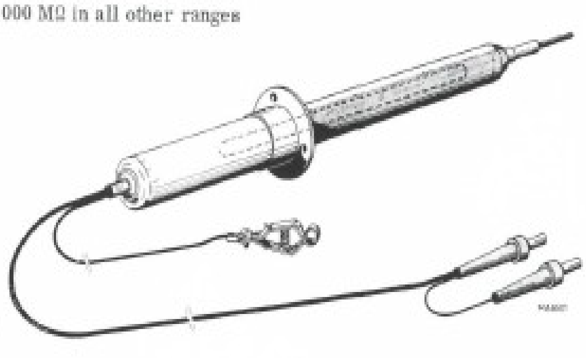


Fig. 1. HT probe PM 9240

IV. Block diagram

A. ANALOG SECTION

The analog section converts all input signals into a time, proportional to the relevant input signal which have bees first normalized in a d.c. level of 2 V at end-of-range values by the input circuit. This is effected by the analog-to-digital converter.

1. Input circuit

The input circuit normalizes all input signals into a d.c. level of 2 V at end of range. For the various measuring modes this is achieved as follows:

- DC

  The d.c. voltage supplied to the instrument is amplified by amplifier A1, the gain of which can be varied by reed-relays.
- AC

  The a.c. voltage supplied to the instrument is amplified by the same amplifier A1 after which the output signal is rectified by an a.c. to d.c. converter.
- Resistances

  At resistance measurements a reference voltage (-8.2 V) is supplied to amplifier A1, which has a gain of 1, 0.1 or 0.01, thus dividing the reference voltage. This voltage is supplied to amplifier A3 via a series resistor R_s, the value of which can be varied by relays.

  As the unknown resistor is included in the feedback circuit of amplifier A3, the gain and thus the output voltage of A3 is determined by $\frac{Rx}{Rs}$.

2. Analog-to-digital converter (Fig. 3)

The analog-to-digital converter of the PM 2423 is based on the dual slope principle (voltage-to-time conversion) and has an automatic zero correction.

The sampling time is 400 msecs. and may be divided in:

- up-integration; the d.c. voltage supplied by the input circuit is integrated by an integrator circuit. The up-integration time is a fixed time of 100 msecs.
- down-integration; by supplying a reference voltage to the integrator its output voltage goes to zero level. As soon as the zero level is reached, a zero detecting (ZD) signal is supplied.

  The down-integration time determines which value is indicated.

  The maximum time is 200 msecs. and is achieved at end-of-range values.
- zero correction; a second measurement is made, the input level during the second up-integration being 0 V.

The timing of the system is effected by the digital section.

B. DIGITAL SECTION

1. Control circuit

This circuit controls the ADC and thus determines which voltage is supplied to the integrator. The control signals are derived from the counter, the stop signal and the zero detecting signal.

2. Stop

From the zero detecting signal supplied by the ADC, a stop signal is formed to set the control circuit to a certain position.

3. Memory

The memory signal, supplied at the completion of the down-integration, is used.

- as clock signal for the auto range circuit
- to block the main gate
- to produce the transfer signal
- as clock signal for the overrange display

4. Transfer

At the end of the down-integration the transfer pulse is initiated, so that the counter-information is stored in the memory.

5. Overload

If, in a certain hold range, the indication is higher than 1999 the overload condition is signalled by indication (R) and in that time the information is not memorized.

6. Polarity

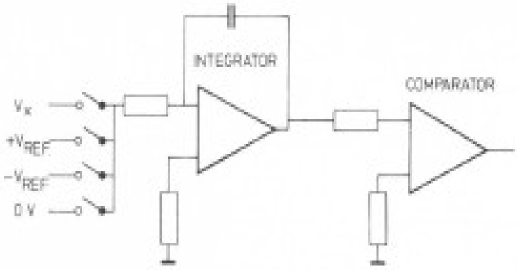
Upon completion of the up-integration the polarity is determined and indicated as soon as a transfer-pulse is supplied.

7. Counter and Memory

The counter counts the clock pulses (10 kHz) with three 10 decade counters. The information is supplied to the indicators via a memory as soon as a transfer pulse is supplied.

8. Auto range

If the indication in a selected range is lower than 180, a more sensitive range is selected; if the indication is higher than 1999 a less sensitive range is selected.



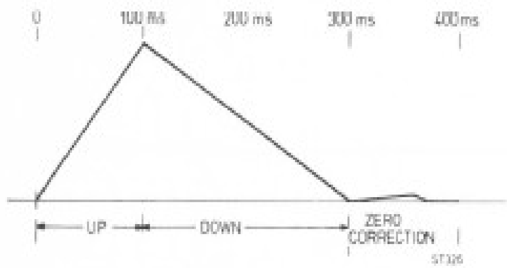


Fig. 3. Principle of the analog-to-digital converter

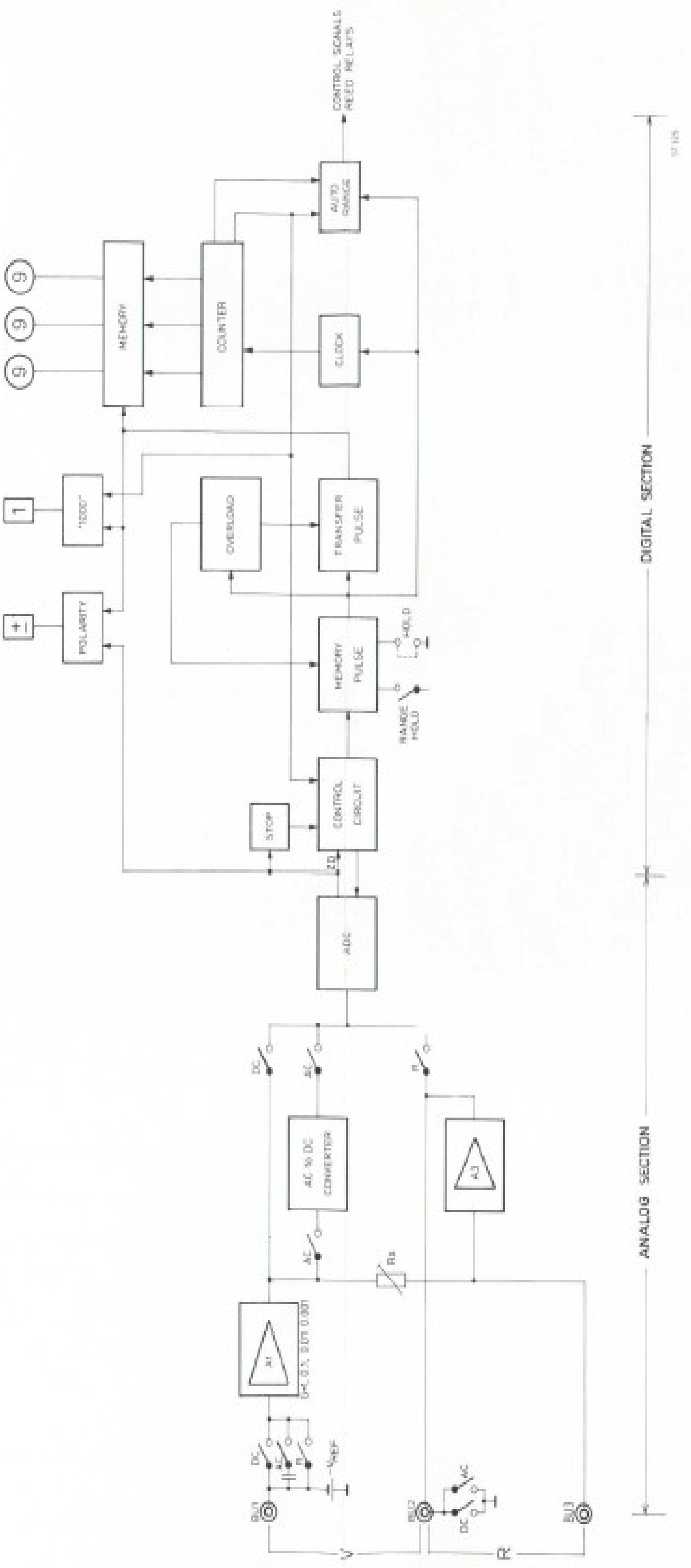


Fig. 2. Block diagram

A. SWITCHING-ON

- The instrument must be connected to a mains socket with rim earthing contacts by means of the 3-core mains lead.
  The housing of the instrument is then earthed via this lead.
- Set the power-switch to the ON-position. Use a mains-voltage of 220 V_{rms} $\pm$10 %, 50/60 Hz.

B. MEASURING

1. Start the measurement by depressing one of the five mode selectors.

DC V	: 1 mV up to 1000 V d.c.
AC V	: 1 mV up to 350 V a.c.
MΩ	: 0.001 MΩ up to 199.9 MΩ
kΩ	: 0.001 kΩ up to 199.9 kΩ
Ω	: 0.1 Ω up to 199.9 Ω

2. Direct voltages

- Depress button DC V.
- Connect the voltage source to be measured to terminals BU1 (red) and BU2 (black).

Notes

- BU1 (red) is "HIGH", BU2 (black) is "LOW"
- Maximum permissible input voltage : 1000 V
- Maximum permissible voltage between terminal BU2 (black) and chassis: 600 V
- The polarity at BU1 (red) with respect to BU2 (black) is indicated at the lefthand side of the figures.
- DC voltages from 1000 V up to 30 kV can be measured with EHT probe PM 9240 (see sub-point 3).

3. EHT voltages up to 30 kV with probe PM 9240

- Depress button DC V
- Connect the probe to the red and blue terminals of the instrument.
- Connect the earthing clip of the probe to a proper earthing point.

Notes

- Maximum permissible d.c. voltage on the probe is 30 kV
- To obtain a correct measurement consult the table below.

Input voltage	Range selected	Input resistance PM 2423 + PM 9240	Attenuation	Position dec. point	To obtain kV multiply with
<2 kV	2 V	991 MΩ	91x	x.xxx	1
>2 kV, <20 kV	20 V	1000 MΩ	100x	x.xx	10
>20 kV, <30 kV	200 V	1000 MΩ	100x	xx.x	100

4. Alternating voltages

- Depress button AC V
- Connect the voltage source to be measured to terminals BU1 (red) and BU2 (black).

Notes

- BU1 (red) is "HIGH", BU2 (black) is "LOW"
- Maximum permissible input voltage: 350 V_{rms}.

5. Resistances

- Depress button Ω, kΩ or MΩ
- Connect the unknown resistance to BU2 (black) and BU3 (blue).

Notes

- Maximum permissible voltage at "R" input 100 V d.c. or a.c. for 10 secs. max.
- Test voltage: 2 V at range end.
- Test current:

Range	Current
200 Ω	10 mA
2 kΩ	1 mA
20 kΩ	100 μA
200 kΩ	10 μA
2 MΩ	1 μA
20 MΩ	100 nA
200 MΩ	10 nA

C. POLARITY INDICATION

When button DC V is depressed to measure direct voltages, the polarity of the input signal is indicated at the lefthand side of the figures. The indicated polarity is present at terminal BU1 (red) with respect to terminal BU2 (black).

D. RANGE HOLD

When button RANGE-HOLD is in its horizontal position, the ranges are selected automatically.
When button RANGE-HOLD is depressed the range selected just before depressing, is memorized.
The position of the decimal point is fixed.

Example

The display is 15.15 V.
When after depressing button RANGE-HOLD the input signal becomes zero, the display is 00.00 V.

E. OVERRANGE INDICATION

Overrange is indicated by Ⓡ and continuous running of the display.

This will occur:

- When, in a fixed range, too a high input signal is applied to the instrument, button RANGE-HOLD being depressed.
  In this case reset button RANGE-HOLD to its horizontal position.

- When the instrument is set to an unsuitable ohm-range.
  In this case select a suitable ohm-range.
- When no resistance is connected to the instrument on the resistance range.

F. HOLD

When the 2-pole connector at the rear of the instrument is shorted, the measured result just before shorting the connector is memorized.
The memorized display-results are maintained even if the input signal is changed.

Example

The display is 15.15 V.
When the input signal becomes zero the display will remain 15.15 V.

Fig. 4. Front view

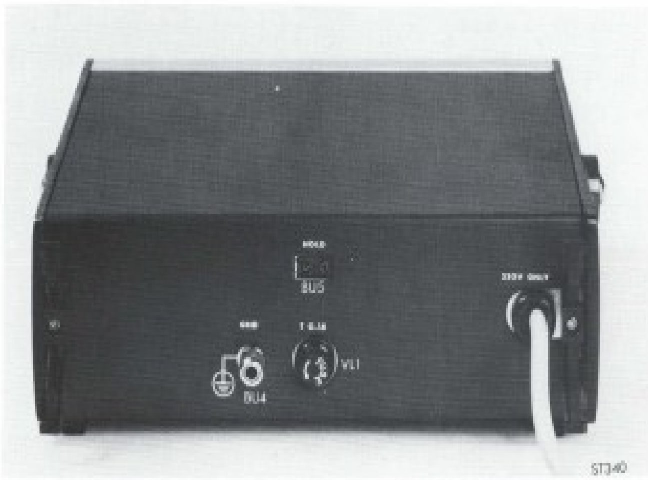


Fig. 5. Rear view

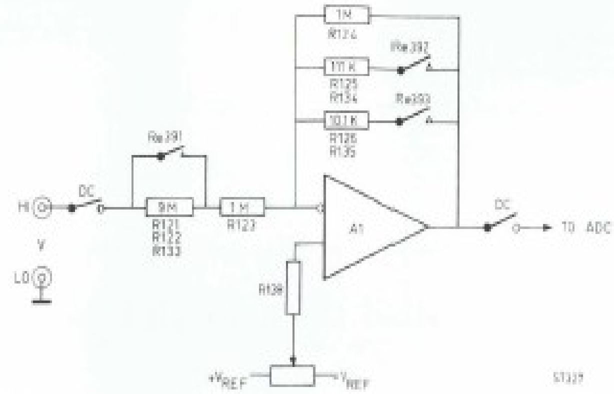


Fig. 6. Direct voltage measuring circuit

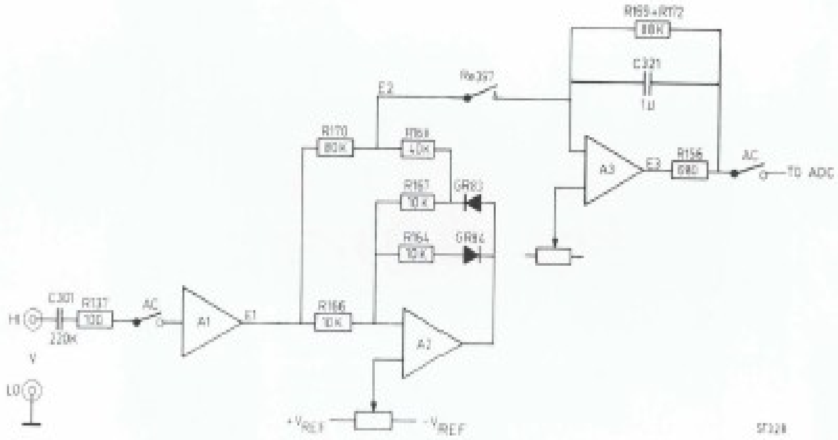


Fig. 7. Alternating voltage measuring circuit

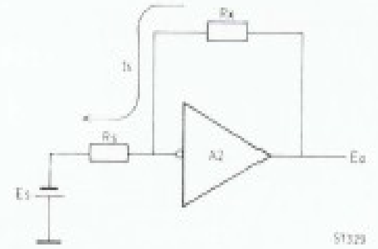


Fig. 8. Principle of resistance measurements

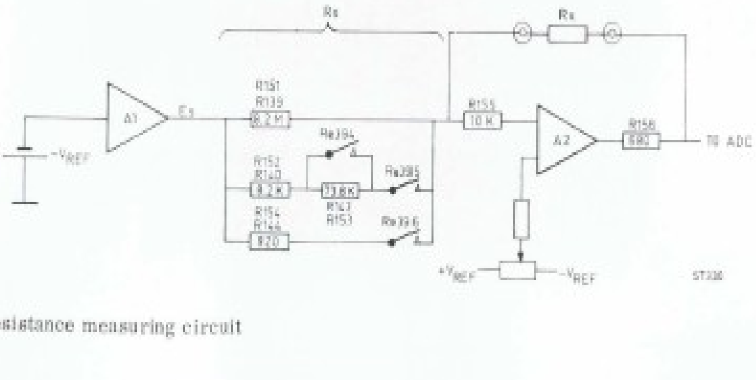


Fig. 9. Resistance measuring circuit

VI. Circuit description

A. ANALOG SECTION

1. Direct voltage measurements (Fig. 6)

At direct voltage measurements, the input voltage is amplified by amplifier A1 to provide 2 V at full scale for all ranges. The obtained direct voltage is supplied to the analog-to-digital converter (ADC) via the push-button switch.

Survey

Range	Reed relay			Gain	Input impedance
	Re391	Re392	Re393		
1.999 V	energized			1	1 MΩ
19.99 V				0.1	10 MΩ
199.9 V		energized		0.01	10 MΩ
1000 V			energized	0.001	10 MΩ

Thus, the amplifier operates as an attenuator. Amplifier A1 consists of a difference amplifier with FET TS31 and an operational amplifier IC1.

2. Alternating voltage measurements (Fig. 7)

The a.c. voltage supplied to the input is applied to amplifier A1 via a d.c. blocking capacitor. The unknown voltage is divided by 1, 10 and 100 by amplifier A1. The output voltage of A1 is applied to the a.c.-to-d.c. converter and rectified by rectifying amplifier A3. The output voltage of amplifier A3 is full-wave rectified by amplifier A2.
In the 350 V range the output voltage of A2 is divided by 10 by blocking TS33.
The obtained direct voltage is supplied to the analog-to-digital converter.

3. Resistance measurements (Fig. 9)

Resistance measurements are based on varying the gain of an inverting amplifier by the unknown resistance as shown in Fig. 8.
Reference voltage $-V_{ref}$ (-8.2 V) is amplified by amplifier A1.
Autoranging is performed by dividing the value of $-V_{ref}$ by 1, 10 and 100 by means of reed-relays Re394, Re395 and Re396.
The gain is determined by $\frac{Rx}{Rs}$.
In the MΩ-range Rs = 8.2 MΩ, in the kΩ range Rs = 820 kΩ and in the Ω range Rs = 820 Ω.
In the 199.9 kΩ range, resistor Rs is changed due to accuracy relationship.
Resistance measuring amplifier A2 consists of TS32 and IC2. In the 200 Ω range the minimum resolution is 0.1 Ω.

Survey

Function	Range	Gain A1	E_s	Reed relay Re394	Re395	Re396	R_s	I_s	E_o
Ω	199.9 Ω	1	8.2 V	-	-	energized	820 Ω	10 mA	1.999 V
kΩ	1.999 kΩ	1	8.2 V	energized	energized	-	8.2 kΩ	1 mA	
	19.99 kΩ	0.1	0.82 V	energized	energized	-	8.2 kΩ	100 μA	
	199.9 kΩ	0.1	0.82 V	energized	-	-	82 kΩ	10 μA	
MΩ	1.999 MΩ	1	8.2 V	-	-	-	8.2 MΩ	1 μA	
	19.99 MΩ	0.1	0.82 V	-	-	-	8.2 MΩ	0.1 μA	
	199.9 MΩ	0.01	82 mV	-	-	-	8.2 MΩ	10 pA	

4. Survey analog section (Fig. 10)

Function	Range	Reed relay Re391	Re392	Re393	Re394	Re395	Re396	Re397	TS33
DC	1.999 V	l.c.							on
	19.99 V								on
	199.9 V		l.c.						on
	1000 V			l.c.					on
AC	1.999 V	l.c.						p.b.	on
	19.99 V	l.c.	l.c.					p.b.	on
	199.9 V	l.c.		l.c.				p.b.	on
	350 V	l.c.		l.c.				p.b.	off
Ω	199.9 Ω	l.c.					p.b.		on
kΩ	1.999 kΩ	l.c.			l.c.	p.b.			on
	19.99 kΩ				l.c.	p.b.			on
	199.9 kΩ					p.b.			on
MΩ	1.999 MΩ	l.c.							on
	19.99 MΩ								on
	199.9 MΩ		l.c.						on

- l.c. means that the corresponding reed-relay is activated by the logic circuit.
- p.b. means that the corresponding reed-relay is activated by the push-button switch.

5. Analog-to-digital converter (Fig. 11)

The d.c. signal delivered by the analog section (2 V at end-of-range) is converted into a "digital" form by means of an analog-to-digital converter.

The conversion system used is conform to the dual slope principle.

The conversion time is 400 msecs. and is divided in three periods as follows (see Fig. 12).

- up-integration from t_0 up to t_1 : 100 msecs.
- down-integration from t_1 up t_2 : 200 msecs. at end-of-range values.
- zero point correction time from t_2 - t_0.

The integrated value at end-of-range value (2 V input) is approximately 10 V.

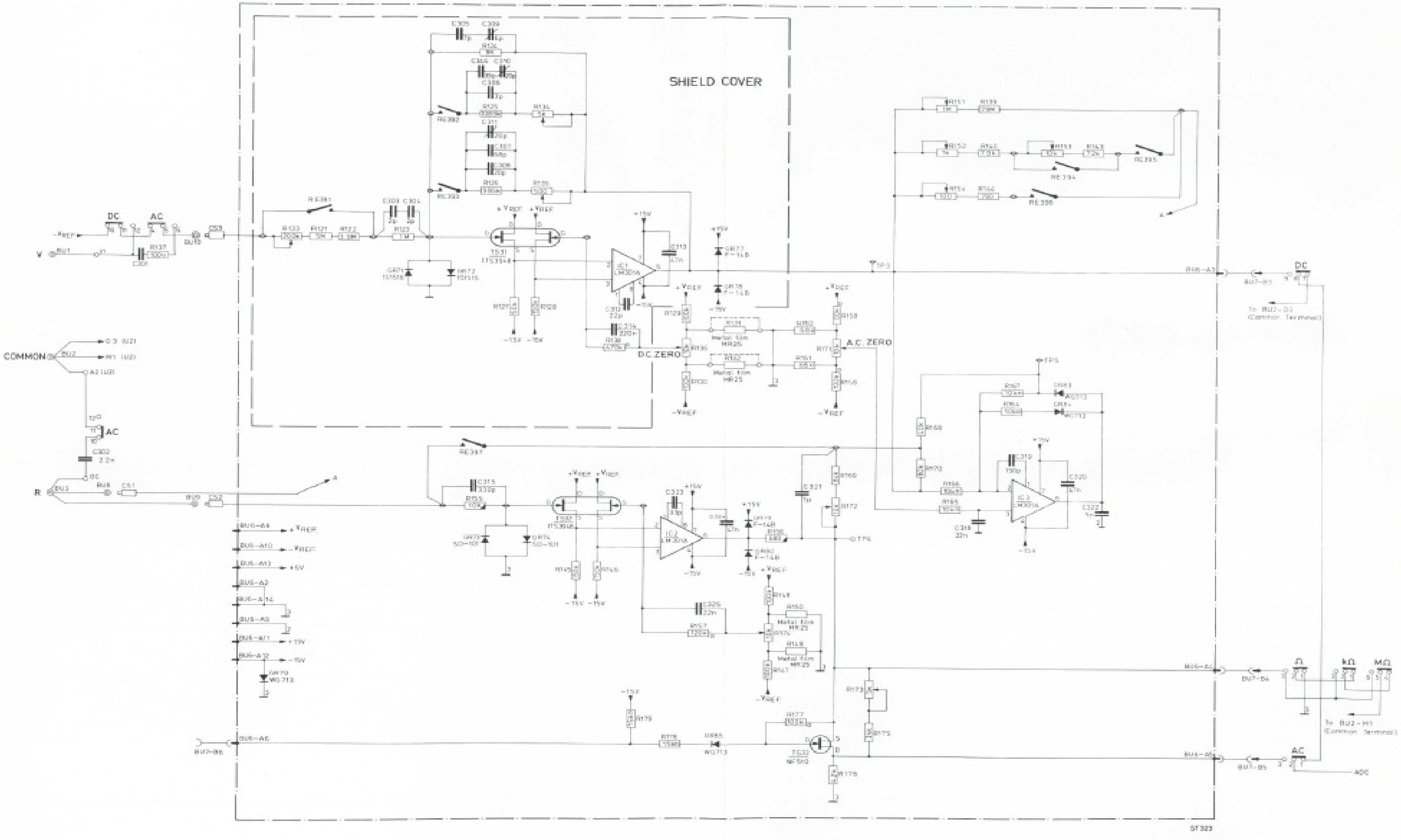


Fig. 10. Diagram input circuit

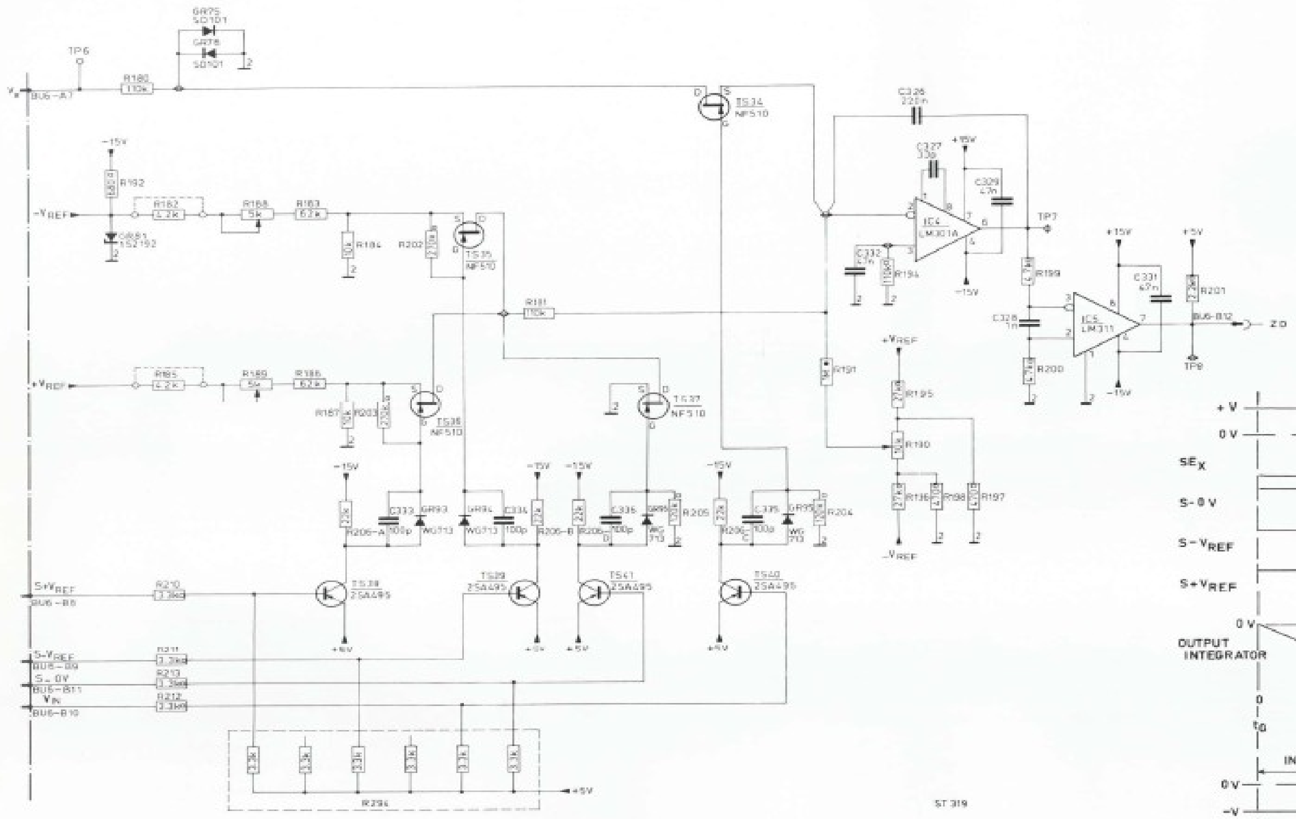


Fig. 11. Analog-to-digital converter

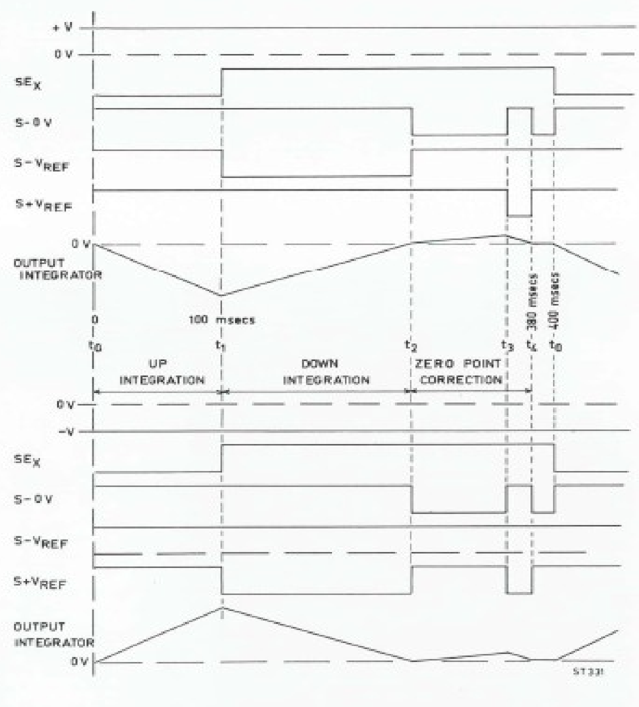


Fig. 12. Sequence diagram ADC

a. Up-integration (t_0 - t_1)

At the start of the up-integration (t_0) TS34 is conductive and the voltage to be measured E_x (2 V at end-of-range) is supplied to the integrator. The FET's TS35, TS36 and TS37 are blocked.
The integrator output voltage decreases linearly with time. The time t_0 up to t_1 (100 msecs.) is determined by counting 1000 clock pulses.

b. Down-integration (t_1 - t_2)

Upon completion of the up-integration (t_1) TS34 is blocked and TS35 or TS36 becomes conductive thus supplying $+V_{ref}$ or $-V_{ref}$ to the integrator.
The down-integration is started.
As the reference voltage is of opposite polarity with respect to the input voltage the integrator output voltage goes to zero level.
The time t_1 to t_2 is 200 msecs. at end-of-range values. The number of clock pulses counted during this time interval are displayed.

c. Zero point correction (t_2 - t_0)

Integrated circuits IC4 and IC5 are drifting.
So the comparator, IC5, does not compare the output voltage of the integrator with the real zero level, unless special measures are taken. To avoid this fault an automatic zero point correction is made by measuring again with respect to zero.
Upon completion of the down-integration (t_2), which is determined at zero passage by a comparator, the zero level is connected to the integrator input via TS37. The drift-voltage is now measured by making an up-integration (t_2 up to t_3) and a down-integration (t_3 up to t_4).
At t_3 (380 msecs. after start) a reference voltage is supplied to the integrator in that way that the integrator output becomes again zero.
This zero level is reached at $t = t_4$.
In this way the zero drift of the integrator and the comparator is corrected automatically.

d. Rest time (t_4 - t_0)

If comparator zero is reached (t_4) the reference voltage is disconnected from the integrator input and TS37 becomes conductive again up to t_0.

The controlling of FET switches TS34 up to TS37, and thus the timing of the conversion system, is effected by signals SE_x, $S{+}V_{REF}$, $S{-}V_{REF}$ and S 0 V, which are formed in the digital section.
The field effect transistors (TS34-TS37) are conductive if their gate is about +5 V and is blocked if the gate is about -15 V.

B. DIGITAL SECTION

1. Integrator input control circuit (Fig. 13)

The integrator input control circuit determines which voltage (E_x, $+V_{REF}$, $-V_{REF}$ or circuit zero) is supplied to the integrator.

The functioning of this circuit can easily be derived from the sequence diagram Fig. 14.

The control circuit is controlled by:

- signal "1000" D, delivered by the counter (see B.7.)
- signal ZD (zero detect) from the analog-to-digital converter (see A.5.)
- signal STOP from the stop-pulse generator (see B.2.).

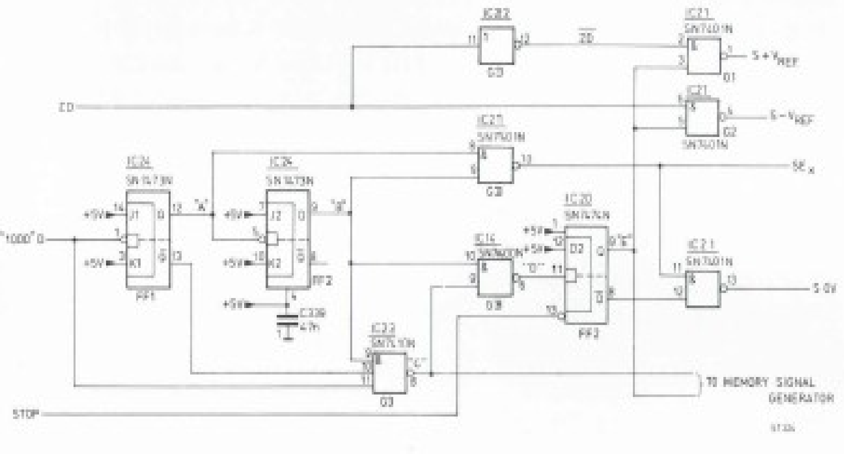


Fig. 13. Integrator input control circuit

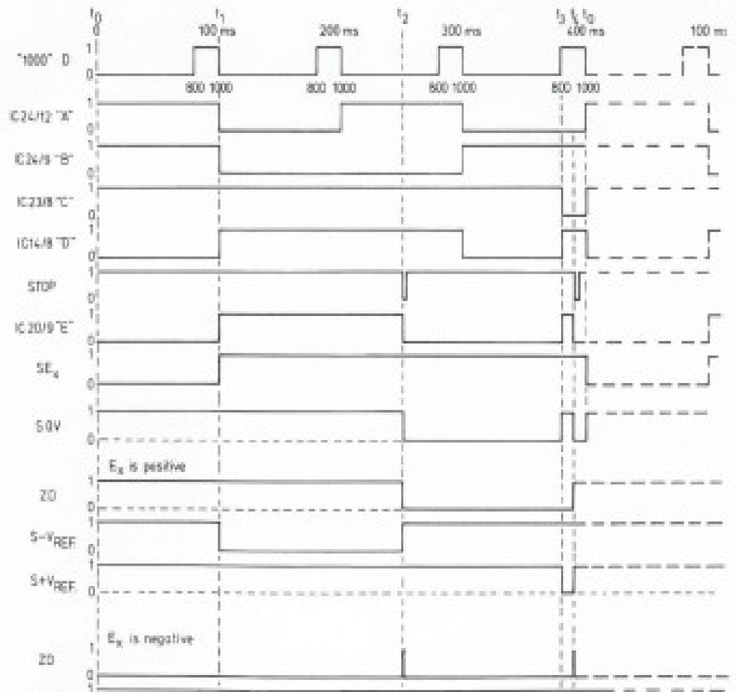


Fig. 14. Sequence diagram

2. Stop signal generator (Fig. 15)

When the output of the integrator passes zero, the comparator supplies a signal 0 V → 5 V or 5 V → 0 V. The signal 0 V → 5 V is fed to the base of TS44 via diode GR100, a signal 5 V → 0 V via diode GR99.
Transistor TS44 becomes conductive for a short period; thus the collector produces a zero level ; the STOP signal.
Signal STOP is produced at $t = t_2$ and $t = t_4$.

3. Memory signal generator

The memory signal is produced via the circuit of Fig. 16 and is formed by signals supplied by the integrator input control circuit (see B.1.).
The memory signal is always logical 1, except at completion of the down-integration (t_2) a short delay of the negative-going edge supplied by IC22/2 ($\overline{F}$) is achieved by capacitor C351.
The memory pulse may be inhibited by interconnecting the 2-pole connector HOLD (BU5) at the rear, so that input IC22/3 is connected to circuit zero and the display is hold.
The memory signal has the following 4 functions
- it is the clock signal for the autorange circuit
- it blocks the main gate
- it produces the transfer signal
- it is the clock signal for the OVER display

4. Transfer pulse and OVER display circuit (Fig. 18)

The transfer pulse and the OVER display are derived from the memory signal.

a. Transfer-pulse

The transfer pulse is logical 0 as long as no memory signal is supplied and no overload condition is signalled (IC20/$\overline{Q}$ is logical 0).
As soon as the memory signal becomes logical 0 at $t = t_2$, the transfer pulse becomes logical 1.
If an overload condition is signalled (IC20/Q becomes logical 1) the transfer-pulse is hold at a logical 1 level via transistor TS46.

b. OVER display

OVER display is performed by not storing the display (the display is running) and by indication Ⓔ .
Overload means that the down-integration time (t_1 up to t_2) is longer than 200 msecs and that the memory signal is supplied after $t_2 \geq 300$ msecs.
This results in a triggering of flip-flop IC20, as input D has become logical 1.
Thus : - Output IC20/Q becomes logical 1.
TS46 is turned on, which results in a continuous logical 1 for the transfer-pulse.
- Output IC20/$\overline{Q}$ becomes logical 0.
TS50 is blocked, so that pilot lamp LA384 lights (OVER indication).

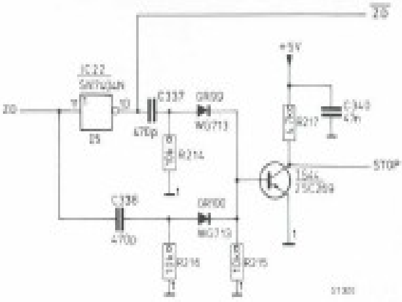


Fig. 15. Stop signal generator

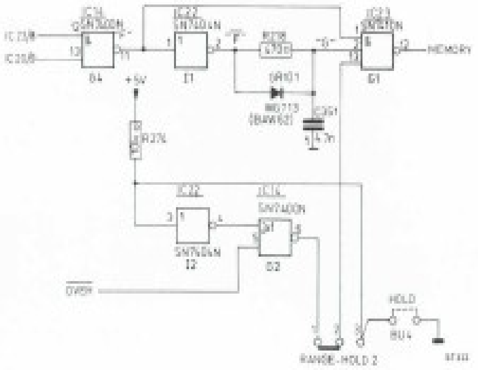


Fig. 16. Memory signal generator

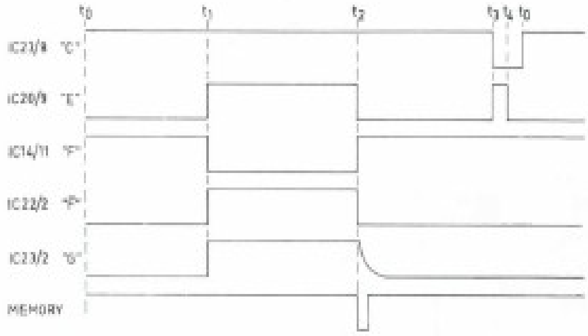


Fig. 17. Sequence diagram memory signal

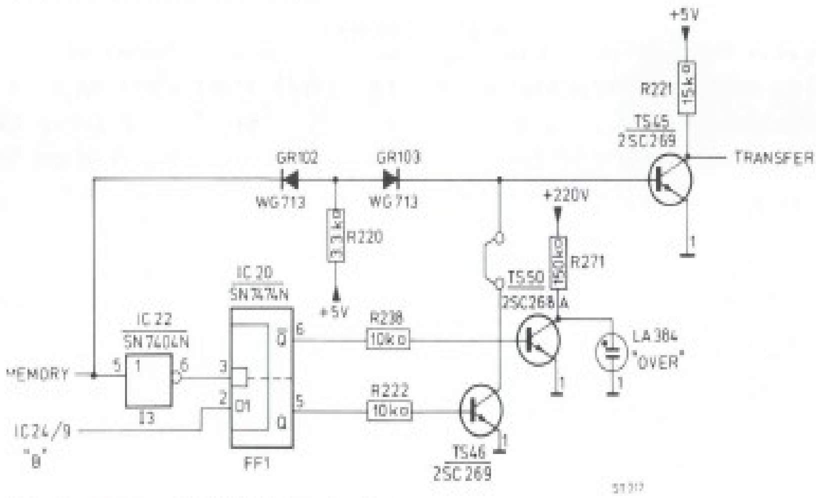


Fig. 18. Transfer pulse and OVER display circuit

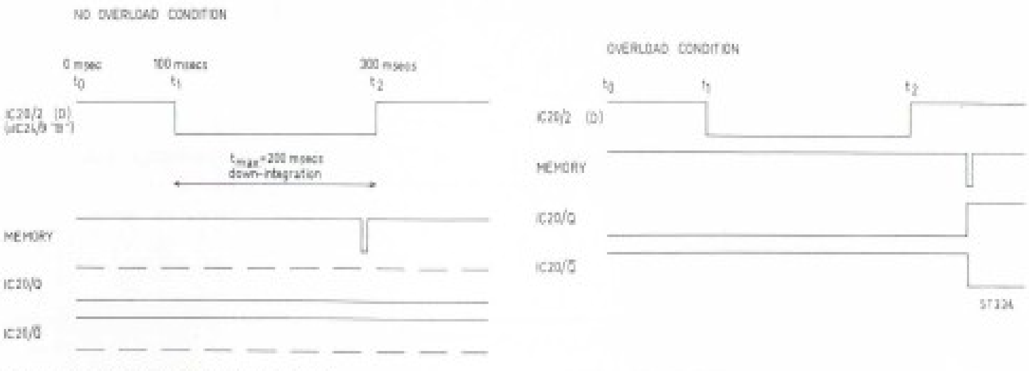


Fig. 19. Sequence diagram overload

5. Polarity indication

The polarity indication is determined by the circuit of Fig. 20.
It is memorized by flip-flop IC13/A upon completion of the up-integration by $\overline{SE}_X$ and shifted into flip-flop IC13/B by the transfer signal.

Survey polarity indication

Polarity of input signal	$\overline{ZD}$	IC13/A/8 after $\overline{SE}_X$ transistion	IC13/B/15 after transfer signal	IC13/B/14 after transfer signal	TS48	TS49	
positive	1	0	0	1	blocked	on	LA382 lights (+ indication)
negative	0	1	1	0	on	blocked	LA383 lights (- indication)

The polarity indication is only operating in the case of DC voltage measurements. If button DC is not depressed the bases of TS48 and TS49 are kept at a positive level via R223 and R224.

6. Clock oscillator

The clock oscillator is an astable multivibrator with a frequency of 10 kHz, which can be adjusted by means of potentiometer R232.

7. Display

The counter consists of three decade counters IC15 ... IC17 for the units, tens and hundreds. The clock pulses are applied to the counter input via main-gate IC23, which can be blocked by applying a logical 0 at inputs 4 and 5.
The thousand figure is indicated by pilot lamp LA381 which is controlled in accordance with Fig. 21.
From output IC16/11 and IC17/1+12 signals are taken to control the automatic range selector and from output IC17/11 a signal to control the integrator input control circuit.
Storing of the information takes place in three Quadruple bistable latches (IC9...IC11). During the transfer pulse the information at the outputs of the decade counters is transferred to the latches.
The measured value is memorized until a new transfer pulse is supplied.

The output signals of the memory (IC9...IC11), which are available in 1-2-4-8 code are decoded by decoder/drivers IC6...IC8, thus converting the measured value into a decimal information which is indicated by indicators B371...B373.

8. Autorange circuit

Fig. 22 represents a simplified block diagram of the autorange circuit.

a. Up-down counter

The up-down counter consists of two J-K flip-flops (IC26).
If signal "UP" or signal "DOWN" is logical 1, the outputs of both flip-flops will change state when a clock signal is applied to the clock terminal.

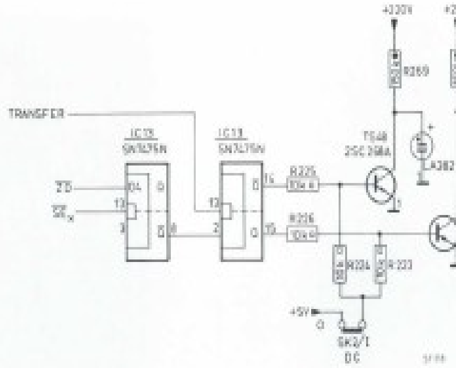


Fig. 20. Polarity indication circuit

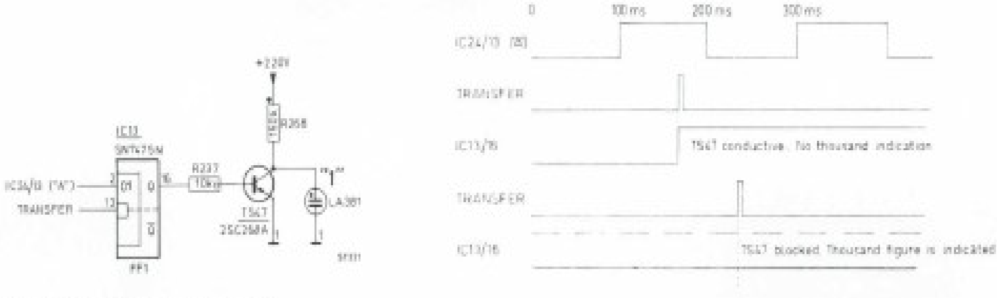


Fig. 21. Thousands indication

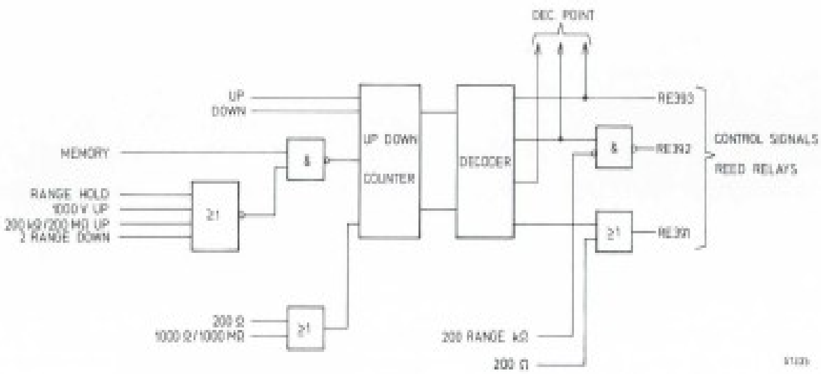


Fig. 22. Block diagram autorange circuit

Truth table up-down counter

Range	Output IC26			
	-/12	-/13	-/9	-/8
2	0	1	1	0
20	1	0	1	0
200	0	1	0	1
1000	1	0	0	1

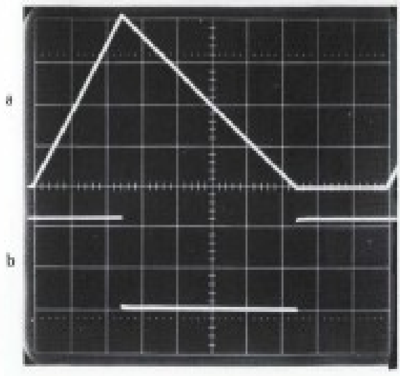


Fig. 23. Up signal ST350A

Oscilloscope settings

Time base: 20 msec/cm, calibrated at 40 msec/cm
Amplitude: 2 V/cm

a. Integrator output (TP7)
b. UP pulse (IC18/4)

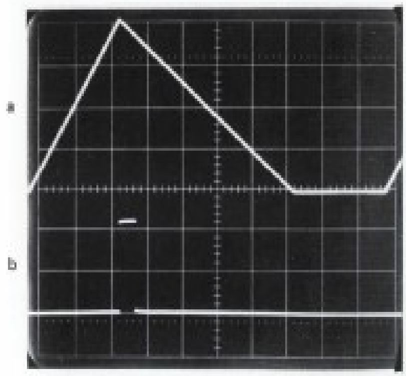


Fig. 24. Down signal ST350B

Oscilloscope settings

Time base: 20 msec/cm, calibrated at 40 msec/cm
Amplitude: 2 V/cm

a. Integrator output (TP7)
b. DOWN pulse (IC18/2)

b. UP signal

The "UP" signal is derived from the counter via flip-flops IC19/FF1 and -/FF2 and corresponds with the inverted signal "B". (Fig. 14).

c. DOWN signal (Fig. 15)

The down signal is produced from output "D" of the 10^1 decade counter, output "A" of the 10^2 decade counter and the inverted signal "B" of Fig. 14.
The "DOWN" signal is only logical 1 to counter position 0000 - 0180 (thus 18 msecs) during down-integration (t_1 = 100 msec.)

d. Inhibit of UP or DOWN ranging

If the autorange circuit is set to the highest or lowest possible range of a certain measuring mode, the up-down counter is not able to select a higher or a lower range.
Inhibiting "UP" or "DOWN" ranging is effected by making the clock input of the counter logical 0 via Nand gates IC19/G1, IC27/G1, IC27/G3 or by depressing button RANGE HOLD. The memory signal is then blocked and no range switching is effected.
The next inhibits are performed:

- RANGE HOLD: by depressing button RANGE HOLD the collector of TS55 becomes logical 0.
- Range 1000 UP (1000 V d.c. or 350 V a.c.): Nand-gate IC27/G1 supplies a logical 0.
- Range 200 kΩ and range 200 MΩ UP: Nand-gate IC27/G3 supplies a logical 0.
- Range 2 DOWN: Nand-gate IC19/G1 supplies a logical 0.

e. Fixed range

If button Ω is depressed the reset inputs of both flip-flops IC26/FF1 and -/FF2 are logical 0.
Both flip-flops are reset, thus the outputs are set to the lowest range.

If now ranges 1000 kΩ or 1000 MΩ are selected both flip-flops are reset via Nand-gate IC29/G1 and the 200 kΩ or 200 MΩ range is set.

f. Decoder

The outputs of the up-down counter are decoded into signals to drive the reed-relays in the input circuit of the analog section.
Furthermore, the control signals for the decimal point are provided by the decoder.

C. POWER SUPPLY

The power supply provides the voltages for the analog and digital sections. The voltages are:

+15 V and -15 V for the amplifier circuits

+5 V for the digital section

The +15 V, -15 V and +5 V are stabilized; the 220 V is a non-stabilized supply voltage.

The reference voltage $+V_{REF}$ is derived from the +15 V circuit.

VII. Gaining access to and replacing of parts

USE A WELL-FITTING CROSS-HEADED SCREW-DRIVER TO DEMOUNT THE INSTRUMENT TO PREVENT DAMAGING THE CROSS-SLOTTED SCREWS.

A. REMOVING THE CABINET

- Remove both screws "A" (Fig. 33)
- Slide the cabinet from the unit

B. PRINTED WIRING BOARDS

1. Analog section U1

- Remove both screws "B" (Fig. 34)
- Remove the screening cap
- Unplug CS1 and CS2
- Slide board U1 out of connector BU6
- Remove board U1.

2. Digital section U2

- Remove board U1
- Unsolder the wires at the wiring side of the printed wiring board of U1
- Remove both screws "C" (Fig. 35)
- Remove both screws "D" (Fig. 35)
- Slide printed wiring board U2 out of connector BU7.

C. SEMICONDUCTORS

1. Integrated circuits IC1 and IC2 (ordering number 5322 209 84214) are selected integrated circuits, type LM301A.
   This IC has been selected following the specifications mentioned below (see Fig. 25).
   - Temperature coefficient of input offset voltage <± 5 μV/°C.
   - Output voltage at 0 °C, +30 °C and +60 °C should be ± 300 mV maximum and <500 μV/°C.
2. Integrated circuit IC3 (ordering number 5322 209 84215) is a selected integrated circuit, type LM301A.
   This IC has been selected following the specifications mentioned below (see Fig. 25).
   - Output voltage should be ± 300 mV maximum and <1 mV/°C.
3. Integrated circuit IC4 (ordering number 5322 209 84216) is a selected integrated circuit, type LM301A.
   This IC has been selected following the specifications mentioned below (see Fig. 26).
   - Temperature coefficient of output voltage <± 100 μV/°C.
   - Output voltage at 0 °C, +30 °C and +60 °C should be ± 30 mV maximum and <± 100 μV/°C.
4. Diodes GR71 and GR72 (ordering number 5322 130 34175), type IS1516, are lackered black to avoid light effects.

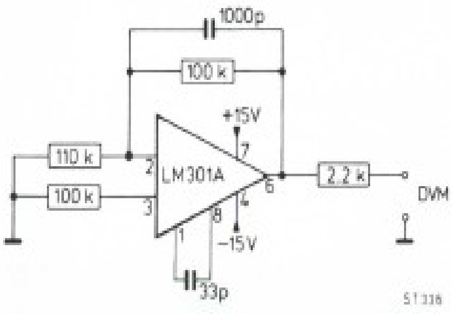


Fig. 25. Circuit for selection of IC1, IC2 and IC3

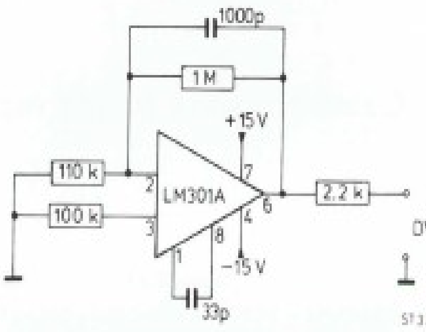


Fig. 26. Circuit for selection of IC4

VIII. Maintenance and service

Digital multimeter PM 2423 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.

Service hints

If service work is to be carried out the following points should be taken into account to avoid damage to 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 solder.
- The IC-circuits are especially sensitive to negative potentials, which will damage the IC.
- For all soldering work on the printed circuit boards use a miniature soldering iron (35 W max.) with a tin-cleaner or a vacuum soldering iron.

In the next table the most important voltages at the test points are given.
General conditions:

- nominal mains voltage (220 V, 50 Hz)
- calibrated
- voltages with respect to circuit zero (black terminal), unless otherwise stated
- the data given represent the properties of an average instrument and may serve as a guide only.
- voltages are measured with digital multimeter PM 2422.
- oscillograms are made with oscilloscope PM 3250.

Test point	Fig.	Function	Condition	Value	Remark
G1	28	Circuit zero of the digital section (⊥ [1])		0 V	G1, G2 and G3 are inter-connected
G2	27	Circuit zero of the analog-to-digital converter (⊥ [2])		0 V	
G3	27	Circuit zero of the analog input circuit (⊥ [3])		0 V	
+220 V	28	Supply voltage indicators		+208 V	
+15 V	27, 28	Supply voltage amplifiers		+14,45 V	
-15 V	27, 28	Supply voltage amplifiers		-14,4 V	
+5 V	27, 28	Supply voltage integrated circuits		+5.15 V	
$+V_{REF}$	28	Reference voltage ADC		+8,61 V	

Test point	Fig.	Function	Condition	Value	Remarks
TP3	27	Output amplifier A1	- Button DC V depressed and supply respectively to input		
			1 V d.c.	-1 V d.c.	
			10 V d.c.		
			100 V d.c.		
			1000 V d.c.		
			- Button AC V depressed and supply respectively to input		
			1 V a.c.	1 V a.c.	see also oscillogram Fig. 29.I.a.
			10 V a.c.		
			100 V a.c.		
			220 V a.c.	2.2 V a.c.	
			- Button MΩ depressed and connect respectively to R input		
			1 MΩ	+870 mV	
			10 MΩ	+870 mV	
			100 MΩ	+88.5 mV	
			- Button kΩ depressed and connect respectively to R input		
			1 kΩ	+8.86 V	
			10 kΩ	+870 mV	
			100 kΩ	+870 mV	
			- Button Ω depressed and connect 100 Ω to R input	+8.86 V	
TP4	27	Output amplifier A2	- Button AC V depressed and supply respectively to input		
			1 V a.c.	-0.83 V d.c.	
			10 V a.c.		
			100 V a.c.		
			220 V a.c.	-2.04 V d.c.	
			- Button MΩ depressed and connect respectively to R input		
			1 MΩ	-1 V d.c.	
			10 MΩ		
			100 MΩ		

Test point	Fig.	Function	Condition	Value	Remark
			- Button kΩ depressed and connect respectively to R input 1 kΩ 10 kΩ 100 kΩ	-1 V d.c.	
			- Button Ω depressed and connect 100 Ω to R input	-1 V d.c.	
TP5	27	Output amplifier A3 (a.c.-to-d.c. converter)	- Button AC V depressed and supply respectively to input 1 V 10 V 100 V	+0.456 V d.c.	see also oscillogram Fig. 29.I.b.
			220 V	+0.98 V d.c.	
TP6	27	Input analog-to-digital converter	- Button DC V depressed and supply respectively to input 1 V d.c. 10 V d.c. 100 V d.c. 1000 V d.c.	-0.83 V	
			- Button AC V depressed and supply respectively to input 1 V a.c. 10 V a.c. 100 V a.c.	-1 V	
			220 V a.c.	-0.22 V	
			- Button MΩ depressed and connect respectively to R input 1 MΩ 10 MΩ 100 MΩ	-1 V	
			- Button kΩ depressed and connect respectively to R input 1 kΩ 10 kΩ 100 kΩ	-1 V	
			- Button Ω depressed and 100 Ω connected to R input	-1 V	

Test point	Fig.	Function	Condition	Value	Remark
TP7	27	Integrator output	+1 V supplied to the input (+ at BU1)		see oscillo-gram Fig. 29.II.a.
			-1 V supplied to the input (+ at BU2)		see oscillo-gram Fig. 29.III.a.
TP8	27	Output comparator (signal ZD)	+1 V supplied to the input (+ at BU1)		see oscillogram Fig. 29.II.b.
			-1 V supplied to the input (+ at BU2)		see oscillogram Fig. 29.III.b.
TP10	28	Control signal "E" of the input control circuit	-1.999 V d.c. supplied to the input (+ at BU2)		see oscillo-gram Fig. 29.IV.b.
TP11	28	Memory signal			see oscillo-gram Fig. 29.V. and VIII.a.
TP12	28	Output clock oscillator			see oscilla-gram Fig. 29.VI.
collector TS43	28	Clock oscillator			see oscillo-gram Fig. 29.VII.
collector TS45	28	Transfer pulse			see oscillo-gram Fig. 29.VIII.b.
IC21/1	28	Control signal S+V_{REF}	at end-of-range values		see oscillo-gram Fig. 29.IX.
IC21/10	28	Control signal SE_x	at end-of-range values		see oscillo-gram Fig. 29.X.
IC21/13	28	S 0 V	at end-of-range values		see oscillo-gram Fig. 29.XI.
IC24/12	28	Control signal			see oscillo-gram Fig. 29.XII.

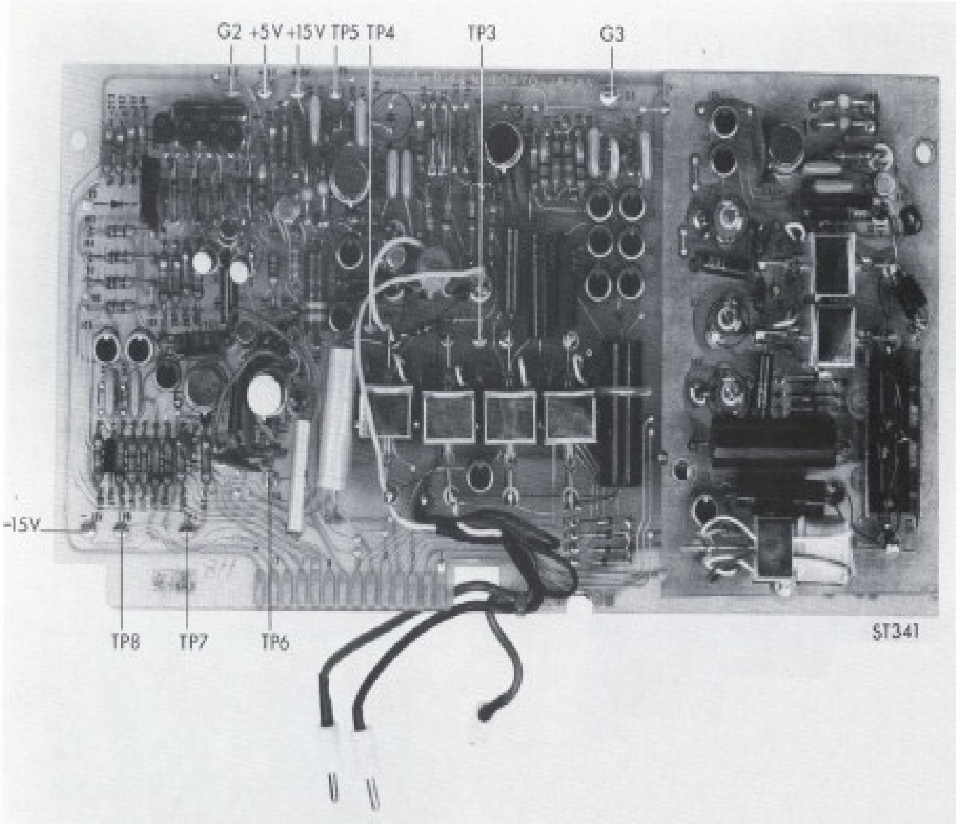


Fig. 27. Test points on unit U1

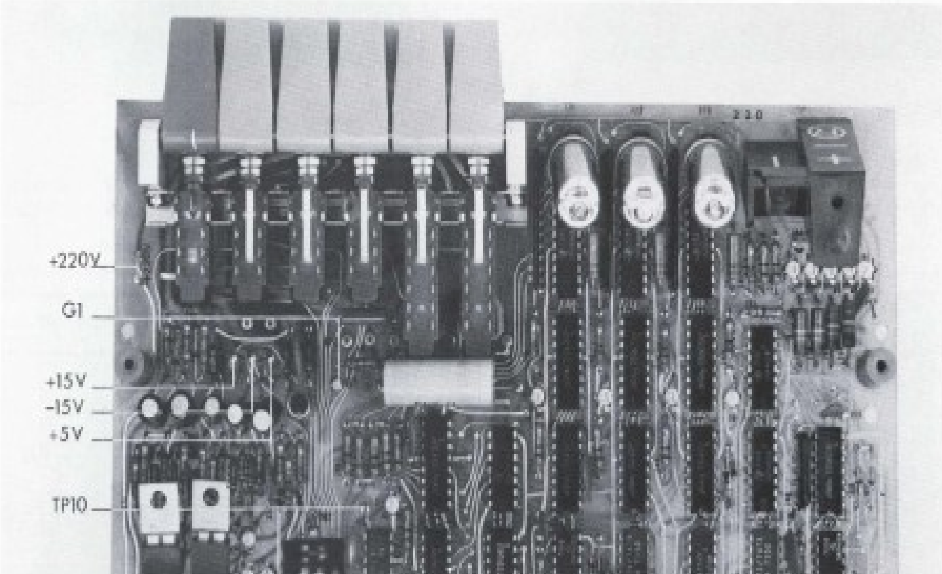


Fig. 28. Test points on unit U2

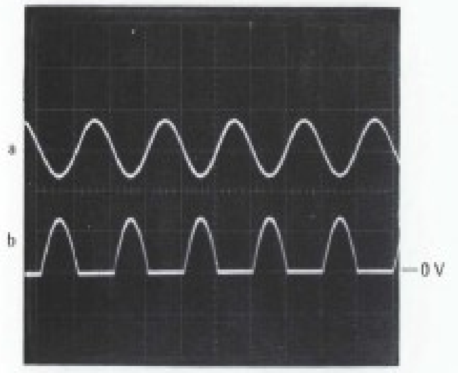


Fig. 29.Ia+b ST351A

<u>Oscilloscope settings</u>

Time base: 20 msec/cm.
calibrated at 40 msec/cm
Amplitude: 1 V/cm

<u>Input voltage</u>

Amplitude: 1 V_{rms}
Frequence: 1 kHz

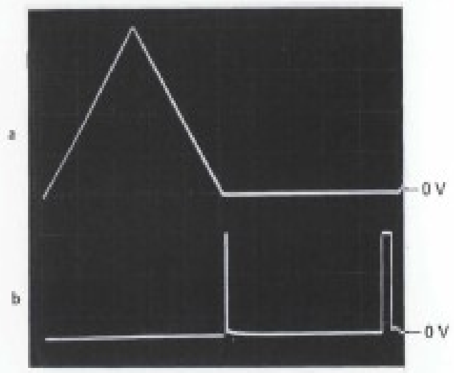


Fig. 29.IIa+b ST351B

<u>Oscilloscope settings</u>

Time base: 0.5 msec/cm
Amplitude: 2 V/cm for
signal a. 1V/cm for signal b.

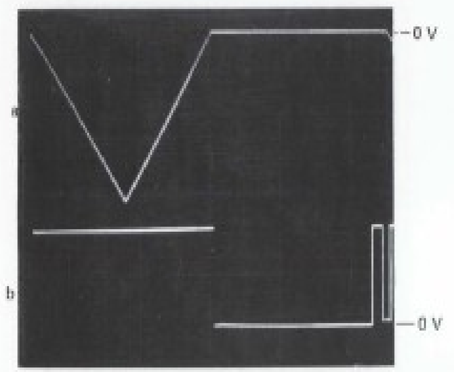


Fig. 29.IIIa+b ST352A

<u>Oscilloscope settings</u>

Time base: 20 msec/cm.
calibrated at 40 msec/cm
Amplitude: 1 V/cm

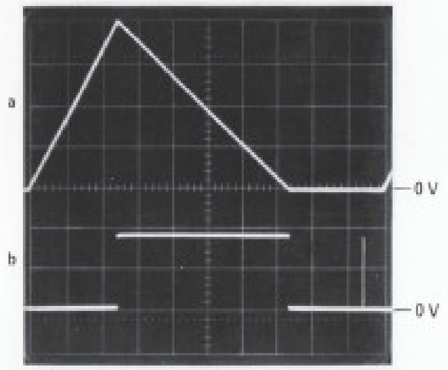


Fig. 29.IVa+b ST352B

<u>Oscilloscope settings</u>

Time base: 20 msec/cm.
calibrated at 40 msec/cm
Amplitude: 2 V/cm

<u>Remark</u>

Signal a is the integrator
output signal available at
TP7.

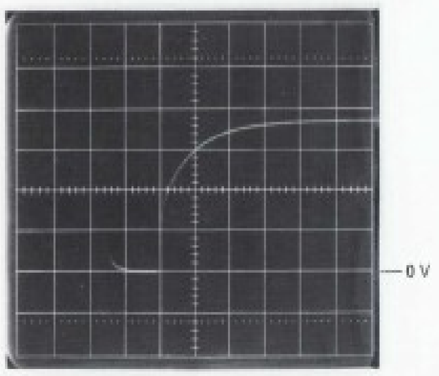


Fig. 29.V. ST353A

<u>Oscilloscope settings</u>

Time base: 2 μsec/cm.
calibrated at 4 μsec/cm
Amplitude: 1 V/cm

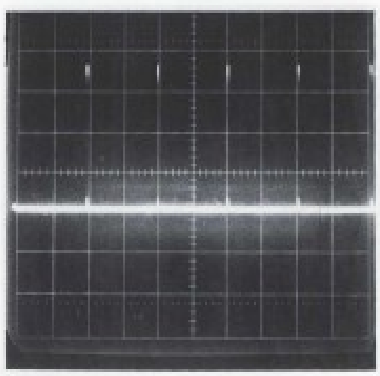


Fig. 29.VI. ST353B

<u>Oscilloscope settings</u>

Time base: 50 μsec/cm
Amplitude: 1 V/cm

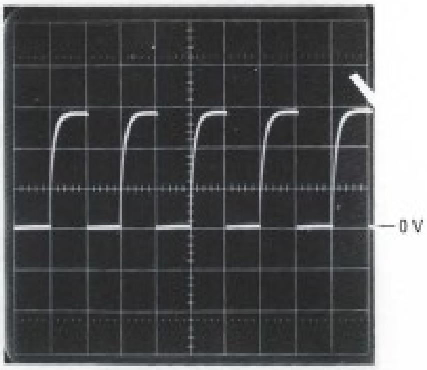


Fig. 29.VII. ST354A

Oscilloscope settings

Time base: 50 µsec/cm
Amplitude: 5 V/cm

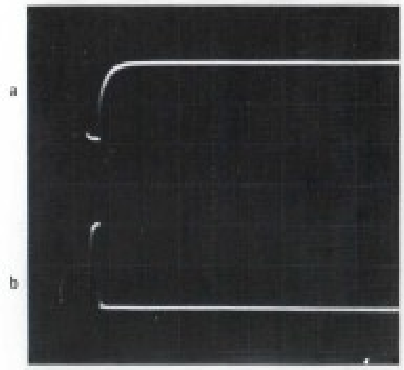


Fig. 29.VIII. ST354B

Oscilloscope settings

Time base: 10 µsec/cm
Amplitude: 2 V/cm

a. Memory signal
b. Transfer signal

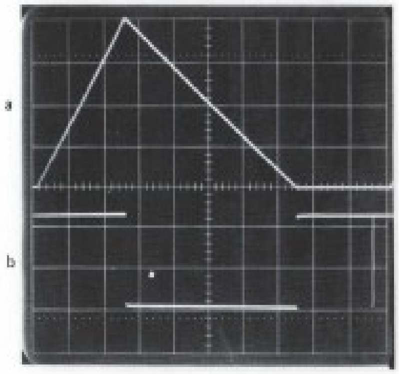


Fig. 29.IX. ST355A

Oscilloscope settings

Time base: 20 msec/cm.
calibrated at 40 msec/cm
Amplitude: 2 V/cm

a. Integrator output (TP7)
b. $S + V_{REF}$

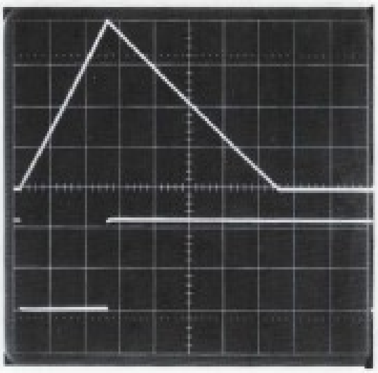


Fig. 29.X. ST355B

Oscilloscope settings

Time base: 20 msec/cm.
calibrated at 40 msec/cm
Amplitude: 2 V/cm

a. Integrator output (TP7)
b. SE_X

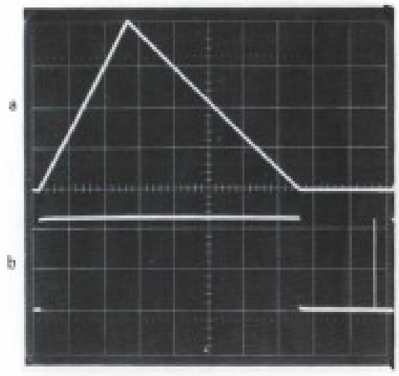


Fig. 29.XI. ST356A

Oscilloscope settings

Time Base: 20 msec/cm
calibrated at 40 msec/cm
Amplitude: 2 V/cm

a. Integrator output (TP7)
b. S 0 V

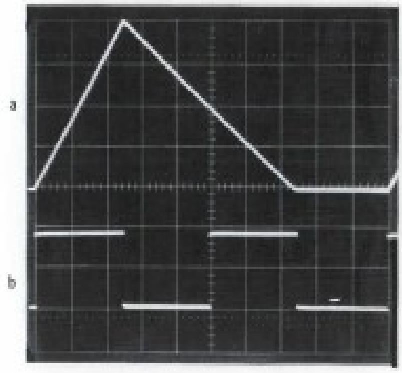


Fig. 29.XII. ST356B

Oscilloscope settings

Time base: 20 msec/cm
calibrated at 40 msec/cm
Amplitude: 2 V/cm

a. Integrator output (TP7)
b. Signal at IC24/12

IX. Survey of adjustments

The next table gives a survey of the adjustments of multimeter PM 2423.
For a complete adjustment adhere to the sequence of chapter X.

Control element	Fig.	Checking or adjusting point	According to chapter
		Supply voltages	X.A
		+15 V, -15 V, +220 V	
R291	-	+5 V	
R232	30	Clock oscillator frequency	X.B
		Zero point settings	X.C
R136	30	DC zero	
R171	30	AC zero	
R174	30	Ω zero	
R190	30	Digital zero	
		DC ranges	X.D
R189	30	+1,999 V range	
R188	30	-1.999 V range	
R133	30	±19.99 V range	
R134	30	±199.9 V range	
R135	30	±1000 V range	
		AC ranges	X.E
R172	30	1,999 V range, 400 Hz	
R173	30	350 V range, 400 Hz	
C309	30	1,999 V range, 20 kHz	
C310	30	19.99 V range, 20 kHz	
C311	30	199.9 V range, 20 kHz	
		Resistance ranges	X.F
R151	30	1,999 MΩ range	
R152	30	1,999 kΩ range	
R153	30	19,99 kΩ range	
R154	30	199.9 Ω range	

Required test equipment

To calibrate this measuring instrument only reference voltages and measuring equipment with the required accuracy should be applied.
The test equipment and standards required for checking, adjusting or calibration are listed in the next table.

Test	Required performance		Recommended equipment
Zero point setting	Sensitivity 160 μV		DC Voltmeter e.g. PM 2434 or PM 2435
DC Calibration	Accuracy : at least ± 0,03 % Range : 1 V up to 1000 V		DC Standard e.g. Fluke 332A
AC Calibration	Accuracy : at least ± 0,1 % Voltage : 1 V up to 350 V_{rms} Frequency : 40 Hz up to 20 kHz		AC Standard e.g. Hewlett Packard HP742A
	Resistance	Accuracy	
	19 Ω	at least 1.0 %	Standard series resistors
	[illegible]	at least 0.1 %	(e.g. metal film 0.1 %)
Resistanc[illegible]	[illegible]	at least 0.1 %	or
calibratic[illegible]	[illegible]	at least 0.1 %	Guildline type 9330
	190 kΩ	at least 0.1 %	
	1.9 MΩ	at least 0.2 %	
	19 MΩ	at least 0.5 %	

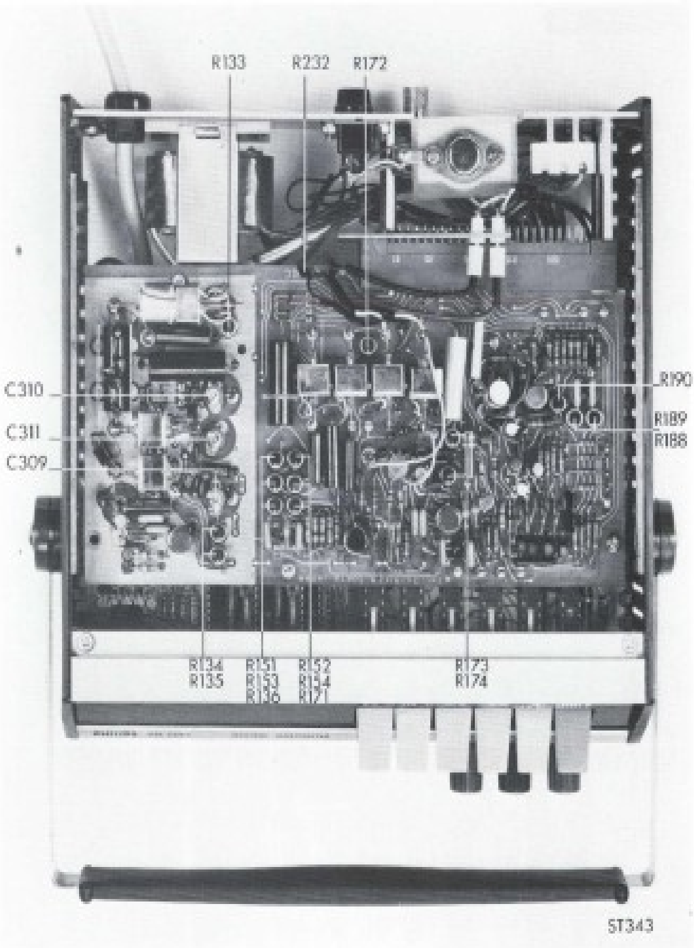


Fig. 30. Indications of adjusting elements

X. Checking and adjusting

The tolerances stated in this chapter correspond to the factory data, which only apply to a newly adjusted instrument.
A survey of the adjustments and adjusting elements is given in chapter IX.
When individual components, especially semi-conductors, are replaced, the relevant section should be completely readjusted.
Perform calibration after a warm-up time of approximately 20 minutes.

A. SUPPLY

1. Current consumption

   The current consumption from the mains should be about 75 mA.

2. +15 V supply

   The output voltage of the +15 V supply source should be +15 V ± 10 %.
   Measuring points : jumper +15 V on board U2 (+) and BU2 (0 V; black terminal).

3. -15 V supply

   The output voltage of the -15 V supply source should be -15 V ± 10 %.
   Measuring points : jumper -15 V on board U2 (-) and BU2 (0 V; black terminal).

4. $+V_{REF}$ supply

   The reference voltage $+V_{REF}$ should be 8.61 V ± 5 %.
   Measuring points : jumper +REF on board U2 (+) and BU2 (0 V; black terminal).

5. +220 V supply

   The output voltage of the +220 V supply source should be +220 V ± 10 %.
   Measuring points : jumper +220 V on board U2 (+) and BU2 (0 V; black terminal).

6. +5 V supply

   The output voltage of the +5 V supply source should be +5 V ± 0.1 V.
   If necessary, adjust with potentiometer R291.
   Measuring points : jumper +5 V on board U2 (+) and BU2 (0 V; black terminal).

B. CLOCK OSCILLATOR FREQUENCY

The output frequency of the clock oscillator should be 10 kHz ± 3 Hz.
If necessary, readjust with potentiometer R232.
Measuring points : TP12 and BU2 (0 V).

C. ZERO POINT SETTINGS

1. DC zero

   - Depress button DC V (SK2/1).
   - Connect a d.c. voltmeter to test points TP6 and G2.
   - The indication on the d.c. voltmeter should be 0 ± 100 µV.
   - If necessary, adjust with potentiometer R136.

2. AC zero

- Depress button AC V (SK2/II).
- Connect a d.c. voltmeter to test points TP6 and G2.
- Short circuit terminals BU1 and BU2.
- The indication on the d.c. voltmeter should be 0 ± 100 μV.
- If necessary, adjust with potentiometer R171.

3. Ω-Zero

- Depress button Ω (SK2/V).
- Connect a d.c. voltmeter to test points TP6 and G2.
- Short-circuit terminals BU2 and BU3.
- The indication on the d.c. voltmeter should be 0 ± 100 μV.
- If necessary, adjust with potentiometer R174.

4. Digital zero

- Depress button DC V (SK2/I).
- Short-circuit terminals BU1 and BU2.
- The display should show .000.
- If necessary, adjust with potentiometer R190.

D. DC RANGES

- Depress button DC V (SK2/I).
- Adjust the d.c. ranges in accordance with the next calibration table.

Supply to BU1 - BU2	Adjust to	Adjust with	Polarity display
+1,900 V ± 0,01 %	1,900	R189	+
-1,900 V ± 0,01 %	1,900	R188	-
+19,00 V ± 0,01 %	19,00	R133	+
-19,00 V ± 0,01 %	19,00	-	-
+190,0 V ± 0,01 %	190,0	R134	+
-190,0 V ± 0,01 %	190,0	-	-
+1000 V ± 0,01 %	1000	R135	+
-1000 V ± 0,01 %	1000	-	-

E. AC RANGES

- Depress button AC V (SK2/II).
- Adjust the a.c. ranges in accordance with the next calibration table

Supply to BU1 - BU2	Adjust with	Adjust to
1,900 V ± 0,05 %, 400 Hz	R172	1,900
350 V ± 0,05 %, 400 Hz	R173	350
1,900 V ± 0,05 %, 20 kHz	C309	1,900
19,00 V ± 0,05 %, 20 kHz	C310	19,00
190,0 V ± 0,05 %, 20 kHz	C311	190,0

F. RESISTANCE RANGES

Adjust the resistance ranges in accordance with the next calibration table

Depress button	Connect to R input	Adjust with	Adjust to
MΩ	1,8 MΩ ± 0,1 %	R151	1,800
kΩ	1,8 kΩ ± 0,05 %	R152	1,800
kΩ	180 kΩ ± 0,05 %	R153	180,0
Ω	180 Ω ± 0,05 %	R154	180,0

Remarks

- When calibrating in the MΩ-ranges pay carefully attention to induction voltages.
- When calibrating in the Ω-range the resistance of the measuring cable (typical 0,2 Ω) should be added.

G. CHECKING THE DC RANGES

- Depress button DC V (SK2/I).
- Check the DC ranges in accordance with the table below.

Supply to V input terminals BU1 (+) and BU2 (-)	Display
Input short-circuited	0,000 + or - 1 digit
+ 10 mV	0,010 + or - 1 digit
+ 100 mV	0,100 + or - 1 digit
+ 1 V	1,000 + or - 2 digits
+ 1,9 V	1,900 + or - 3 digits
+ 19 V	19,00 + or - 3 digits
+ 190 V	190,0 + or - 3 digits
+1000 V	1000 + or - 2 digits

H. CHECKING THE AC RANGES

- Depress button AC V (SK2/II).
- Check the DC ranges in accordance with the table below.

Supply to V input terminals BU1 and BU2		Display
Input short-circuited		0,000 + 5 digits
1 V	400 Hz	1,000 + 6 digits - 8 digits
1,9 V	400 Hz	1,900 + 11 digits - 11 digits
1,9 V	20 kHz	1,900 + 11 digits - 11 digits
19 V	400 Hz	19,00 + 11 digits - 11 digits
19 V	20 kHz	19,00 + 11 digits - 11 digits
190 V	400 Hz	190,0 + 11 digits - 11 digits
190 V	20 kHz	190,0 + 11 digits - 11 digits
350 V	400 Hz	350 + 3 digits - 3 digits

J. CHECKING THE RESISTANCE RANGES

Check the resistance ranges in accordance with the table below

Button depressed	Connect to input	Display
Ω	input	0.000 ± 1 digit
kΩ	short	0.000 ± 1 digit
MΩ	circuited	0.000 ± 1 digit
Ω	19 Ω	019.0 ± 2 digits *
	190 Ω	190.0 ± 11 digits *
kΩ	1.9 kΩ	1.900 ± 11 digits
	19 kΩ	19.00 ± 11 digits
	190 kΩ	190.0 ± 11 digits
MΩ	1.9 MΩ	1.900 ± 20 digits
	19 MΩ	19.00 ± 39 digits

* Observe the resistance value of the measuring cable (about 0.2 Ω).

K. CHECKING THE AUTOMATIC RANGE SELECTION

- Depress button DC V.
- Supply to terminals BU1 and BU2 a variable d.c. voltage (0 up to 1000 V).
- Check the range selection in accordance with Fig. 31.

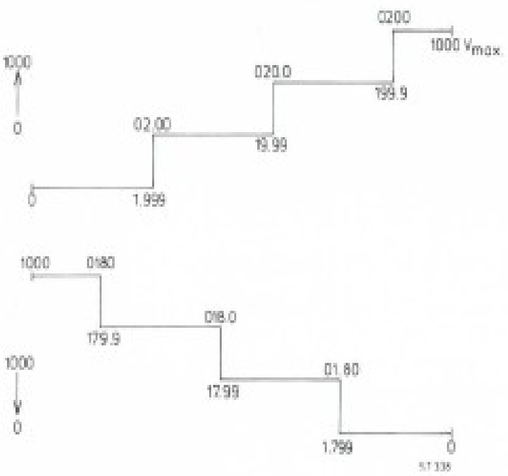


Fig. 31. Checking the automatic range selector

L. CHECKING RANGE HOLD

When button RANGE HOLD is depressed the automatic range selector remains in the range set just before depressing button RANGE HOLD, no matter the magnitude of the input signal.

M. CHECKING HOLD

When terminal HOLD at the rear is short-circuited the indication is hold also if the input value is changed.

XI. List of parts

A. MECHANICAL

Item	Fig.	Qty	Ordering number	Description
1	32	1	5322 456 14009	Filter plate
2	32	2	5322 528 34089	Fixed part
3	32	2	5322 528 34091	Movable part
4	32	2	5322 492 64345	Wave spring
5	32	2	5322 462 44132	Cover
6	32	2	5322 325 84326	Shaft
7	32	1	5322 414 24847	Knob
8	32	5	5322 414 24848	Knob
9	32	1	5322	Terminal BU3 (blue)
10	32	1	5322	Terminal BU2 (black)
11	32	1	5322	Terminal BU1 (red)
12	32	1	5322 456 14008	Dressing panel
13	32	1	5322 277 14055	Switch SK1
14	33	1	5322 290 40065	Earthing terminal BU4
15	33	1	5322 267 34021	Connector BU5
16	33	1	5322 256 40017	Fuse holder VL1
17	33	1	5322 325 54029	Cable grommet
18	33	1	5322 321 10071	Mains cable
19	33	2	5322 462 54073	Stand
20	34	3	5322 267 64018	Socket BU8...BU10
21	34+35	2	5322 268 24018	2x22-pole connector BU6, BU7
22	34	4	5322	Switch SK2/III... -/VI
23	34	2	5322 276 14082	Switch SK2/I and -/II
24	-	4	5322 462 54072	Foot

Fig. 32. Front view with item numbers

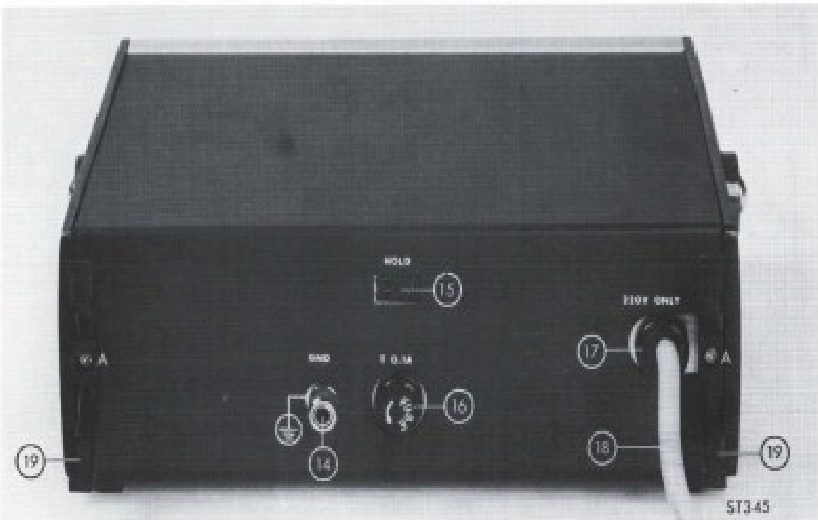


Fig. 33. Rear view with item numbers

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 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 > 2,2 MΩ	5% 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 > 1 MΩ	5% 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 > 5 ≤ 10 MΩ > 10 MΩ	1% 2% 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 ≤ 1,5 MΩ > 1,5 MΩ	5% 10%
Wire-wound resistor Drahtwiderstand Draadgewonden weerstand Résistance bobinée Resistencia bobinada	5,5 W ≤ 200 Ω > 200 Ω	10% 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.

Resistors

No.	Ordering number	Value		%	Watt	Description
R121	5322 116 54298	5	MΩ	0.5	1	Metal film
R122	5322 116 54299	3.9	MΩ	0.5	1	Metal film
R123	5322 116 54301	1	MΩ	0.1	1	Metal film
R124	5322 116 54301	1	MΩ	0.5	1	Metal film
R125	5322 116 54302	108.6	kΩ	0.5	0.25	Metal film
R126	5322 116 54303	9.85	kΩ	0.5	0.25	Metal film
R127	5322 116 50113	150	kΩ	5	0.25	Metal film
R128	5322 116 50113	150	kΩ	5	0.25	Metal film
R129	5322 116 54155	100	kΩ	5	0.25	Metal film
R130	5322 116 54155	100	kΩ	5	0.25	Metal film
R133	5322 101 14035	200	kΩ			Potentiometer
R134	5322 101 14036	5	kΩ			Potentiometer
R135	5322 101 14037	500	Ω			Potentiometer
R136	5322 101 14038	10	kΩ			Potentiometer
R139	5322 116 54304	7.9	MΩ	1	1	Metal film
R140	5322 116 54305	7.9	kΩ	1	0.25	Metal film
R143	5322 116 54306	72	kΩ	1	0.25	Metal film
R144	5322 116 54307	790	Ω	1	0.5	Metal film
R145	5322 116 50113	150	kΩ	5	0.25	Metal film
R146	5322 116 50113	150	kΩ	5	0.25	Metal film
R147	5322 116 54155	100	kΩ	5	0.25	Metal film
R148	5322 116 54155	100	kΩ	5	0.25	Metal film
R151	5322 101 14039	1	MΩ			Potentiometer
R152	5322 101 14041	1	kΩ			Potentiometer
R153	5322 101 14038	10	kΩ			Potentiometer
R154	5322 100 10138	100	Ω			Potentiometer
R166	5322 116 50748	10	kΩ	1	0.1	Metal film
R167	5322 116 50748	10	kΩ	1	0.1	Metal film
R168	5322 116 54308	40	kΩ	1	0.1	Metal film
R169	5322 116 54309	84	kΩ	1	0.1	Metal film
R170	5322 116 54311	80	kΩ	1	0.1	Metal film
R171	5322 101 14038	10	kΩ			Potentiometer
R172	5322 101 14038	10	kΩ			Potentiometer
R173	5322 101 14036	5	kΩ			Potentiometer
R174	5322 101 14038	10	kΩ			Potentiometer
R175	5322 116 54196	34	kΩ	1	0.1	Metal film
R176	5322 116 54312	4.2	kΩ	1	0.1	Metal film
R180	5322 116 50198	110	kΩ	1	0.125	Metal film
R181	5322 116 50198	110	kΩ		0.125	Metal film
R182	5322 116 50729	4.2	kΩ	5	0.25	Metal film
R183	5322 116 54313	62	kΩ	1	0.1	Metal film
R184	5322 116 50748	10	kΩ	1	0.1	Metal film
R185	5322 116 50729	4.2	kΩ	5	0.25	Metal film
R186	5322 116 54313	62	kΩ	1	0.1	Metal film
R187	5322 116 50748	10	kΩ	1	0.1	Metal film

No.	Ordering number	Value	%	Watt	Description
R188	5322 101 14036	5 kΩ			Potentiometer
R189	5322 101 14036	5 kΩ			Potentiometer
R190	5322 101 14038	10 kΩ			Potentiometer
R227	5322 116 50117	4,7 kΩ	1	0,25	Metal film
R228	5322 116 50117	4,7 kΩ	1	0,25	Metal film
R229	5322 116 50649	68 kΩ	1	0,25	Metal film
R230	5322 116 50649	68 kΩ	1	0,25	Metal film
R232	5322 101 14042	20 kΩ			Potentiometer
R234	5322 209 84221	10x100 kΩ			Composition
R235	5322 209 84221	10x100 kΩ			Composition
R236	5322 209 84221	10x100 kΩ			Composition
R248	5322 209 84222	5x3,3 kΩ			Composition
R249	5322 209 84222	5x3,3 kΩ			Composition
R276	5322 116 50117	4,7 kΩ	1	0,25	Metal film
R277	5322 116 54314	5,9 kΩ	1	0,25	Metal film
R283	5322 116 50936	18 kΩ	1	0,25	Metal film
R284	5322 116 54202	7,5 kΩ	1	0,25	Metal film
R287	5322 116 50117	4,7 kΩ	1	0,25	Metal film
R288	5322 116 50657	6,8 kΩ	1	0,25	Metal film
R290	5322 116 54202	7,5 kΩ	1	0,25	Metal film
R291	5322 101 14041	1 kΩ			Potentiometer
R292	5322 116 50657	6,8 kΩ	1	0,25	Metal film
R294	5322 209 84222	5x3,3 kΩ			Composition

Capacitors

No.	Ordering number	Value	%	V	Description
C1	5322 122 34019	10 nF		500	Ceramic
C2	5322 122 34019	10 nF		500	Ceramic
C301	4822 121 40226	220 nF		600	Polyester
C302	5322 121 44106	2,2 nF		100	Mylar
C303	5322 123 34008	2 pF	10	500	Mica
C304	5322 123 34008	2 pF	10	500	Mica
C305	5322 123 34009	7 pF	10	300	Mica
C306	5322 123 34011	15 pF	10	300	Mica
C307	5322 123 34012	130 pF	10	300	Mica
C308	5322 123 34013	68 pF	10	300	Mica
C309	5322 125 54004	6 pF			Trimmer
C310	5322 125 54005	20 pF			Trimmer
C311	5322 125 54005	20 pF			Trimmer
C312	4822 122 40007	22 pF	10		Ceramic
C313	5322 122 34021	47 nF			Ceramic
C314	5322 122 30103	22 nF			Ceramic
C315	4822 122 30055	330 pF	10		Ceramic
C316	4822 124 20575	100 μF		16	Electrolytic

No.	Ordering number	Value	%	Watt	Description
C318	5322 122 30103	22 nF			Ceramic
C319	5322 122 30002	150 pF	10		Ceramic
C320	5322 122 34021	47 nF			Ceramic
C321	5322 121 40013	1 µF	10	200	Polyester
C322	5322 122 30003	3 pF	10		Ceramic
C323	5322 122 30016	33 pF	10		Ceramic
C324	5322 122 34021	47 nF			Ceramic
C325	5322 122 30103	22 nF			Ceramic
C326	5322 121 40061	220 nF	10	200	Polyester
C327	5322 122 30016	33 pF	10		Ceramic
C328	5322 122 30027	1 nF			Ceramic
C329	5322 122 34021	47 nF			Ceramic
C330	5322 122 30027	1 nF			Ceramic
C331	5322 122 34021	47 nF			Ceramic
C332	5322 122 34021	47 nF			Ceramic
C333	5322 122 30021	100 pF	10		Ceramic
C334	5322 122 30021	100 pF	10		Ceramic
C335	5322 122 30021	100 pF	10		Ceramic
C336	5322 122 30021	100 pF	10		Ceramic
C337	5322 122 30034	470 pF	10		Ceramic
C338	5322 122 30034	470 pF	10		Ceramic
C339	5322 122 34021	47 nF			Ceramic
C340	5322 122 34021	47 nF			Ceramic
C341	5322 121 54051	1000 pF	5	50	Metal film
C342	5322 121 54051	1000 pF	5	50	Metal film
C343	5322 122 30101	220 pF	10		Ceramic
C344	5322 122 30129	4,7 nF			Ceramic
C345	5322 122 34021	47 nF			Ceramic
C346	5322 123 34014	20 pF		300	Mica
C348	5322 122 34021	47 nF			Ceramic
C349	5322 122 34021	47 nF			Ceramic
C350	5322 122 30027	1 nF			Ceramic
C351	5322 122 30129	4,7 nF			Ceramic
C352	5322 122 34021	47 nF			Ceramic
C353	4822 124 20575	100 µF		25	Electrolytic
C354	4822 124 20355	10 µF		25	Electrolytic
C355	4822 124 20355	10 µF		25	Electrolytic
C356	4822 124 20355	10 µF		16	Electrolytic
C357	5322 122 34021	47 nF			Ceramic
C358	4822 124 20575	100 µF		25	Electrolytic
C359	5322 122 34022	100 nF			Ceramic
C360	4822 124 20368	33 µF		10	Electrolytic
C361	5322 122 34021	47 nF			Ceramic
C362	4822 124 20417	1000 µF		16	Electrolytic
C363	4822 124 20065	2,2 µF		315	Electrolytic
C366	4822 124 20355	10 µF		16	Electrolytic

Miscellaneous

Item	Ordering number	Description
T1	5322 146 34022	Power transformer
U1	5322 216 64091	Printed wiring board
U2	5322 216 64092	Printed wiring board
U3	5322 216 64093	Printed wiring board
VL1	5322 253 30006	Mains fuse 100 mA, delayed action
B371	5322 131 94016	Indicator tube
B372	5322 131 94016	Indicator tube
B373	5322 131 94016	Indicator tube
LA381	5322 134 24011	Neon lamp
LA382	5322 134 24011	Neon lamp
LA383	5322 134 24011	Neon lamp
LA384	5322 134 24011	Neon lamp
RE391	5322 280 24034	Reed relay
RE392	5322 280 24035	Reed relay
RE393	5322 280 24035	Reed relay
RE394	5322 280 24035	Reed relay
RE395	5322 280 24035	Reed relay
RE396	5322 280 24035	Reed relay
RE397	5322 280 24035	Reed relay
L1	5322 158 14045	Filter coil

SEMICONDUCTORS

Integrated circuits

No.	Type	Ordering number	Replacement type	Ordering number	Remark
IC1	LM301A	5322 209 84214	-	-	Selected (see VII.C.1)
IC2	LM301A	5322 209 84214	-	-	Selected (see VII.C.1)
IC3	LM301A	5322 209 84215	-	-	Selected (see VII.C.2)
IC4	LM301A	5322 209 84216	-	-	Selected (see VII.C.3)
IC5	LM311	5322 209 84217	-	-	
IC6	SN74141N (Texas Instr)		N7441 B	5322 209 84159	
IC7	SN74141N (Texas Instr)		N7441 B	5322 209 84159	
IC8	SN74141N (Texas Instr)		N7441 B	5322 209 84159	
IC9	SN7475N (Texas Instr)		FJJ181	5322 209 84047	
IC10	SN7475N (Texas Instr)		FJJ181	5322 209 84047	
IC11	SN7475N (Texas Instr)		FJJ181	5322 209 84047	

No.	Type	Ordering number	Replacement type	Ordering number	Remark
IC12	SN7402N (Texas Instr)		FJH221	5322 209 84145	
IC13	SN7475N (Texas Instr)		FJJ181	5322 209 84047	
IC14	SN7400N (Texas Instr)		FJH131	5322 209 84143	
IC15	SN7490N (Texas Instr)		FJJ141	5322 209 84114	
IC16	SN7490N (Texas Instr)		FJJ141	5322 209 84114	
IC17	SN7490N (Texas Instr)		FJJ141	5322 209 84114	
IC18	SN7405N (Texas Instr)		FJH251	5322 130 30613	
IC19	SN7401N (Texas Instr)		FJH231	5322 209 84218	
IC20	SN7474N (Texas Instr)		FJJ131	5322 209 80065	
IC21	SN7401N (Texas Instr)		FJH231	5322 209 84218	
IC22	SN7404N (Texas Instr)		FJH241	5322 209 84147	
IC23	SN7410N (Texas Instr)		FJH121	5322 209 84153	
IC24	SN7473N (Texas Instr)		FJJ121	5322 209 84142	
IC25	SN7400N (Texas Instr)		FJH131	5322 209 84143	
IC26	SN7473N (Texas Instr)		FJJ121	5322 209 84142	
IC27	SN7412N (Texas Instr)	5322 209 84219			
IC28	SN7400N (Texas Instr)		FJH131	5322 209 84143	
IC29	SN7401N (Texas Instr)		FJH231	5322 209 84218	
IC30	SN7401N (Texas Instr)		FJH231	5322 209 84218	

Transistors

No.	Ordering number	Type	Replacement type	Ordering number	
TS31	5322 130 44166	ITS3948	-	-	Dual FET
TS32	5322 130 44166	ITS3948	-	-	Dual FET
TS33	5322 130 44167	NF510	-	-	FET
TS34	5322 130 44167	NF510	-	-	FET
TS35	5322 130 44167	NF510	-	-	FET
TS36	5322 130 44167	NF510	-	-	FET
TS37	5322 130 44167	NF510	-	-	FET
TS38	-	2SA495	2N2907A	5322 130 40621	
TS39	-	2SA495	2N2907A	5322 130 40621	
TS40	-	2SA495	2N2907A	5322 130 40621	
TS41	-	2SA495	2N2907A	5322 130 40621	
TS42	5322 130 44168	2SC269	-	-	
TS43	5322 130 44168	2SC269	-	-	
TS44	5322 130 44168	2SC269	-	-	
TS45	5322 130 44168	2SC269	-	-	
TS46	5322 130 44168	2SC269	-	-	
TS47	5322 130 44169	2SC268A	-	-	
TS48	5322 130 44169	2SC268A	-	-	
TS49	5322 130 44169	2SC268A	-	-	
TS50	5322 130 44169	2SC268A	-	-	
TS51	5322 130 44169	2SC268A	-	-	
TS52	5322 130 44169	2SC268A	-	-	
TS53	5322 130 44169	2SC268A	-	-	
TS54	5322 130 44169	2SC268A	-	-	
TS55	5322 130 44168	2SC269	-	-	
TS56	5322 130 44168	2SC269	-	-	
TS57	-	2SA495	2N2907A	5322 130 40621	
TS58	-	2SA495	2N2907A	5322 130 40621	
TS59	5322 130 44168	2SC269			
TS60	5322 130 44168	2SC269			
TS61	5322 130 44168	2SC269			
TS62	5322 130 44171	2SC1014			
TS63	5322 130 44168	2SC269			
TS64	5322 130 44168	2SC269			
TS65	5322 130 44168	2SC269			
TS66	5322 130 44171	2SC1014			
TS67	5322 130 44168	2SC269			
TS68	5322 130 44168	2SC269			
TS1		2SD315D	BD124	5322 130 40504	

No.	Ordering number	Type	Replacement type	Ordering number	
Dioden					
GR70		WG713	BAW62	5322 130 30613	
GR71	5322 130 34175	IS1516			Selected (see VII.C.4)
GR72	5322 130 34175	IS1516			Selected (see VII.C.4)
GR73	5322 130 34176	SD-101			
GR74	5322 130 34176	SD-101			
GR75	5322 130 34176	SD-101			
GR76	5322 130 34176	SD-101			
GR77	5322 130 34177	F-14B			
GR78	5322 130 34177	F-14B			
GR79	5322 130 34177	F-14B			
GR80	5322 130 34177	F-14B			
GR81	5322 130 34178	1S2192			
GR82	5322 130 34178	1S2192			
GR83		WG713	BAW62	5322 130 30613	
GR84		WG713	BAW62	5322 130 30613	
GR85		WG713	BAW62	5322 130 30613	
GR86		WG713	BAW62	5322 130 30613	
GR87		WG713	BAW62	5322 130 30613	
GR88		WG713	BAW62	5322 130 30613	
GR89		WG713	BAW62	5322 130 30613	
GR90		WG713	BAW62	5322 130 30613	
GR91		WG713	BAW62	5322 130 30613	
GR92		WG713	BAW62	5322 130 30613	
GR93		WG713	BAW62	5322 130 30613	
GR94		WG713	BAW62	5322 130 30613	
GR95		WG713	BAW62	5322 130 30613	
GR96		WG713	BAW62	5322 130 30613	
GR97		WG713	BAW62	5322 130 30613	
GR98		WG713	BAW62	5322 130 30613	
GR99		WG713	BAW62	5322 130 30613	
GR100		WG713	BAW62	5322 130 30613	
GR101		WG713	BAW62	5322 130 30613	
GR102		WG713	BAW62	5322 130 30613	
GR103		WG713	BAW62	5322 130 30613	
GR104		WG713	BAW62	5322 130 30613	
GR105		WG713	BAW62	5322 130 30613	
GR106		WG713	BAW62	5322 130 30613	
GR107		WG713	BAW62	5322 130 30613	
GR108		WG713	BAW62	5322 130 30613	
GR109	5322 130 34179	1S1850R			Dual diode
GR110	5322 130 34181	1S1850			Dual diode
GR111	5322 130 34179	1S1850R			Dual diode
GR112	5322 130 34181	1S1850			Dual diode

No.	Ordering number	Type	Replacement type	Ordering number	
GR113	5322 130 34179	1S1850R			Dual diode
GR114	5322 130 34181	1S1850			Dual diode
GR115	5322 130 34182	1S1851R			Dual diode
GR116	5322 130 34183	1S1851			Dual diode
GR117	5322 130 34184	WG713			
GR118	5322 130 34184	WG713			
GR119	5322 130 34185	RD-9A			

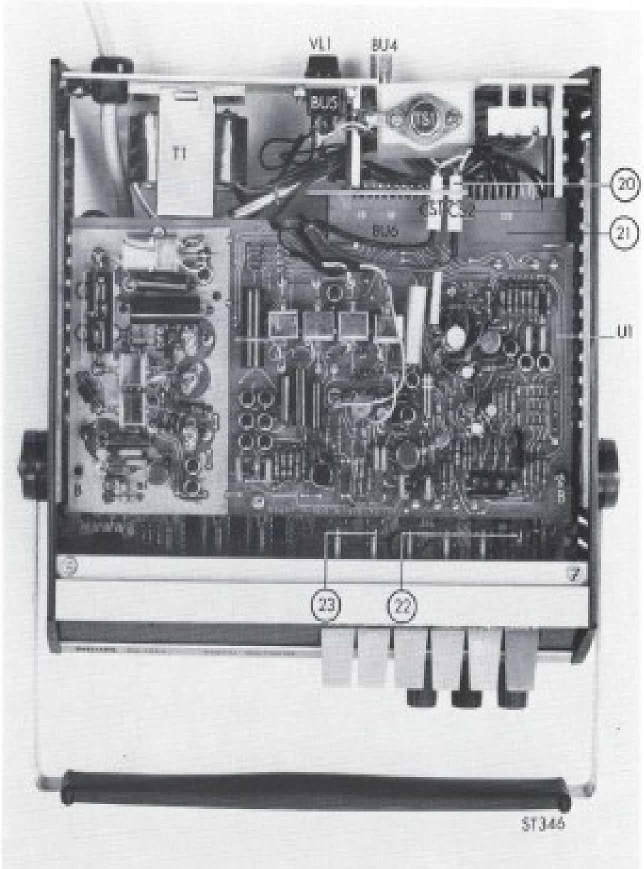


Fig. 34. Top view (cabinet removed)

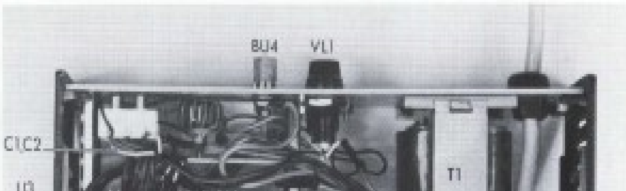


Fig. 35, Bottom view (cabinet removed)

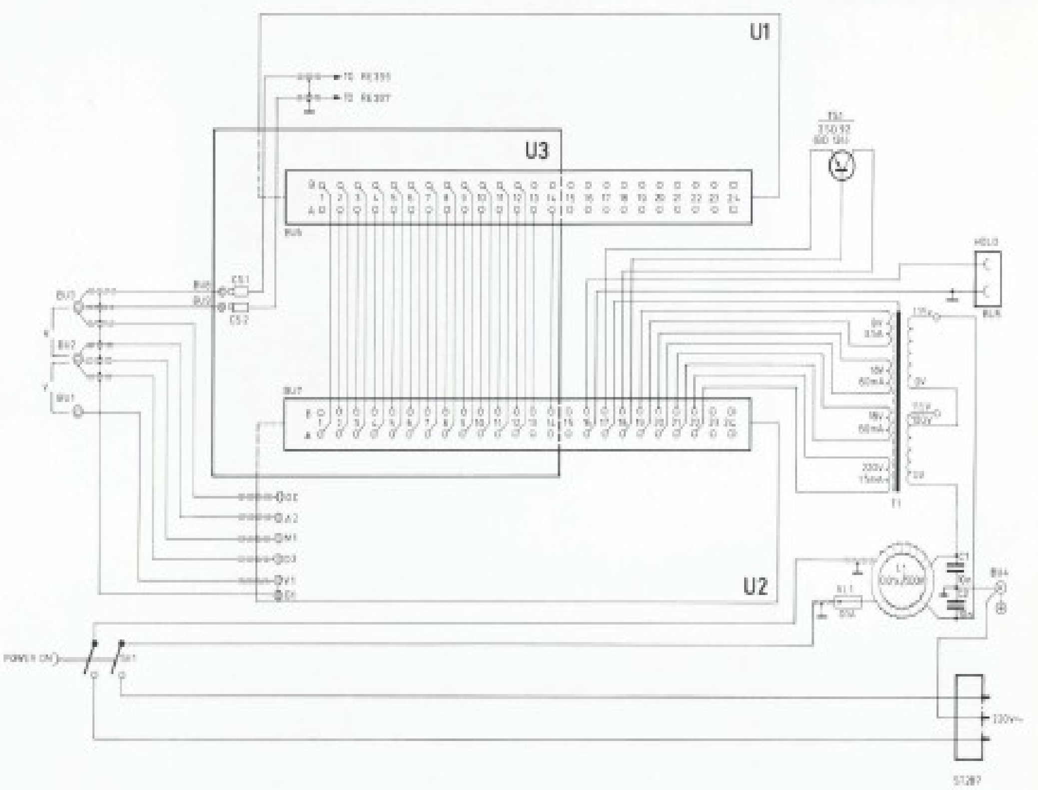


Fig. 36. Wiring diagram

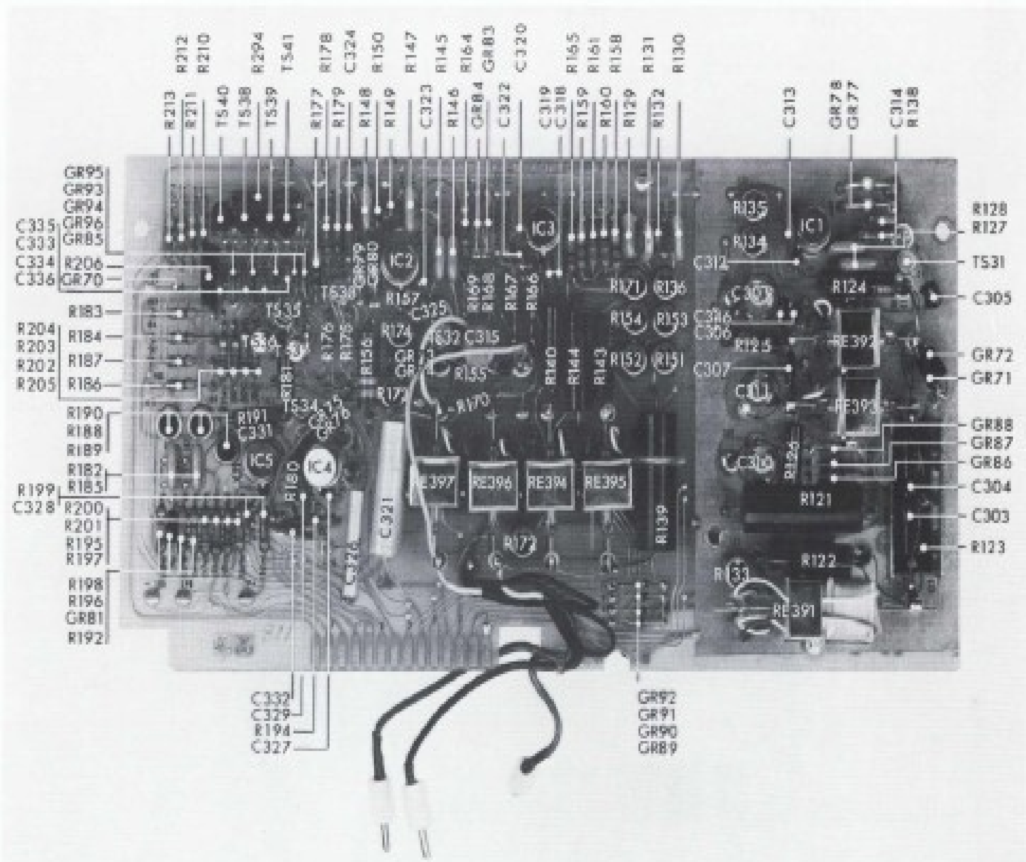


Fig. 37. Printed wiring board U1

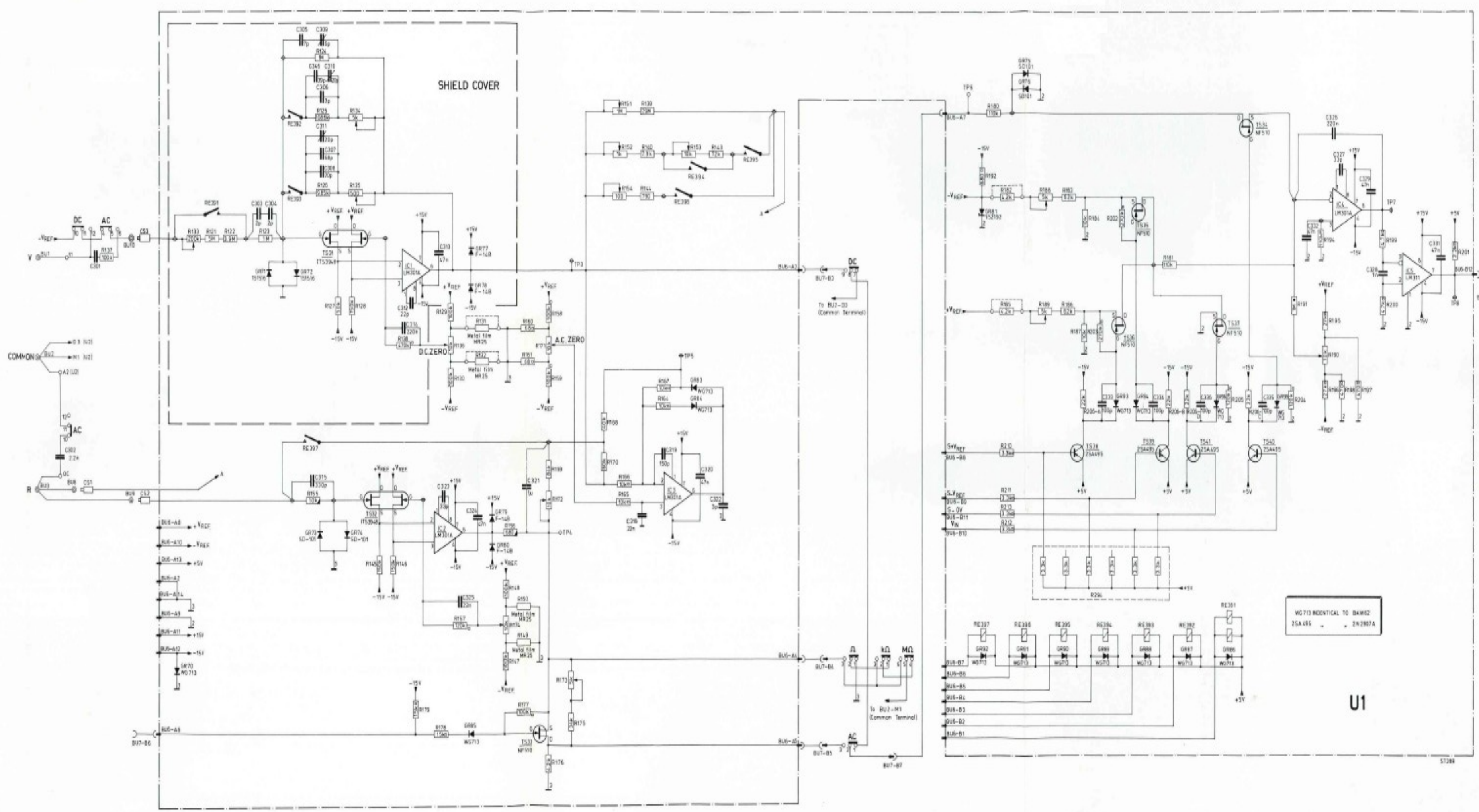


Fig. 38. Circuit diagram analog section U1

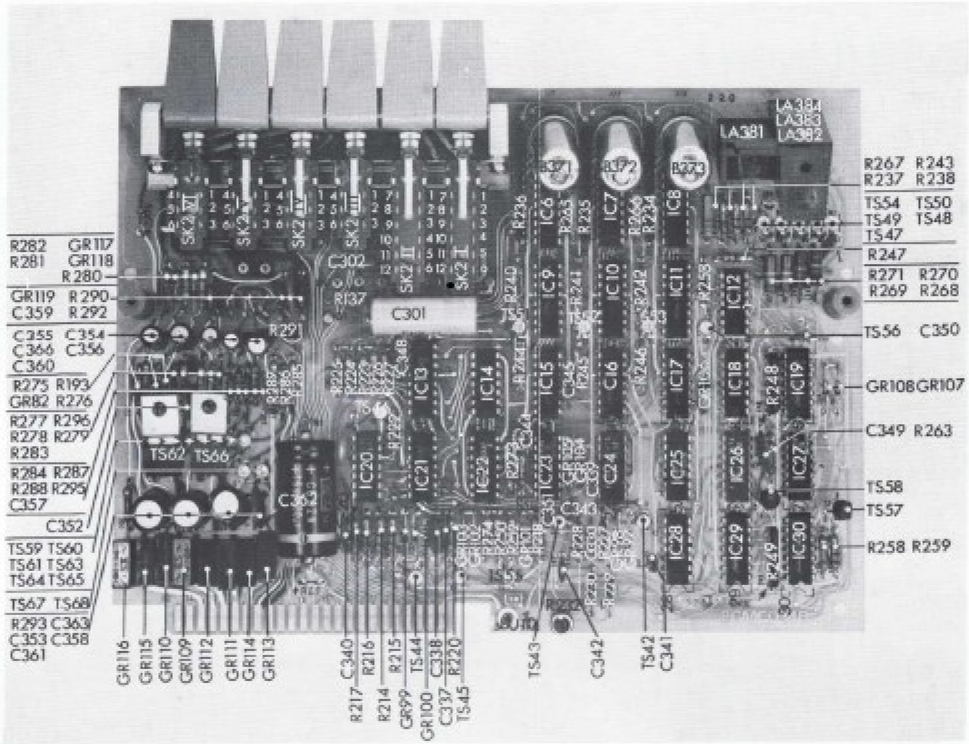


Fig. 39. Printed wiring board U2

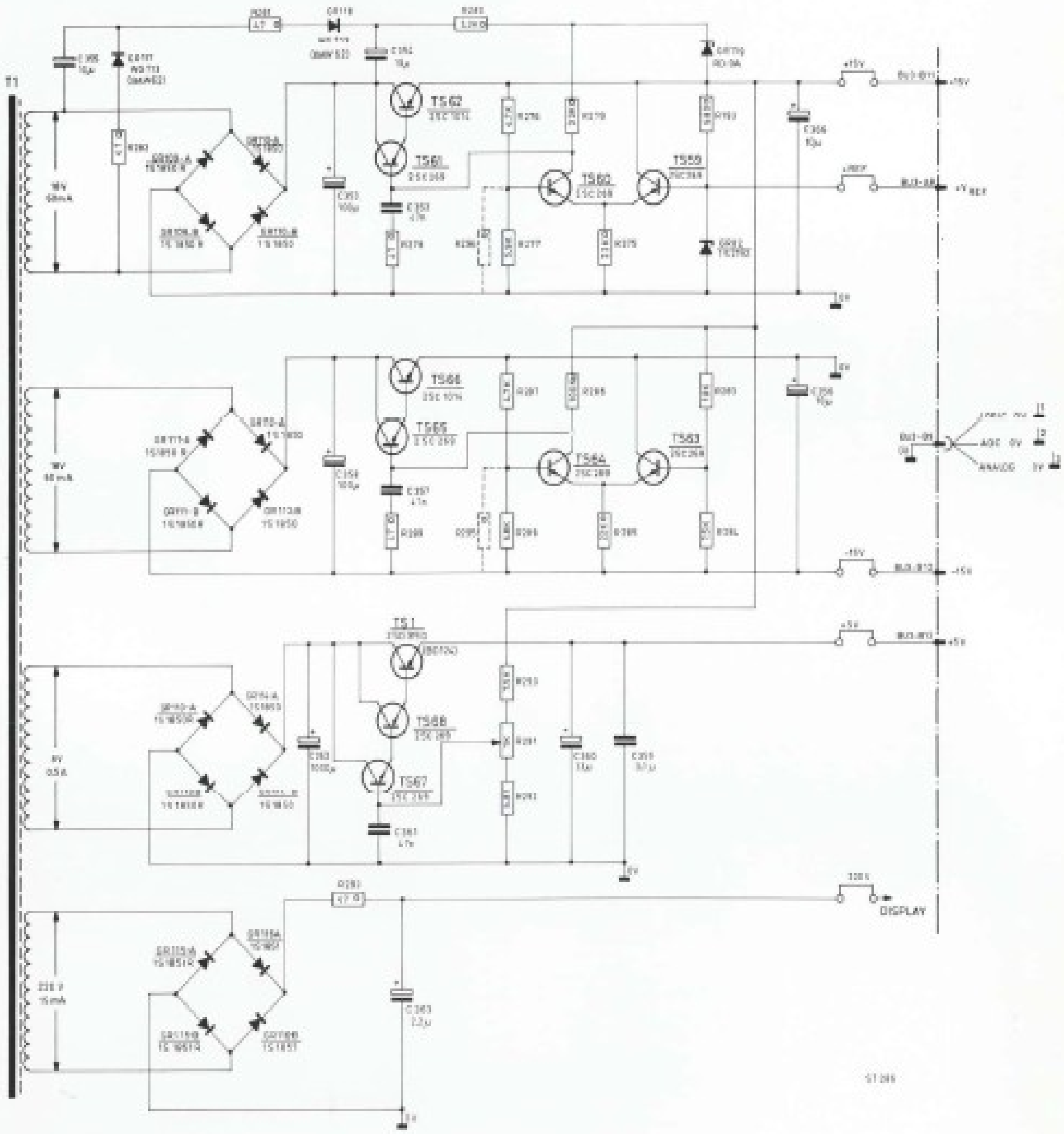


Fig. 40. Circuit diagram power supply

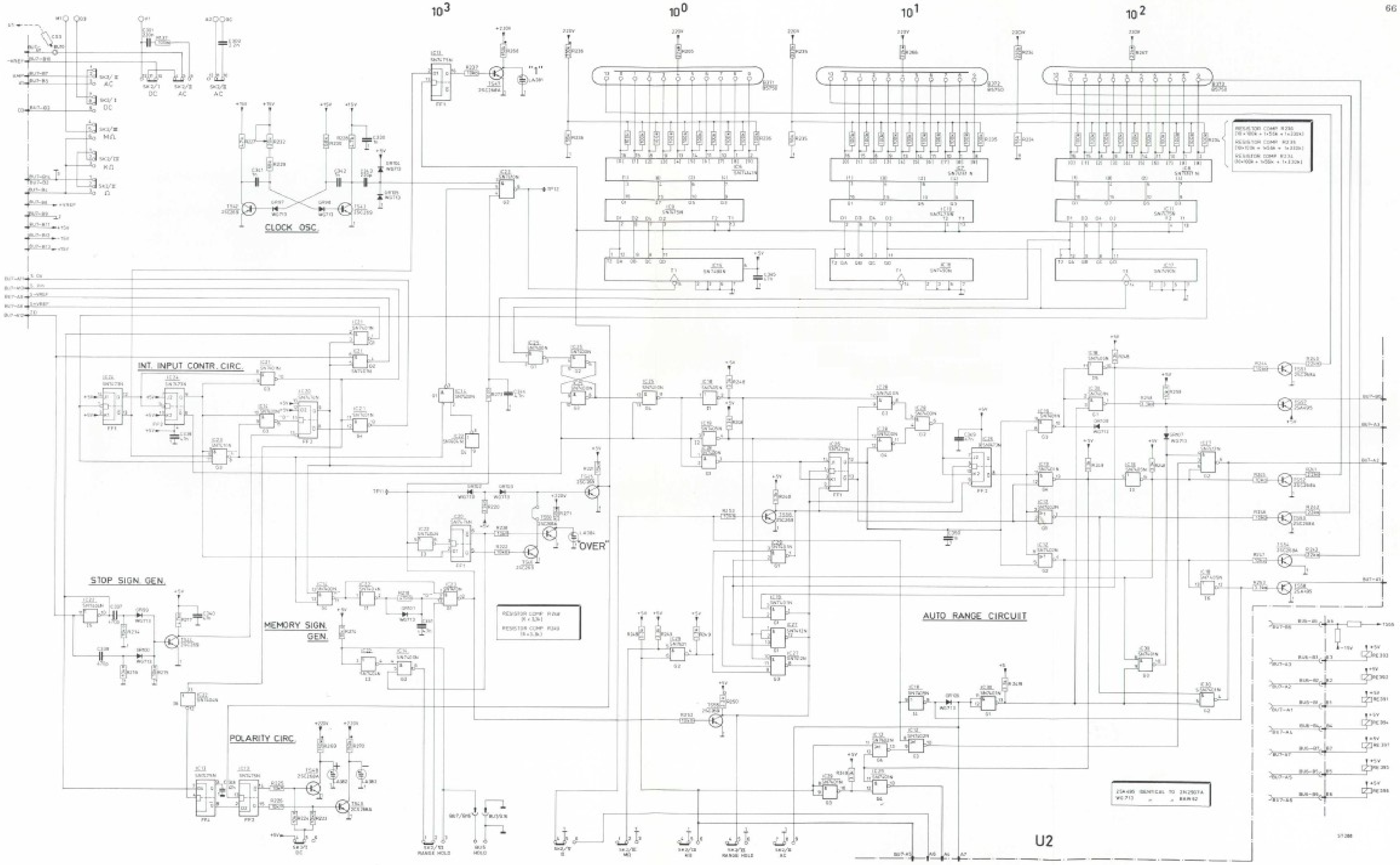


Fig. 41. Circuit diagram digital section

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

COMPONENT/SEQUENCE NUMBER

☐☐☐☐☐☐

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

GR1003	Diode GR1003
TS0023	Transistor TS23
IC0101	Integrated circuit IC101
R0....	Resistor, potentiometer
C0....	Capacitor, variable capacitor
B0....	Tube, valve
LA....	Lamp
VL....	Fuse
SK....	Switch
BU....	Connector, socket, terminal
T0....	Transformer
L0....	Coil
X0....	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

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

Sales and service all over the world

Argentina: Philips Argentina S.A., Cassila Correo 3479, Buenos Aires; tel. T.E. 70, 7741 al 7749

Australia: Philips Electrical Pty Ltd., Philips House, 69-79 Clarence Street, Box 2703 G.P.O., Sydney; tel. 2.0223

België/Belgique: M.B.L.E., Philips Bedrijfsapparatuur, 80 Rue des Deux Gares, Bruxelles; tel. 230000

Bolivia: Philips Sudamericana, Casilla 1609, La Paz; tel. 5270-5664

Brasil: S.A. Philips Do Brasil, Inbelsa Division; Avenida Paulista 2163; P.O. Box 8681, Sao Paulo S.P.; tel. 81-2161

Burundi: Philips S.A.R.L., Avenue de Grèce, B.P. 900, Bujumbura

Canada: Philips Electronic Industries Ltd., Electronic Equipment Division, Philips House, 116 Vanderhoof Avenue, Toronto 17 (Ontario); tel. 425-5161

Chile: Philips Chilena S.A., Casilla 2687, Santiago de Chile; tel. 35081

Colombia: Industrias Philips de Colombia S.A., Calle 13 no. 51-03, Apartado Nacional 1505, Bogota; tel. 473640

Costa Rica: Philips de Costa Rica Ltd., Apartado Postal 4325, San José; tel. 210111

Danmark: Philips Elektronik Systemer A/S Afd. Industri & Forskning, Strandlodsvej 4 2300-København S; Tel (0127) AS 2222, telex 27045

Deutschland (Bundesrepublik): Philips Elektronik Industrie GmbH, Röntgenstrasse 22, Postfach 630111, 2 Hamburg 63; tel. 501031

Ecuador: Philips Ecuador S.A., Casilla 343, Quito; tel. 239080

Eire: Philips Electrical (Ireland) Ltd., Newstead, Clonskeagh, Dublin 14; tel. 976611

El Salvador: Philips de El Salvador, Apartado Postal 865, San Salvador; tel. 217441

España: Philips Ibérica S.A.E., Avenida de America, Apartado 2065, Madrid 17; tel 2462200

Ethiopia: Philips Ethiopia (Priv. Ltd. Co.), P.O.B. 2565; Cunningham Street, Addis Abeba; tel. 4ʟ300

France: Philips Industrie, Division de la S.A. Philips Industrielle et Commerciale 105, Rue de Paris, 93 002 Bobigny; tel. 84527-09

Ghana: Philips (Ghana) Ltd., P.O.B. M 14, Accra; tel. 66019

Great Britain: Pye Unicam Ltd., York Street, Cambridge; tel. (0223) 58866

Guatemala: Compañia Comercial Philips de Guatemala S.A., Apartado Postal 238, Guatemala City; tel. 64857

Hellas: Philips S.A. Hellénique, B.P. 153, Athens; tel. 230476

Hong Kong: Philips Hong Kong Ltd., P.O.B. 2108, St. George's Building, 21st floor, Hong Kong; tel. H 249246

India: Philips India Ltd., Shivsagar Estate Block "A", Dr. Annie Besant Road, P.O.B. 6598, Worli, Bombay 18; tel. 370071

Indonesia: P. T. Philips Development Corporation, Djalan Proklamasi 33, P.O.B. 2287, Djakarta; tel. 51985-51986

Iran: Philips Iran Ltd., P.O.B. 1297, Teheran; tel. 48344-68344

Island: Heimilistaeki SF, Saetún 8, Reykjavik; tel. 24000

Islas Canarias: Philips Ibérica S.A.E., Triana 132, Las Palmas; Casilla 39-41, Santa Cruz de Tenerife

Italia: Philips S.p.A., Sezione PIT, Via Le Elvezia 2, 20052 Monza; tel. (039) 361-441; telex 35290

Kenya: Philips (Kenya) Ltd., P.O.B. 30554, Nairobi; tel. 29981

Malaysia: Electronic Supplies (Malaysia) Sdn Bhd. P.O. Box 332, Kuala Lumpur; tel. 564173

Mexico: Philips Comercial S.A. de C.V., Uruapan 7, Apdo 24-328, Mexico 7 D.F.; tel. 25-15-40

Nederland: Philips Nederland B.V., Boschdijk, Gebouw VB, Eindhoven; tel. 793333

Ned. Antillen: N.V. Philips Antillana, Postbus 523, Willemstad; tel. Curaçao 36222-35464

New Zealand: Philips Electronical Industries (N.Z.) Ltd., Professional and Industrial Division, 70-72 Kingsford Smith Street, P.O.B. 2097, Lyall Bay, Wellington; tel. 73-156

Nigeria: Philips (Nigeria) Ltd., Philips House, 6 Ijora Causeway, P.O.B. 1921, Lagos; tel. 45414/7

Nippon: Nihon Philips Corporation, P.O.B. 13, Trade Center, Tokyo 105; tel. (03) 435-5211

Norge: Norsk A.S. Philips, Postboks 5040, Oslo; tel. 463890

Österreich: Oesterreichische Philips Industrie GmbH, Abteilung Industrie Elektronik, Triesterstrasse 64, A-1101 Wien; tel. (0222) 645511/31

Pakistan: Philips Electrical Co. of Pakistan Ltd., El-Markaz, M.A. Jinnah Road, P.O.B. 7101, Karachi; tel. 70071

Paraguay: Philips del Paraguay S.A., Casilla de Correo 605, Asuncion; tel. 8045-5536-6666

Perú: Philips Peruana S.A., Apartado Postal 1841, Lima; tel. 326070

Philippines: Electronic Development & Application Center, 2246 Pasong Tamo Street, P.O.B. 911, Makati Commercial Center, Makati Rizal D-708; tel. 889453 to 889456

Portugal: Philips Portuguesa S.A.R.L., Rua Joaquim Antonio d'Aquiar 66, Lisboa; tel. 683121/9

Republique du Zaire: Philips du Zaire S.C.R.L., 137, Boulevard du 30 Juin, B.P. 1798, Kinshasa

Rwanda: Philips Rwanda S.A.R.L., B.P. 449, Kigali

Schweiz-Suisse-Svizzera: Philips A.G., Binzstrasse 38, Postfach 8027, Zürich; tel. 051-442211

Singapore: Electronic Supplies (Singapore) Private Ltd. P.O. Box 4029, Singapore 21

South Africa: South African Philips (Pty) Ltd., P.O.B. 7703, 2, Herb Street, New Doornfontein, Johannesburg; tel. 24-0531

Suomi: Oy Philips Ab, Postboks 10255, Helsinki 10; tel. 10915

Sverige: Svenska A.B. Philips, Fack, Lidingövagen 50, Stockholm 27; tel. 08/635000

Taiwan: Yung Kang Trading Co. Ltd., San Min Building, 1st Floor, 57-1 Chung Shan N Road, 2 Section, P.O.B. 1467, Taipei; tel. 577281

Tanzania: Philips (Tanzania) Ltd., p/a P.O.B. 30554, Nairobi, Kenya

Thailand: Philips Thailand Ltd., 283, Silom Road, Bangkok; tel. 36980, 36984-9

Türkiye: Türk Philips Ticaret A.S., Posta Kutusu 504, Istanbul; tel. 453250

Uruguay: Philips de Uruguay, Avda Uruguay 1287, Montevideo; tel. 956 41-2-3-4

U.S.A.: Test and Measuring Instruments Inc.; 224 Duffy Avenue, Hicksville, L.I., N.Y. 11802; tel. (516) 433-8800; telex no. 510-221-1839

Venezuela: C.A. Philips Venezolana, Apartado Postal 1167, Caracas; tel. 360511

Zambia: Philips Electrical Ltd., Professional Equipment Division, P.O.B. 553 Kitwe; tel. 2526/7/8; Lusaka P.O. Box 1878

730101

For countries not listed and for information on changes of address:
N.V. Philips
Test and Measuring Instruments Dept.
Eindhoven - Netherlands