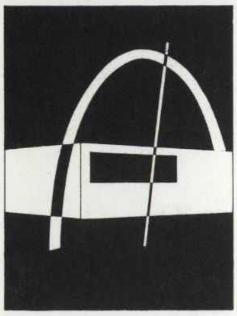
PHILIPS



Digital Multimeter

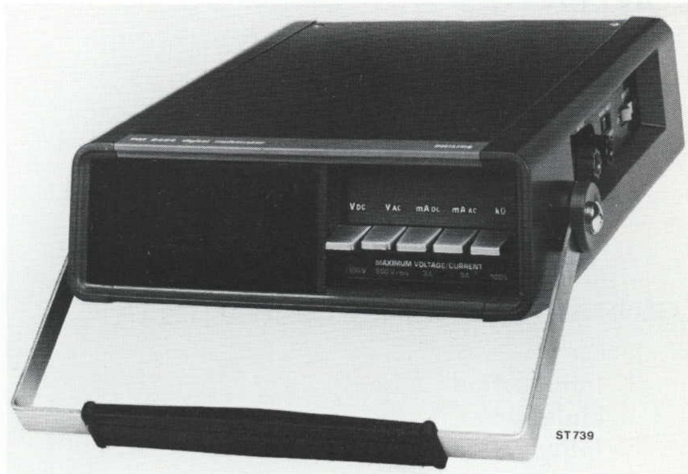
PM2424

9447 024 240.1

9499 470 07301 731215

PHILIPS

PHILIPS



Manual

Digital multimeter PM2424

9447 024 240.1

PHILIPS

9499 470 07301

731215

CONTENTS

List of figures

I. Introduction

The PM 2424 is a digital multimeter having a 4-digit display, capable of a maximum reading of 9999.
The instrument can measure:

- d.c. voltages of 100 µV to 1000 V
- a.c. voltages of 100 µV to 500 V rms
- d.c. currents of 100 nA to 1000 mA
- a.c. currents of 100 nA to 1000 mA rms
- Resistances of 100 mΩ to 10 MΩ

Protection for all measurement functions is provided.
The measuring range, the polarity for d.c. measurements and the position of the decimal point are all determined fully automatically. However, range and sample-hold facilities do exist.
Extremely high accuracies are obtained due to automatic - zero drift correction being carried out before each measurement.
The power consumption of the instrument is low due to the use of low-power and MOS-LSI digital integrated circuits.
Operation from mains or a d.c. supply is possible.
The d.c. supply provided by the optional accessory PM 9207 enables the portability of this instrument to be fully exploited.

II. Technical data

Properties expressed in numerical values with tolerances, are guaranteed by the manufacturer. Numerical values without tolerances serve only for information purposes and represent the properties of a typical instrument.

II-1. ELECTRICAL SPECIFICATIONS.

II-1.1. DC Voltage Measurement.

Range:	1/10/100/1000 V.
Ranging:	Fully automatic.
Max. sensitivity:	100 µV.
Resolution:	1/9999.
Input impedance:	More than 1000 MΩ for 10 V ranges, 10 MΩ for 100/1000 V ranges.
Accuracy:	± 0.01% of reading ± 0.01% at end-of-range ± 1 digit (at a temperature 23°C ± 2°C and humidity less than 85%).
Temperature coefficient:	0.005% of reading/°C at all ranges.
Stability (180 days):	0.02% of reading for 1 V range 0.01% of reading for 10 V range 0.02% of reading for 100/1000 V ranges
Offset current of input:	Less than 1 nA.
Protection:	1100 V max.
Response time:	0.2 sec. (without range changing)

II-1.2. AC Voltage Measurement.

Range:	1/10/100/500 V rms.
Ranging:	Fully automatic.
Max. sensitivity:	100 µV.
Resolution:	1/9999.
Input impedance:	1 MΩ shunted by 100 pF.
Accuracy:	± 0.3% of reading ± 0.2% at end-of-range ± 1 digit for 1/10/100 V ranges (frequency: 45 Hz to 20 kHz). ± 0.5% of reading ± 0.5% at end-of-range ± 1 digit for 1/10/100 V ranges (frequency: 40 Hz to 50 kHz). ± 0.5% of reading ± 0.5% at end-of-range ± 1 digit for 500 V range (frequency: 45 Hz to 10 kHz). (at a temperature 23°C ± 2°C and humidity less than 85%).

Temperature coefficient:	0.02% of reading/°C.
Stability (180 days):	0.05% of reading.
Protection:	500 V rms max.
Response time:	2.5 sec. (without range changing).

II-1.3. DC Current Measurement.

Range:	1/10/100/1000 mA.
Ranging:	Fully automatic.
Max. sensitivity:	100 nA.
Resolution:	1/9999.
Accuracy:	$\pm$ 0.2% of reading $\pm$ 0.01% at end-of-range $\pm$ 1 digit for 1/10/100 mA ranges. $\pm$ 0.3% of reading $\pm$ 0.01% at end-of-range $\pm$ 1 digit for 1000 mA range. (at a temperature 23°C $\pm$ 2°C and humidity less than 85%).
Temperature coefficient:	0.01% of reading/°C.
Stability (180 days):	0.02% of reading.
Protection:	3A max.
Response time:	0.2 sec. (without range changing).

II-1.4. AC Current Measurement.

Range:	1/10/100/1000 mA.
Ranging:	Fully automatic.
Max. sensitivity:	100 nA.
Resolution:	1/9999.
Accuracy:	$\pm$ 0.5% of reading $\pm$ 0.2% at end-of-range $\pm$ 1 digit for 1/10/100 mA ranges. $\pm$ 0.7% of reading $\pm$ 0.2% at end-of-range $\pm$ 1 digit for 1000 mA range (at a temperature 23°C $\pm$ 2°C and humidity less than 85%).
Temperature coefficient:	0.02% of reading/°C.
Stability (180 days):	0.05% of reading.
Protection:	3A max.
Response time:	2.5 sec. (without range changing).

II-1.5 Resistance Measurement.

Range:	1/10/100/1000/10000 kΩ.
Ranging:	Fully automatic.
Max. sensitivity:	100 mΩ.
Resolution:	1/9999.

Accuracy:	± 0.1% of reading ± 0.01% at end-of-range ± 1 digit for 1/10 kΩ ranges. ± 0.2% of reading ± 0.01% at end-of-range ± 1 digit for 100 kΩ range. ± 0.8% of reading ± 0.02% at end-of-range ± 1 digit for 1000 kΩ range. ± 1.5% of reading ± 0.05% at end-of-range ± 1 digit for 10000 kΩ range (at a temperature 23°C ± 2°C and humidity less than 85%).
Temperature coefficient:	0.015% of reading/°C for 1/10/100 kΩ ranges. 0.03% of reading/°C for 1000 kΩ range. 0.07% of reading/°C for 10000 kΩ range.
Stability (180 days):	0.03% of reading for 1/10/100 kΩ ranges. 0.05% of reading for 1000 kΩ range. 0.1% of reading for 10000 kΩ range.
Protection:	100 V max. in a.c./d.c. for continuous input. 200 V max. in a.c./d.c. for 5 sec. input.
Response time:	0.2 sec. (without range changing).

II-2. GENERAL DATA.

Type of operation:	Dual-slope integration.
Input terminal:	Completely floating.
Sampling speed:	2-5 samples/sec.
Ranging time:	200 ms-300 ms/range.
Polarity display:	+ or - can be automatically displayed.
Isolation:	600 V d.c. between chassis and black terminal (LO).
Display hold:	Measured result and range can be held.
CMRR (input):	50 dB (mains operation).
SMRR (analogue-to-digital converter):	40 dB (mains operation).
Power requirement:	220 V ± 10%, 50/60 Hz. Note: Mains transformer wiring can be altered for other mains voltages.
DC operation:	External + 12 V d.c. supply. Operation possible from + 10 V to + 15 V.
Power consumption:	Approx. 9 VA on mains operation. Approx. 3.5 VA on d.c. supply operation.

II-3. MECHANICAL DATA.

Dimensions:	Width 200 mm Height 72 mm Depth 253 mm.
Weight:	Approx. 2.1 kg.

III. Accessories

III-1. SUPPLIED WITH THE INSTRUMENT.

- mains input cable with connectors
- grounding lead
- measuring leads
- two shorting-plugs for range and sample-hold functions
- mating connector for the external d.c. supply input
- fuse, 50 mA, slow-blow
- manual.

III-2. OPTIONAL.

- d.c. power supply PM 9207.

Mechanically, this power supply (Fig. 1) consists of an aluminium metal case designed to fit under the digital multimeter PM 2424 in place of the base plate. It houses a battery pack which contains 10 x 1.5 V nickel-cadmium rechargeable batteries. It also houses circuitry (Fig. 30) which enables a low-voltage indication to be generated within the display and a charging circuit which allows the batteries to be recharged via the mains supply to the multimeter.
Electrical connections to the multimeter circuitry are made via the free connector (BU363) plugging into the fixed connector (BU364) on the underside of the printed circuit board U2. An external terminal on the case allows the condition of the batteries to be checked with ease.

Dimensions:			
	Width	160 mm	approximate.
	Height	30 mm	
	Depth	210 mm	
	Weight	1 kg	

Notes:

- R25 of the low-voltage indicator circuit should be adjusted so that LOW BATT indication is made in the display when the voltage of the battery pack falls below + 10 V d.c.
- The charging circuit for the batteries of the battery pack operates when the multimeter is connected to the mains supply irrespective of the settings of the power and power selector switches. Therefore, it is IMPORTANT that mains is only connected to the multimeter when the battery pack contains rechargeable batteries.

IV. Principle of operation

A simple block diagram of the instrument is shown in Fig. 2.

IV-1. ANALOGUE SECTION.

The analogue section consists of an input circuitry section and an analogue-to-digital converter (ADC).

IV-1.1. Input circuitry.

The function selector selects the required block of this circuitry depending upon the type of measurement being made. All input signals are converted to a d.c. voltage by the input circuitry.

- d.c. voltage.
  The input is applied to the DCV/ATT. section which attenuates the unknown d.c. voltage in accordance with the range.
- a.c. voltage.
  The input is applied to the ACV/DCV section and is attenuated, rectified and filtered to a d.c. voltage.
- d.c. current.
  The input is applied to the I/V section, where the unknown current is passed through a shunt resistor, which differs with each range. The voltage drop across this resistor is then measured and applied directly to the ranging amplifier of the analogue-to-digital converter.
- a.c. current.
  As d.c. current measurement with the exception that the output of the I/V section is applied to the input of the ACV/DCV section and not directly to the ranging amplifier.
- resistance (Fig. 3).
  Fixed current is passed through the unknown resistance Rx and the voltage across Rx is applied to the input of the ranging amplifier.
  This principle can be represented by the following equations.

$$Vx = Is.Rx$$

but

$$Is = \frac{-V_{REF} - (-Vo)}{Rs} = -\frac{(V_{REF} - Vo)}{Rs}$$

where

Is: constant current

Rs: standard resistance

$-V_{REF}$: negative reference voltage

-Vo:	voltage derived from $-V_{REF}$
Rx:	unknown resistance
Vx:	voltage across Rx.

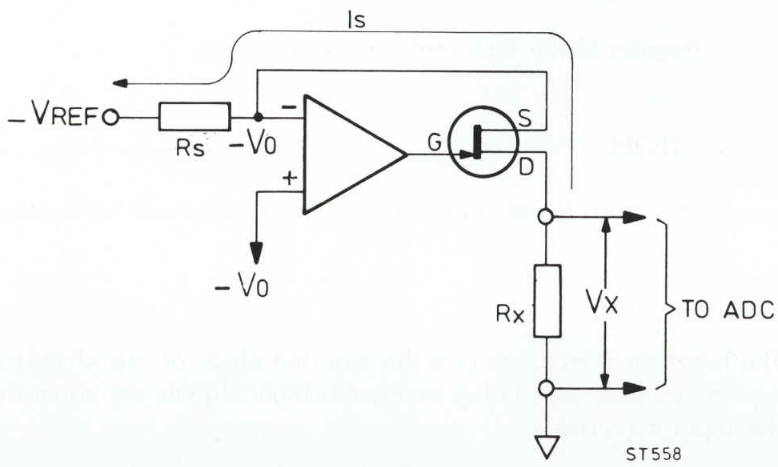


Fig. 3. Principle of resistance measurement.

IV-1.2. Analogue-to-Digital Converter (ADC).

This instrument employs a double-integrating system in the ADC and has an automatic-zero correction period.
The d.c. voltage from the input circuitry is applied to the ranging amplifier, where it is amplified in order to provide optimum range setting of the instrument.
The output of the ranging amplifier is applied to the integrator. A schematic diagram of the integrator is shown in Fig. 4.

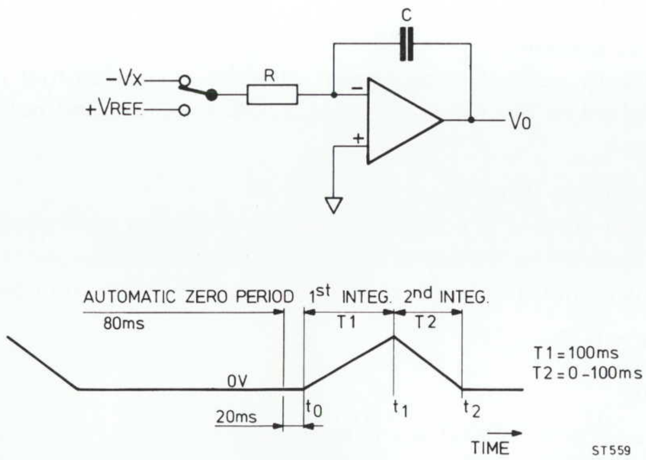


Fig. 4. Analogue-to-digital conversion system.

During the reference time ($t_0 \rightarrow t_1$), -Vx, the input voltage is integrated. At the end of the 1st integration, the input to the integrator is switched to a reference voltage of opposite polarity to that of the input. This reference voltage is integrated and a waveform having a slope in the zero-level direction is produced at the output of the integrator.

A comparator detects the crossing of the zero-level by the output voltage Vo and ends the 2nd integration operation.
The magnitude of the input signal is obtained by measuring the duration of this 2nd integration.

The above operation is represented by the following equations:

$$Vo = \frac{1}{c}\int_{t_o}^{t_1} \frac{(-Vx)}{R} \cdot dt \quad + \frac{1}{c}\int_{t_o}^{t_2} \frac{(V_{REF})}{R}\, dt, \quad = 0$$

but

$$t_1 - t_o = T1\ ,\ t_2 - t_1 = T2$$

$$\therefore Vo = \frac{T1}{CR} \cdot (-Vx) + \frac{T2}{CR} \cdot V_{REF}\ , = 0$$

$$\therefore \frac{T1}{CR} \cdot Vx = \frac{T2}{CR} \cdot V_{REF}$$

$$\therefore T2 = \frac{T1}{V_{REF}} \cdot Vx$$

but

T1 and V_{REF} are known and constant.

$$\therefore T2 = KVx.$$

The automatic-zero correction period precedes the 1st integration and the offset voltage of the ranging amplifier, integrating amplifier and comparator are stored. The timing of the system is controlled by the digital section.

IV-2. DIGITAL.

IV-2.1. Display and logic section.

IV-2.1.1. Control circuitry.

The control signals are derived from the counter and the comparator.
The control circuitry is used to:

- generate the 1st integration period
- inhibit the clock at the end of the 1st integration
- generate the memory pulse at the end of the 2nd integration
- select the required polarity reference voltage for the 2nd integration
- generate the auto-zero correction period

- generate the settling times
- generate the DOWN and UP signals.

IV-2.1.2. Memory Pulse.

This pulse is generated at the end of the 2nd integration. It inhibits the clock and loads the contents of the counter into the latch.

IV-2.1.3. Counter and Latch.

The counter consists of four BCD-decade counters and counts the clock pulses (100 kHz). The contents of the four decade counters are supplied to the display via a latch on the occurrence of the memory pulse.

IV-2.1.4. Sample Hold.

The generation of the memory pulse is inhibited when the sample-hold condition is activated. Therefore, as the memory pulse acts as the transfer pulse between the counter and the latch, the display will be held.

IV-2.1.5. Over.

If the memory pulse has not been generated within 100 ms after the start of the 2nd integration then the OVER signal will be generated. When this occurs in the range-hold condition, the OVER indicator is permanently lit.

IV-2.1.6. Polarity.

The polarity is determined at the start of the 2nd integration and is indicated at the display after the occurrence of the memory pulse.

IV-2.2. Autorange Section.

IV-2.2.1. Autorange and Relay Drive.

The automatic ranging selects and sets the optimum range in accordance with the magnitude of the input signal. Control functions for the FET and relay switches of the input circuitry are generated. Also decode for the indication of the appropriate decimal point in the display is produced.

IV-2.2.2. Range Hold.

When the range-hold condition is activated, the autoranging is inhibited and the decimal point position in the display remains fixed.

V. Installation

V-1. POWER SOURCE.

V-1.1. AC supply.

The instrument is wired for operation from a 220 V, 50/60 Hz mains supply, but by altering the wiring to the mains transformer (refer Fig. 31) other mains voltages can be used. The cabinet of the instrument is earthed via the mains lead.

V-1.2. DC supply.

Operation from an external d.c. supply of between + 10 V and + 15 V is possible. The optional accessory PM 9207 is recommended for this mode of supply as it becomes an integral part of the instrument. The cabinet of the instrument may be earthed via a terminal on the rear panel.

V-2. CONTROLS AND CONNECTORS.

Front	Panel Fig. 5.	
No.	Name	Function
1	Numerical Display Tubes	4 digit numerical display. Maximum display 9999. Decimal Point is automatically positioned.
2	Polarity Indicator	+ or - automatically indicated in accordance with polarity of input signal for d.c. voltage and d.c. current measurement.
3	OVER Indicator	Indicates that the input signal has exceeded the measurement range.
4	LOW BATT. Indicator	Indicates that the voltage of the battery pack (of the optional accessory PM 9207) is between + 5 V and + 10 V d.c. and unsuitable for satisfactory operation of the instrument.
5	Function Selector	Selects the required measurement function.
	VDC	d.c. voltage measurement.
	VAC	a.c. voltage measurement.
	mADC	d.c. current measurement.
	mAAC	a.c. current measurement.
	kΩ	Resistance measurement.

Right side panel Fig. 6		
No.	Name	Function
6	POWER switch	ON/OFF switch for both mains and d.c. supply operation
7	INPUT terminals	Input signal is connected to these terminals via input cable. Red terminal is HI Black terminal is LO.
8	SAMPLE HOLD terminals	By shorting with the two-pin accessory plug, the display is held until the short is removed.
9	RANGE HOLD terminals	By shorting with the two-pin accessory plug, the decimal point position is held until the short is removed.

Rear panel Fig. 7		
No.	Name	Function
10	a.c. power connector	Mains input via the accessory mains cable.
11	AC-DC power source selector switch	Selects between the a.c. and d.c. power sources.
12	EXT.DC + 12 V	External d.c. power source input. Note: Input for the d.c. power supply (optional accessory PM 9207) is not made via this connector.
13	Ground terminal	This terminal can be used to connect the cabinet to earth when operating from d.c. power source.
14	Fuse	Mains supply fuse of 50 mA rating (slow-blow).
15	PROTECTOR	Overcurrent protection in current measurement mode. To resume measurement, the cut-out button is depressed.

VI. Operating instructions

Note: It is important that the calibration procedure (as described in the Service Data) has been carried out within 6 months prior to the use of the instrument.

VI-1. SWITCHING-ON.

The instrument can be operated from an a.c. or d.c. power source.

VI-1.1. a.c. source.

- Set the AC-DC power selector switch to AC.
- Connect the instrument to the mains supply via the accessory mains cable.
- Set the POWER switch to ON.

VI-1.2. d.c. source.

It is recommended that the optional accessory PM 9207 d.c. power supply is used. This is fitted to the instrument in place of the base plate. The free connector of this accessory must be plugged into the fixed connector protruding from the under-side of the printed circuit board U2 before the accessory case is secured to the instrument. If an external d.c. supply is used, this is connected to the EXT. DC + 12 V connector at the rear of the instrument (the central pin of this connector is negative).

- Set AC-DC power selector to DC
- Set the POWER switch to ON.

Note: It is advisable to check the voltage of the d.c. supply (refer V.2). The optional PM 9207 has an external terminal for this purpose. Also, the LOW BATT indicator of the display is functional when using this accessory and will be lit if the battery voltage is inadequate (refer III.2).

VI-2. MEASURING.

The function required is set at the function selector.

VDC:	100 μV to 1000 V d.c.
VAC:	100 μV to 500 V r.m.s.
mADC:	100 nA to 1000 mA d.c.
mAAC:	100 nA to 1000 mA r.m.s.
kΩ:	0.1 Ω to 10 MΩ.

VI-2.1. d.c. voltages.

- Depress the switch VDC.
- Connect the voltage source to the INPUT terminals via the input cable.

Notes:

- The maximum permissible input is 1100 V.
- Maximum permissible voltage between the black (LO) input terminal and chassis is 600 V.
- Polarity indication is made.
- OVER range indication is not made for input voltages exceeding 1000 V d.c.

VI-2.2. a.c. voltages.

- Depress the switch VAC.
- Connect the voltage source to the INPUT terminals via the input cable.

Notes:

- OVER range indication is not made for input voltages exceeding 500 V r.m.s.

VI-2.3. d.c. currents.

- Depress the switch mADC.
- Connect the current circuit to the INPUT terminals via the input cable.

Notes:

- Maximum permissible input current is 3A.
- Maximum measurable input current is 1A and an overcurrent protector is actuated for input currents exceeding 1.6A, disconnecting the measuring circuit. Measurement can be resumed by pushing the protector button on the rear panel.
- OVER range indication is made for currents exceeding 1A, unless the protector has been actuated.
- Polarity indication is made.

VI-2.4. a.c. currents.

- Depress the switch mAAC.
- Connect the current circuit to the INPUT terminals via the input cable.

Note: As 2.3., but there is no polarity indication for a.c. currents.

VI-2.5. Resistance.

- Depress the switch kΩ.
- Connect the unknown resistance to the input terminals via the input cable.

Notes:

- Maximum permissible voltage at the input terminals when measuring resistance is 100 V (continuous) or 200 V (5 sec. duration).

- In a noisy environment, particularly when measuring resistance, the display may vary considerable. If this does occur, connect the (LO) input terminal to the ground (chassis) terminal. Otherwise, place the unknown resistance inside a shielded box.

VI-3. GENERAL NOTES.

VI-3.1. Polarity indication.

For d.c. measurements (VDC, mADC) the polarity of the input signal is indicated to the left of the display. The indicated polarity is that of the red (HI) input terminal with respect to the black (LO) input terminal.

VI-3.2. Range-hold.

When the RANGE-HOLD terminals are shorted, the range, prior to applying the short, is held and the position of the decimal point is fixed. Automatic ranging has been inhibited.

Example.

Input	Display	Range hold terminals
0 V	.0000	Open
+ 19.19 V	+ 19.19	Open
+ 19.19 V	+ 19.19	Shorted
0 V	00.00	Shorted

VI-3.3. Sample-hold.

When the SAMPLE-HOLD terminals are shorted the complete display, prior to applying the short, is held.
It remains held until the short is removed.

VI-3.4. Overrange indication.

The OVER indicator is situated above the polarity indicator and is lit when:

- The input signal exceeds the held measurement range.
- Set to kΩ with the INPUT terminals open and autoranging.

I. Einleitung

ALLGEMEINES

Das PM 2424 ist ein digitales Vielfachmessgerät mit 4-stelliger Anzeige; ihr höchster Ziffernwert ist: 9999.
Das Gerät hat folgende Messbereiche:

- Gleichspannung	:	100 µV bis 1000 V
- Wechselspannung (effektiv)	:	100 µV bis 500 V eff.
- Gleichstrom	:	100 nA bis 1000 mA
- Wechselstrom (effektiv)	:	100 nA bis 1000 mA eff.
- Widerstand	:	100 mΩ bis 10 MΩ

Für alle Messfunktionen ist ein Ueberlastungsschutz eingebaut.
Messbereich, Polarität bei Gleichstrom-/Gleichspannungsmessungen und Kommaposition werden vollautomatisch bestimmt. Ausserdem können angezeigter Bereich und Messwertanzeige festgehalten werden.
Automatische Nullpunkt-Konpensation und -Korrektur vor jeder Messung garantieren eine extrem hohe Genauigkeit.
Durch den Einsatz von Kleinleistungs- und MOS-LSI Festkörperschaltkreisen wird ein geringer Eigenstromverbrauch des Gerätes erreicht.
Sowohl Netz- als auch Batteriebetrieb sind möglich.
Dazu kann auf Wunsch der Zusatz PM9207 geliefert werden, der das Gerät vom Netz völlig unabhängig macht.

II. Technische Daten

Zahlenwerte mit Toleranzangaben werden vom Hersteller garantiert.
Werte ohne Toleranzen dienen der Information und stellen den jeweils serientypischen Wert eines Instrumentes dar.

II-1. ELEKTRISCHE SPEZIFIKATIONEN.

II-1.1. Gleichspannungsmessungen.

Messbereiche:	1/10/100/1000 V.
Bereichswahl:	vollautomatisch.
Höchstempfindlichkeit:	100 µV.
Auflösung:	1/9999.
Eingangsimpedanz:	Grösser als 1000 MΩ für 1 V und 10 V-Bereich, 10 MΩ für 100 bis zum 1000 V-Bereich.
Genauigkeit:	± 0.01% der Anzeige ± 0.01% vom Bereichsendwert ± 1 Ziffer (bei 23°C ± 2°C und weniger als 85% Feuchtigkeit)
Temperaturkoeffizient:	0.005% der Anzeige/°C in allen Bereichen
Stabilität:	0.02% der Anzeige für 1 V-Bereich, 0.01% der Anzeige für 10 V-Bereich, 0.02% der Anzeige für 100/1000 V-Bereich.
Eingangsversatzstrom:	kleiner als 1 nA.
Ueberspannungsschutz	1100 V max.
Ansprechzeit:	0.2 sek. (ohne Bereichswechsel).

II-1.2. Wechselspannungsmessungen.

Messbereiche:	1/10/100/500 V eff.
Bereichswahl:	vollautomatisch
Höchstempfindlichkeit:	100 µV
Auflösung:	1/9999
Eingangsimpedanz:	1 MΩ über 100 pF.
Genauigkeit:	± 0.3% der Anzeige ± 0.2% vom Bereichsendwert ± 1 Ziffer für 1/10/100 V-Bereich (Frequenz: 45 Hz bis 20 kHz). ± 0.5% der Anzeige ± 0.5% vom Bereichsendwert ± 1 Ziffer für 1/10/100 V-Bereich (Frequenz: 40 Hz bis 50 kHz). ± 0.5% der Anzeige ± 0.5% vom Bereichsendwert ± 1 Ziffer für den 500V-Bereich (Frequenz: 45 Hz bis 10 kHz) (bei 23°C ± 2°C und weniger als 85% Feuchtigkeit).

Temperaturkoeffizient:	0.02% der Anzeige/°C
Stabilität (180 Tage):	0.05% der Anzeige
Ueberspannungsschutz:	500 V eff. max.
Ansprechzeit:	2.5 sek. (ohne Bereichswechsel)

II-1.3. Gleichstrommessungen.

Messbereiche:	1/10/100/1000 mA
Bereichswahl:	vollautomatisch
Höchstempfindlichkeit:	100 nA
Auflösung:	1/9999
Genauigkeit:	± 0.2% der Anzeige ± 0.01% vom Bereichsendwert ± 1 Ziffer für 1/10/100 mA-Bereich ± 0.3% der Anzeige ± 0.01% vom Bereichsendwert ± 1 Ziffer für 1000 mA-Bereich (bei 23°C ± 2°C und weniger als 85% Feuchtigkeit)
Temperaturkoeffizient:	0.01% der Anzeige/°C
Stabilität (180 Tage):	0.02% der Anzeige
Ueberstromschutz:	3 A max.
Ansprechzeit:	0.2 sek. (ohne Bereichswechsel)

II-1.4 Wechselstrommessungen.

Messbereiche:	1/10/100/1000 mA
Bereichswahl:	vollautomatisch
Höchstempfindlichkeit:	100 nA
Auflösung:	1/9999
Genauigkeit:	± 0.5% der Anzeige ± 0.2% vom Bereichsendwert ± 1 Ziffer für 1/10/100 mA-Bereich ± 0.7% der Anzeige ± 0.2% vom Bereichsendwert ± 1 Ziffer für 1000 mA-Bereich (bei 23°C und weniger als 85% Feuchtigkeit).
Temperaturkoeffizient:	0.02% der Anzeige/°C
Stabilität (180 Tage):	0.05% der Anzeige
Ueberstromschutz:	3 A max.
Ansprechzeit:	2.5 sek. (ohne Bereichswechsel)

II-1.5 Widerstandmessungen.

Messbereiche:	1/10/100/1000/10000 kΩ
Bereichswahl:	vollautomatisch
Höchstempfindlichkeit:	100 mΩ
Auflösung:	1/9999

Genauigkeit:	± 0.1% der Anzeige ± 0.01% vom Bereichsendwert ± 1 Ziffer für 1/10 kΩ-Bereich ± 0.2% der Anzeige ± 0.01% vom Bereichsendwert ± 1 Ziffer für 100 kΩ-Bereich ± 0.8% der Anzeige ± 0.02% vom Bereichsendwert ± 1 Ziffer für 1000 kΩ-Bereich ± 1.5% der Anzeige ± 0.05% vom Bereichsendwert ± 1 Ziffer für 10.000 kΩ-Bereich (bei 23°C ± 2°C und weniger als 85% Feuchtigkeit).
Temperaturkoeffizient:	0.015% der Anzeige/°C für 1/10/100 kΩ-Bereich 0.03 % der Anzeige/°C für 1000 kΩ-Bereich 0.07 % der Anzeige/°C für 10000 kΩ-Bereich
Stabilität (180 Tage):	0.03 % der Anzeige für 1/10/100 kΩ-Bereich 0.05 % der Anzeige für 1000 kΩ-Bereich 0.1 % der Anzeige für 10.000 kΩ-Bereich
Ueberspannungsschutz:	100 V max. ≅ -Spannung für Dauermessung 200 V max. ≅ -Spannung für 5 sek-Messung
Ansprechzeit:	0.2 sek (ohne Bereichswechsel)

II-2. ALLGEMEINE ANGABEN.

Betriebsart:	Integrierendes Messverfahren
Eingangsbuchse:	Schwebend
Abtastgeschwindigkeit:	2 - 5 Abtastungen/sek.
Bereichswahlzeit:	200 bis 300 msek/Bereich
Polaritätsanzeige:	+ oder -, automatisch
Spannungsfestigkeit:	600 V ⎓ zwischen Chassis und schwarzer Buchse (LO)
Anzeige-Speicherung:	gemessenes Resultat und Bereich können festgehalten werden.
CMRR (Eingang Gleichtaktunterdrückung):	50 dB (Netzbetrieb)
SMRR (Analog-Digital-Umsetzer):	40 dB (Netzbetrieb)
Stromversorgung:	220 V ± 10%, 50/60 Hz Bemerkg.: Netztrafo kann auf andere Netzspannungen umgeschaltet werden.
Gleichstrombetrieb:	Externe + 12 V -Versorgung Betrieb zwischen + 10 V und + 15 V zugelassen
Aufnahmeleistung:	ca. 9 VA bei Netzbetrieb ca. 3 VA bei Gleichstromversorgung.

II-3. MECHANISCHE ANGABEN.

Abmessungen:	Breite 200 mm Höhe 72 mm Tiefe 253 mm
Gewicht:	ca. 2,1 kg

III. Zubehör

III-1.DAS GERAET WIRD GELIEFERT MIT:

- Netzkabel mit Steckern
- Erdungskabel
- Messkabel
- zwei Kurzschlussstecker fur Bereichs- und Messwertfixierung
- Uebergangsstecker für externe Gleichstromversorgung
- Sicherung, 50 mA, träge
- Handbuch

III-2.AUF WUNSCH LIEFERBAR:

- Gleichstromversorgungsteil PM 9207.

Dieses Stromversorgungsteil (Abb. 1) besteht aus einem Aluminiumgehäuse, das aufgrund seiner Konstruktion unter dem Multimeter statt der Bodenplatte befestigt werden kann. Es enthält 10 aufladbare 1,5 V-Nickel-Kadmium-Batterien. Ausserdem sind eine Schaltung (Abb. 39) zur Unterspannungsanzeige und ein Lade-Schaltkreis für Batterieladung aus dem Netz eingebaut.
Die elektrische Verbindung zum Vielfachmessgerat erfolgt über den Stecker (BU363) mit dem Gegenstecker (BU364) an der Unterseite der gedruckten Schaltung U2. Ueber eine Anschlussbuchse am Gehäuse kann der Ladezustand der Batterien ohne Schwierigkeiten kontrolliert werden.

Abmessungen:	Breite	160 mm
	Höhe	30 mm
	Tiefe	210 mm
	Gewicht	1 kg

Bemerkungen:

- R25 der Unterspannungsanzeige ist so einzustellen, dass die LOW BATT-Anzeige bei einer Batteriespannung unter + 10 V erfolt.
- Der Lade-Schaltkreis ist immer eingeschaltet, wenn das Gerät mit dem Netz verbunden ist; unanhängig vom Spannungswähler und der Stellung des Speisungswahlschalters. Daher ist es WICHTIG, dass das Gerät nur dann mit dem Netz verbunden wird, wenn der Batterie-Einschub wiederaufladbare Batterien enthält.

IV. Kurzbeschreibung

Ein vereinfachtes Blockschaltbild zeigt Abb.2.

IV-1. ANALOG-TEIL.

Der Analogteil umfasst den Eingangskreis und den Analog-Digital-Umsetzer (ADC).

IV-1.1. Eingangskreis

Die Funktions-Wahlschaltung wählt den der jeweils durchzuführenden Messung entsprechenden Block in der Messschaltung an. Alle Eingangssignale werden im Eingangskreis in Gleichspannungen umgesetzt.

- Gleichspannung.
  Der Eingang wird mit der Teil (Block) DCV/ ATT verbunden, die die unbekannte Gleichspannung entsprechende dm Bereich herunterteilt.

- Wechselspannung.
  Der Eingang ist mit ACV/DCV verbunden, die die Eingangsspannung herunterteilt, gleichrichtet und zu einer Gleichspannung glättet.

- Gleichstrom.
  Mit dem gemessenen Eingangsstrom wird die 1/V-Teilschaltung beaufschlagt; dort durchläuft der unbekannte Strom einen Shunt-Widerstand, dessen Wert dem jeweiligen Bereich angepasst ist. Der so gemessenen Spannungsabfall wird dem Bereichsverstärker des Analog-Digital-Umsetzers zugeführt.

- Wechselstrom.
  siehe: Gleichstrommessung; hier wird allerdings der Ausgang der 1/V-Teilschaltung mit dem Eingang der ACV/DCV verbunden (und nicht direkt mit dem Bereichsverstärker).

- Widerstand (Abb. 3).
  Ein bestimmter Stromwert wird durch den unbekannten Widerstand Rx geschickt. Dann wird der Spannungsabfall über Rx dem Bereichsverstärker zugeführt.
  Diese Messung erfolgt nach folgenden Gleichungen:

$$Vx = Is.Rx$$

es ist aber

$$Is = \frac{-V_{REF} - (-Vo)}{Rs} = -\frac{(V_{REF} - Vo)}{Rs}$$

hierin sind

Is: konstanter Messstrom

Rs: Standardwiderstand

$-V_{REF}$: negative Referenzspannung

- Vo: von $-V_{REF}$ abgeleitete Spannung
Rx: unbekannter Widerstand
Vx: Spannung über Rx.

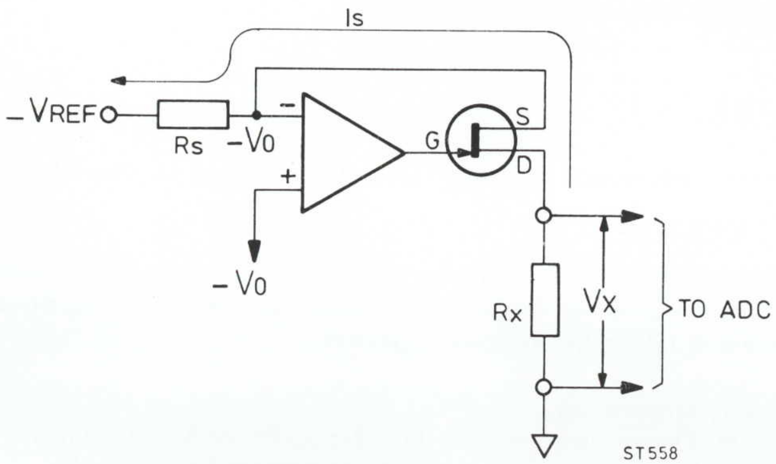


Fig. 3. Prinzip der Widerstandsmessung.

IV-1.2. Analog-Digital-Umsetzer (ADC)

Das Messgerät arbeitet mit einem Doppel-Integrationssystem im ADC und einer Periode für automatische Null-Korrektur.
Die Gleichspannung aus der Eingangsschaltung wird dem Bereichsverstärker zugeführt, in dem sie fur eine optimale Bereichswahl verstärkt wird.
Der Ausgangswert des Bereichsverstärkers läuft dem Integrator zu. Ein Schema dieses Integrators zeigt Abb. 4.

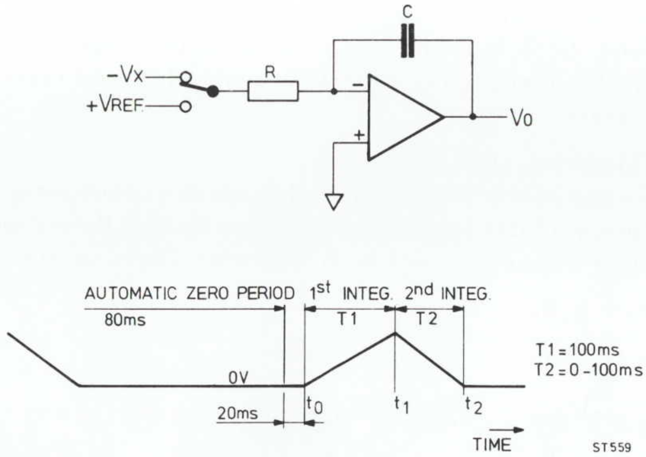


Fig. 4. Analog/Digital-Wandlersystem

Im Laufe des Referenzzeitraumes ($t_o \rightarrow t_1$), wird die Eingangsspannung - Vx integriert.

Nach erfolgter erster Integration wird das Integratoreingangssignal auf eine Referenzspannung mit einer der Eingangsspannung entgegengesetzten Polarität geschaltet. Die Referenzspannung wird integriert. Am Ausgang des Integrators entsteht dann eine in Nullrichtung fallende Spannung.

Der Durchgang dieser Ausgangsspannung Vo durch die Null-Linie wird von einem Komparator festgestellt, der dann die zweite Integration abbricht.
Durch Messung der Dauer dieser zweiten Integration wird die Grösse des Eingangssignals festgestellt.

Die genannte Messmethode bedient sich folgender Formeln:

$$Vo = \frac{1}{c} \int_{t_o}^{t_1} \frac{(-Vx).}{R} \; dt \quad + \frac{1}{c} \int_{t_o}^{t_2} \frac{(V_{REF})}{R} \, dt \quad = \quad 0$$

aber

$$t_1 - t_o = T1, \quad t_2 - t_1 = T2$$

$$\therefore \quad Vo = \frac{T1}{CR} \; . \; (-Vx) \; + \; \frac{T2}{CR} \; . \; V_{REF}, \; = \; 0$$

$$\therefore \; \frac{T1}{CR} \; . \; Vx = \frac{T2}{CR} \; . \; V_{REF}$$

$$\therefore \; T2 = \frac{T1}{V_{REF}} \; . \; Vx$$

aber

darin sind T1 und V_{REF} bekannt und konstant.

$$\therefore \quad T2 = KVx.$$

Die automatische Null-Korrektur erfolgt vor der ersten Integration; die Versatzspannungen (offset) des Bereichsverstärkers, des Integrationsverstärkers und des Integrationsverstärkers und des Integrators werden gespeichert.
Die interne Zeitkorrelation wird vom Digitalteil überwacht und gesteuert.

IV-2. DIGITALTEIL.

IV-2.1. Anzeige und Logik

IV-2.1.1. Steuerkreis.

Der Zähler und der Komparator liefern die Steursignale.
Der Steuerkreis erfüllt folgende Funktionen.

- Erzeugung der ersten Integrationsperiode
- Blockierung des Taktgebers nach Ablauf der ersten Integration
- Erzeugung des Speicherimpulses nach Abschluss der zweiten Integration
- Polaritätswahl der Referenzspannung für die zweiten Integration
- Erzeugung der Periode für die automatische Null-Korrektur

- Erzeugung der Einstellzeiten
- Erzeugung des DOWN- und UP-Signals.

IV-2.1.2. Speicherimpuls.

Dieser Impuls wird nach Abschluss der zweiten Integration erzeugt. Er blockiert den Taktgeber und überträgt den Zählerinhalt in die Verriegelungsschaltung für die Zifferanzeige (Anzeigespeicher).

IV-2.1.3. Zähler und Anzeigezwischenspeicher.

Der Zähler ist aus vier BCD-Dekaden aufgebaut und zählt die Taktimpulse (100 kHz). Der Inhalt der vier Dekadenzähler wird der Ziffernanzeige über einen Anzeige-zwischenspeicher bei Auftreten eines Speicherimpulses zugeführt.

IV-2.1.4. Messwertfixierung.

Soll der Messwert in der Anzeige festgehalten werden, wird die Erzeugung des Speicherinpulses blockiert. Auf diese Weise wird die Anzeige konstant gehalten, da der Speicherimpuls als Uebertragungsimpuls zwischen Zähler und Anzeigespeicher. seine Funktion nicht ausüben kann.

IV-2.1.5. Over (Anzeige: Bereichsüberschreitung).

Tritt der Speicherimpuls nicht innerhalb von 100 msek nach dem Beginn der zweiten Integration auf, wird das OVER-Signal erzeugt. Erfolgt dies bei Bereichsfixierung, leuchtet die OVER-Anzeige konstant.

IV-2.1.6. Polarität.

Die Polarität wird nach Beginn der zweiten Integration bestimmt und nach Auftreten des Speicherimpulses zur Anzeige gebracht.

IV-2.2. Bereichsautomatik.

IV-2.2.1. Bereichsautomatik und Relaissteuerung.

Die Bereichsautomatik wählt und schaltet den der Grösse des Eingangssignals optimal entsprechenden Bereich, Ausserdem werden die für die FET- und Relaisschaltungen benötigten Steuersignale erzeugt. Schliesslich erfolgt hier auch die Dekodierung für die korrekte Anzeige der Kommaposition.

IV-2.2.2. Bereichsfixierung.

Soll der Bereich in der Anzeige festgehalten werden, wird die Bereichsautomatik und das Komma festgehalten.

V. Installation

GEBRAUCHSANWEISUNG

V-1 STROMVERSORGUNG

V-1.1. Netzbetrieb.

Das Messgerät ist eingestellt auf eine Netzspannung von 220 V, 50/60 Hz, kann aber durch Umschaltung am Netztrafo (siehe: Abb 40) auch an anderen Netzspannungen verwendet werden. Das Gerätegehäuse ist über das Netzkabel geerdet.

V-1.2. Batteriebetrieb.

Das Gerät kann mit einer Gleichspannung zwischen + 10 V und + 15 V betrieben werden. Empfohlen wird dazu ein auf Wunsch lieferbarer Batterieteil PM 9207, der mit dem Messgerät ein organisches Ganzes bildet. Erdung des Instrumentengehäuses erfolgt über einen Anschlusspunkt an der Gehäuserückseite.

V-2 REGLER UND ANSCHLUESSE

Frontplatte Abb. 5.		
No.	Bezeichnung	Funktion
1	Ziffernanzeige	4-stellige nummerische Anzeige Anzeige-Maximalwert: 9999 automatische Kommapositionierung
2	Polaritäts-anzeige	+ oder - , automatisch angezeit bei Gleichstrom- und Gleichspannungsmessungen
3	OVER-Anzeige	Anzeige bei Ueberschreitung des höchsten Messbereiches durch das gemessene Signal.
4	LOW BATT	Anzeige, dass die Spannung des Batterie-Einschubes (lieferbarer Zusatz PM 9207) zwischen + 5 V und + 10 V liegt und für eine einwandfreie Funktion des Messinstrumentes unzureichend ist.
5	Funktions-wahlschalter	Einstellung der gewünschten Messfunktion
	VDC	Gleichspannungsmessung
	VAC	Wechselspannungsmessung
	mADC	Gleichstrommessung
	mAAC	Wechselstrommessung
	kΩ	Widerstandmessung

Rechte Seitenplatte Abb. 6		
Nr.	Bezeichnung	Funktion
6	POWER Schalter	ON/OFF-Schalter für Batterie- und Netzbetrieb
7	INPUT Buchsen	Ueber die Messkabel wird das Eingangssignal diesen Eingangsbuchsen zugeführt. Rote Buchse HI (Messbuchse) Schwarze Buchse LO (Massebuchse
8	SAMPLE HOLD	Durch Ueberbrückung mit dem mitgelieferten zweipoligen Kurzschlussstecker wird der angezeigte Messwert festgehalten (bis der Stecker wieder entfernt wird).
9	RANGE HOLD	Durch Ueberbrückung mit dem mitgelieferten zweipoligen Kurzschlussstecker wird die Kommaposition festgehalten (bis der Stecker wieder entfernt wird).

Rückseite Abb.7		
Nr.	Bezeichnung	Funktion
10	Netzbuchse	Ueber Netzkabel erfolgt hier die Verbindung mit dem Netz.
11	AC-DC Stromversorgungs Wahlschalter	Wahl der Stromversorgung (Wechsel-/Gleichspannung.
12	EXT.DC + 12 V	Anschluss für externe Gleichstromversorgung. Bemerkg.: Die Verbindung mit dem Batterie-Einschub (Zusatz PM 9207) erfolgt nicht über diesen Anschluss.
13	Erdungsanschluss	Ueber diesen Anschluss erfolgt die Erdung des Messgerates, wenn mit Batteriebetrieb der EXT DC + 12 V Betrieb gearbeitet wird.
14	Sicherung	Netzsicherung, 50 mA, träge
15	PROTECTOR	Ueberstromsicherung bei Strommessungen. Nach Ansprechen des Automaten können die Messungen erst fortgesetzt werden, wenn vorher der Knopf wieder eingedrückt wurde.

VI. Bedienung

Bemerkung: Wichtig ist, dass die Kalibrierung (siehe: Wartungsangaben) bei Gebrauch des Messgerätes nicht länger als 6 Monate zurückliegt.

VI-1.EINSCHALTEN

Das Gerat kann sowohl mit Netz- als auch mit Batterieversorgung betrieben werden.

VI-1.1. Netzbetrieb.

- AC-DC-Stromversorgungswahlschalter auf AC schalten
- Gerät über Netzkabel mit dem Netz verbinden.
- POWER-Schalter auf ON.

VI-1.2. Batteriebetrieb.

Hierzu wird die Verwendung des lieferbaren Zusatzes PM 9207 (Batterie-Einschub) empfohlen Dieser wird an Stelle der Bodenplatte mit dem Messgerät verbunden. Der Stecker des Zusatzes ist dazu (vor der Befestigung des Zusatzes am Gerät) mit dem an der Unterseite der gedruckten Schaltung U2 befindlichen Gegenstück zu verbinden. Bei Benutzung einer externen Gleichstromquelle erfolgt deren Verbindung über den EXT. DC + 12 V - Anschluss an der Rückseite des Instrumentes (der Mittelstift dieses Anschlusses ist "negativ").

- AC-DC-Stromversorgungswahlschalter auf DC schalten.
- POWER-Schalter auf ON.

Bemerkung: Empfohlen wird die Ueberprüfung der Spannung der Batterieversorgung. Dazu hat der Zusatz PM 9207 einen herausgeführten Testanschluss. Ausserdem leuchtet bei Verwendung des PM 9207 mit ungenügender Gleichspannung die LOW BATT - Anzeige auf (siehe: III-2).

VI-2 MESSEN.

Die gewünschte Messfunktion wird mit dem Funktionswahlschalter eingestellt.

VDC:	100 µV bis 1000 V Gleichspannung
VAC:	100 µV bis 500 V Wechselspannung (effektiv)
mADC:	100 nA bis 1000 mA Gleichstrom
mAAC:	100 nA bis 1000 mA Wechselstrom effektiv.
kΩ:	0.1 Ω bis 10 MΩ

VI-2.1. Gleichspannungen

- Taste VDC bestätigen.
- Mit dem Messkabel (INPUT-Anschluss) Spannungsmessung durchführen.

Bemerkungen:

- Die maximal zulässige Eingangsspannung beträgt 1100 V.
- Die höchstzulässige Spannung zwischen der schwarzen (LO) Eingangsbuchse und dem Chassis beträgt 600 V.
- Polaritätsanzeige muss erfolgen
- OVER-Anzeige (maximal zulässiger Messbereich ist überschritten) erfolgt hier nicht bei Spannungen, die 1000 V übersteigen.

VI-2.2. Wechselspannungen.

- Taste VAC bestatigen
- Spannungsmessung mit dem Messkabel (INPUT-Anschluss) durchführen

Bemerkung:

- OVER-Anzeige erfolgt hier nicht bei Spannungen, die 500 V eff. überschreiten

VI-2.3. Gleichströme

- Taste mADC bestätigen
- Strommessung mit dem Messkabel (INPUT-Anschluss) durchführen

Bemerkungen:

- Höchstzulässiger Eingangsstrom ist 3 A
- Der höchste Stromwert, der mit diesem Instrument gemessen werden kann, beträgt 1 A; bei Strömen, die 1,6 A überschreiten, spricht eine Ueberstromsicherung an, die die Messchaltung vom Messeingang abtrennt. Die Messungen können fortgesetzt werden, nachdem der Automat wieder eingeschaltet wurde.
- OVER-Anzeige (Ueberschreitung des höchstzulässogen Messwertes) erfolgt bei Strömen über 1 A, wenn der Ueberstromsicherungsautomat noch nicht angesprochen hat.
- Polarität wird automatisch angezeigt.

VI-2.4. Wechselströme.

- Taste mAAC bestätigen
- Strommessung mit dem Messkabel (INPUT-Anschluss) durchführen.

Bemerkung: siehe 2.3, ohne Polaritätsanzeige.

VI-2.5. Widerstände

- Taste kΩ bestätigen
- Unbekannten Widerstand über Messkabel mit den Eingangsbuchsen (INPUT) verbinden.

Bemerkungen:

- Höchstzulässige Spannung bei Widerstandsmessung an den Eingangsbuchsen ist 100 V (Dauer) oder 200 V (5 sek).

- Bei starken Störungen - vor allem bei Widerstandsmessungen kann die Anzeige sehr unruhig sein. In diesem Fall ist die (LO) Eingangsbuchse mit Masse (Chassis) zu verbinden. Andernfalls muss der zu messende Widerstand in einem abgeschirmten Gehäuse gemessen werden.

VI-3 ALLGEMEINE HINWEISE

VI-3.1. Polaritätsanzeige.

Bei Gleichstrom/-Spannungsmessungen (VDC, mADC) wird die Polaritat des Eingangssignals links von der Ziffernanzeige dargestellt. Die Anzeige entspricht der Polarität der roten (HI) Eingangsbuchse gegenüber dem schwarzen (LO) Anschluss.

VI-3.2. Messbereichsfixierung.

Werden die RANGE-HOLD-Buchsen kurzgeschlossen, wird der Messbereich, der vor der Ueberbrückung eingestellt war, gehalten und die Kommaplatzierung fixiert. Automatische Bereichswahl ist damit blockiert.

Beispiel:

Eingangswert	Anzeige	RANGE HOLD-Buchsen
0 V	. 0000	Offen
+ 19.19 V	+ 19.19	Offen
+ 19.19 V	+ 19.10	Ueberbrückt
0 V	00.00	Ueberbrückt

VI-3.3. Messwertfixierung.

Werden die SAMPLE-HOLD-Buchsen überbrückt, wird die Gesamtanzeige vor der Ueberbrückung fixiert.
Sie bleibt bis zur Entfernung des Kurzschlusssteckers fixiert.

VI-3.4. Anzeige: Bereichsüberschreitung.

Die OVER-Anzeige ist oberhalb der Polaritätsanzeige angebracht, und leuchtet auf, wenn:

- das Eingangssignal den fixierten Messbereich überschreitet,
- der Messfunktionswahlschalter auf kΩ eingestellt ist und die Eingangsbuchsen offen sind (bei automatischer Bereichswahl).

I. Introduction

GENERALITES

Le PM 2424 est un multimètre digital à affichage maximal de 4 chiffres 9999.

L'appareil peut mesurer:

- des tensions continues de 100 µV à 1000 V
- des tensions alternatives de 100 µV à 500 V eff
- des courants continus de 100 nA à 1000 mA
- des courants alternatifs de 100 nA à 1000 mA eff
- des résistances de 100 mΩ à 10 MΩ

Il y a protection de toutes les fonctions de mesure.
La gamme de mesure, la polarité pour mesures de continu et la position du point décimal sont toutes déterminées de façon entièrement automatique.
Cependant, il existe des possibilités de maintien de gamme et d'étalon.
Des précisions extrêmement hautes sont obtenues par la correction automatique de la dérive zéro à effectuer avant chaque mesure.
La consommation de puissance de l'appareil est basse à la suite de l'utilisation de circuits digitaux intégrés à basse puissance et MOS-LSI.
L'appareil peut fonctionner sur secteur ou par une alimentation continue.
L'alimentation continue produite par l'accessoire en option PM 9207 permet d'exploiter pleinement le caractère portable de l'appareil.

II. Caractéristiques techniques

Les propriétés exprimées en valeurs numériques avec tolérances sont garanties par le fabricant. Les valeurs numériques sans tolérance servent à titre d'information et représentent les propriétés d'un appareil moyen.

II-1. SPECIFICATIONS ELECTRIQUES

II-1.1. Mesure de tension continue

Gamme:	1/10/100/1000 V
Sélection de gamme:	complètement automatique
Sensibilité maximale:	100 µV
Résolution:	1/9999
Impédance d'entrée:	Plus de 1000 MΩ pour gammes 10 V, 10 MΩ pour gammes 100/1000 V
Précision:	± 0.01% d'affichage ± 0.01% en fin de gamme ± 1 chiffre (à une température de 23°C ± 2°C et une humidité inférieure à 85%)
Coefficient de température:	0.005% d'affichage/°C dans toutes les gammes
Stabilité (180 jours):	0.02% d'affichage pour gamme 1 V 0.01% d'affichage pour gamme 10 V 0.02% d'affichage pour gammes 100/1000 V
Courant offset d'entrée:	Moins de 1 nA
Protection:	1100 V max.
Temps de réponse:	0.2 sec (sans modification de gamme)

II-1.2. Mesure de tension alternative.

Gamme:	1/10/100/500 V eff
Sélection de gamme:	Complètement automatique
Sensibilité maximale	100 µV
Résolution	1/9999
Impédance d'entrée	1 MΩ shunté par 100 pF
Précision: (à température de 23°C ± 2°C et humidité inférieure à 85%)	± 0.3% d'affichage ± 0.2% en fin de gamme ± 1 chiffre pour gammes 1/10/100 V (fréquence: 45 Hz à 20 kHz) ± 0.5% d'affichage ± 0.5% en fin de gamme ± 1 chiffre pour gammes 1/10/100 V (fréquence: 40 Hz à 50 kHz) ± 0.5% d'affichage ± 0.5% en fin de gamme ± 1 chiffre pour gamme 500 V (fréquence: 45 Hz à 10 kHz)

Coefficient de température:	0.02% d'affichage/^{o}C
Stabilité (180 jours):	0.05% d'affichage
Protection:	500 V eff max.
Temps de réponse:	2.5 sec (sans changement de gamme)

II-1.3. Mesure de courant continu.

Gamme:	1/10/100/1000 mA
Sélection de gamme:	complètement automatique
Sensibilité maximale:	100 nA
Résolution:	1/9999
Précision: (à température de 23^{o}C $\pm$ 2^{o}C et humidité inférieure à 85%)	$\pm$ 0.2% d'affichage $\pm$ 0.01% en fin de gamme $\pm$ 1 chiffre pour gammes 1/10/100 mA $\pm$ 0.3% d'affichage $\pm$ 0.01% en fin de gamme $\pm$ 1 chiffre pour gamme 1000 mA
Coefficient de température:	0.01% d'affichage/^{o}C
Stabilité (180 jours):	0.02% d'affichage
Protection:	3 A max.
Temps de réponse:	0.2 sec. (sans changement de gamme)

II-1.4 Mesure de courant alternatif.

Gamme:	1/10/100/1000 mA
Sélection de gamme:	complètement automatique
Sensibilité maximale:	100 nA
Résolution:	1/9999
Précision: (à température 23^{o}C $\pm$ 0.2^{o}C et humidité inférieure à 85%)	0.5% d'affichage $\pm$ 0.2% en fin de gamme $\pm$ 1 chiffre pour gammes 1/10/100 mA 0.7% d'affichage $\pm$ 0.2% en fin de gamme 1000 mA
Coefficient de température:	0.02% d'affichage/^{o}C
Stabilité (180 jours):	0.05% d'affichage
Protection:	3 A max
Temps de résponse	2.5 sec (sans changement de gamme)

II-1.5. Mesure de résistance.

Gamme:	1/10/100/1000/10000 kΩ
Sélection de gamme:	complètement automatique
Sensibilité maximale:	100 mΩ
Résolution:	1/9999

Précision: (à température de 23°C ± 2°C et humidité inférieure à 85%)	± 0.1% d'affichage ± 0.01% en fin de gamme ± 1 chiffre pour gammes 1/10 kΩ
	± 0.2% d'affichage ± 0.01% en fin de gamme ± 1 chiffre pour gamme 100 kΩ
	± 0.8% d'affichage ± 0.02% en fin de gamme ± 1 chiffre pour gamme 1000 kΩ
	± 1.5% d'affichage ± 0.05% en fin de gamme ± 1 chiffre pour gamme 10000 kΩ
Coefficient de température:	0.15% d'affichage/°C pour gammes 1/10/100 kΩ
	0.3% d'affichage/°C pour gamme 1000 kΩ
	0.07% d'affichage/°C pour gamme 10000 kΩ
Stabilité (180 jours):	0.03% d'affichage pour gammes 1/10/100 kΩ
	0.05% d'affichage pour gamme 1000 kΩ
	0.1 % d'affichage pour gamme 10000 kΩ
Protection:	100 V max. en alternatif/continu pour entrée continue
	200 V max. en alternatif/continu pour entrée 5 sec.
Temps de réponse:	0.2 sec (sans changement de gamme)

II-2. DONNEES GENERALES.

Type de fonctionnement:	Intégrant
Borne d'entrée:	Flottement complet
Vitesse d'échantillonnage:	2 à 5 échantillons/sec.
Temps de sélection de gamme:	200 ms-300 ms/gamme
Affichage de polarité:	+ ou - peut être affiché automatiquement
Isolement:	600 V continu entre châssis et borne noir (LO)
Maintien d'affichage:	Résultat mesuré et gamme peuvent être retenus
Réjection de mode commun (entrée)	50 dB (fonctionnement secteur)
Réjection de mode série (convertisseur analogue-digital)	40 dB (fonctionnement secteur)
Puissance requise:	220 V ± 10%, 50/60 Hz
	Remarque: Le transformateur secteur peut être endommagé par d'autres tensions secteur.
Fonctionnement en continu:	Externe + 12 V alimentation continue
	Fonctionnement possible de + 10 V à + 15 V
Consommation:	env. 9 VA en fonctionnement secteur
	env. 3.5 V en fonctionnement sur alimentation continue

II-3. DONNES MECANIQUES.

Dimensions:	Largeur 200 mm Hauteur 72 mm Profondeur 253 mm
Poids:	env. 2,1 kg.

III. Accessoires

III-1. LIVRÈS AVEC L'APPAREIL.

- câbles d'entrée secteur avec connecteurs
- fil de terre
- fils de mesure
- deux fiches de court-circuitage pour fonctions de gamme et de maintien d'échantillon
- connecteur pour entrée d'alimentation continue
- fusible 50 mA à action différée
- notice d'emploi et d'entretien

III-2 EN OPTION.

- alimentation continue PM 9207

Cette alimentation (Fig. 1) est un boîtier d'aluminium à fixer sous le multimètre digital PM 2424 en place de la plaque de base. Elle contient un jeu de 10 batteries 1,5 V nickel-cadmium rechargeables. Elle présente un circuit (Fig. 30) qui permet de produire une indication basse tension sans affichage et un circuit de charge permettant de recharger les batteries par l'intermédiaire de l'alimentation secteur au multimètre.

Les connexions électriques vers le circuit de multimètre sont réalisées en enfichant le connecteur libre (BU363) dans le connecteur fixe (BU364) sur la partie inférieure de la platine U2. Une borne externe sur le boîtier permet de contrôler facilement l'état des batteries.

Dimensions:	Largeur	160 mm	env.
	Hauteur	30 mm	
	Profondeur	210 mm	
	Poids	1 kg	

Remarques:

- R 25 du circuit d'indicateur basse tension doit être réglé de telle sorte que l'indication LOW BATT est visible sur l'affichage lorsque la tension du jeu de batteries est inférieure à + 10 V continu.
- Le circuit de charge pour les batteries fonctionne lorsque le multimètre est connecté à l'alimentation secteur indépendamment des réglages de puissance et de sélection de puissance. C'est pourquoi il est IMPORTANT que le secteur soit uniquement connecté au multimètre lorsque le jeu de batteries est composé de batteries rechargeables.

IV. Principe de functionnement

Un schéma synoptique simplifié est représenté à la figure 2.

IV-1.SECTION ANALOGUE.

La section analogue est composée d'un circuit d'entrée et d'un convertisseur analogue-digital (CAD)

IV-1.1. Circuit d'entrée.

Le sélecteur de fonction sélectionne le bloc requis de ce circuit en fonction du type de mesure. Tous les signaux d'entrée sont convertis en tension continue par le circuit d'entrée.

- tension continue.
  L'entrée est appliquée à la section DCV/ATT. laquelle atténue la tension continue inconnue conformément à la gamme.

- tension alternative.
  L'entrée est appliquée à la section ACV/DCV et est atténuée, rectifiée et filtrée à la tension continue

- courant continu.
  L'entrée est appliqueée à la partie 1/V, où le courant inconnu passe par une résistance parallèlle, laquelle diffère par gamme. La perte de tension par cette résistance est alors mesurée et appliquée directement à l'amplificateur de sélection de gamme du convertisseur analogue-digital.

- courant alternatif.
  Comme un courant continu, si ce n'est que la sortie de la section 1/V est appliquée à l'entrée de l'amplificateur de sélection de gamme.

- résistance (Fig. 3.).
  Le courant fixe passe par la résistance inconnue Rx et la tension par Rx est appliquée à l'entrée de l'amplificateur de sélection de gamme.
  Ce principe peut être représenté par les équations suivantes.

$$V_x = I_s . R_x$$

mais

$$I_s = \frac{-V_{REF} - (-V_o)}{R_s} = \frac{-(V_{REF} - V_o)}{R_s}$$

I_s:	étant le courant constant
R_s:	la résistance standard
$-V_{REF}$:	la tension de référence négative

- Vo:	la tension dérivée de $-V_{REF}$
Rx:	la résistance inconnue
Vx:	la tension par Rx

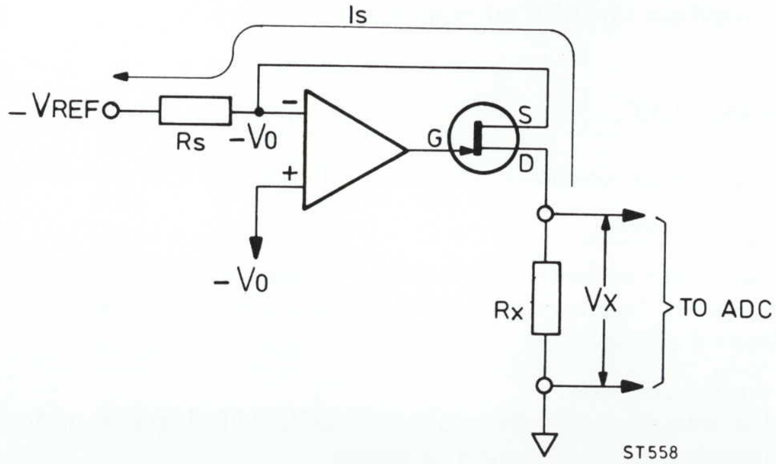


Fig. 3. Principe de mesure de résistance.

IV-1.2. Convertisseur analogue-digital (CAD)

Cet appareil utilise un système d'intégration double dans le CAD et présente une période de correction automatique du zéro.
La tension continue du circuit d'entrée est appliquée à l'amplificateur de sélection de gamme, où elle est amplifiée afin d'obtenir un réglage de gamme maximal de l'appareil.
La sortie de l'amplificateur de sélection de gamme est appliquée à l'intégrateur.
Un schéma de l'intégrateur est représenté à la figure 4.

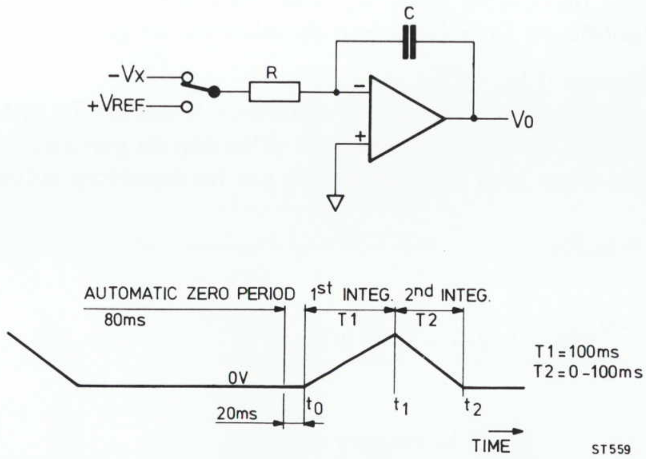


Fig. 4. Système de conversion analogue-digital.

Pendant le temps de référence ($t_0 \rightarrow t_1$), - Vx, la tension d'entrée est intégrée.

A la fin de la première intégration, l'entrée à l'intégrateur est connecté à la tension de référence de polarité opposée à celle de l'entrée. Cette tension de référence est intégrée et une forme d'onde dont la pente se dirige vers le niveau zéro est produite à la sortie de l'intégrateur.

Un comparateur détecte le croisement du niveau zéro par la tension de sortie Vo et termine la seconde intégration. La grandeur du signal d'entrée s'obtient en mesurant la durée de la seconde intégration.

L'operation précédente est représentée par les équations suivantes:

$$Vo = \frac{1}{c} \int_{t_o}^{t_1} \frac{(-Vx)}{R} \cdot dt \quad + \frac{1}{c} \int_{t_o}^{t_2} \frac{(V_{REF})}{R} \, dt, \quad = 0$$

hors

$$t_1 - t_o = T1, \; t_2 - t_1 = T2$$

$$\therefore \; Vo = \frac{T1}{CR} \cdot (-Vx) + \frac{T2}{CR} \cdot V_{REF}, = 0$$

$$\therefore \; \frac{T1}{CR} \cdot Vx = \frac{T2}{CR} \cdot V_{REF}$$

$$\therefore \; T2 = \frac{T1}{V_{REF}} \cdot Vx$$

hors

T1 et V_{REF} sont connus et constants

$$\therefore \; T2 = KVx$$

La période de correction automatique du zéro précède la première intégration et la tension offset de l'amplificateur de sélection de gamme, de l'amplificateur d'intégration et du comparateur est emmegasinée. Le minutage du système est piloté par la partie digitale.

IV-2. PARTIE DIGITALE.

IV-2.1. Affichage et section logique.

IV-2.1.1 Circuit de commande.

Les signaux de commande sont dérivés du compteur et du comparateur.
Le circuit de commande est utilisé pour:

- engendrer la première période d'intégration
- inhiber l'horloge à la fin de la première intégration
- engendrer l'impulsion de mémoire à la fin de la seconde intégration
- sélectionner la tension de référence à polarité de référence pour la seconde intégration
- engendrer la période de correction automatique du zéro

- engendrer la temps de réglage
- engendrer les signaux UP et DOWN

IV-2.1.2. Impulsion de mémoire.

Cette impulsion est engendrée à la fin de la seconde intégration. Il inhibite l'horloge et charge le contenu du compteur dans la mémoire.

IV-2.1.3. Compteur et mémoire.

Le compteur est composé de quatre compteurs à décades BCD et compte les impulsions d'horloge (100 kHz). Le contenu des quatre compteurs est conduit à l'affichage par une mémoire à la suite d'une impulsion de mémoire.

IV-2.1.4. Maintien d'échantillon.

L'impulsion de mémoire est inhibitée en condition de maintien d'échantillon. Des lors, étant donné que l'impulsion de mémoire fonctionne comme une impulsion de transfert entre compteur et mémore, l'affichage peut être retenu.

IV-2.1.5. Over.

Si l'impulsion de mémoire n'est pas engendrée en 100 ms après le démarrage de la seconde intégration, le signal OVER est engendré. Si ceci se produit dans la condition maintien de gamme, l'indicateur OVER est allume en permannence.

IV-2.1.6. Polarité.

La polarité est déterminée au démarrage de la seconde intégration et indiquée sur l'affichage après l'impulsion de mémoire.

IV-2.2. Section gamme automatique.

IV-2.2.1. Gamme automatique et relais.

La sélection de gamme automatique permet de sélectionner et de régler la gamme optimale en fonction de la grandeur du signal d'entrée. Laccommande fonctionne par commutateurs à transistors (TEC) et relais du circuit d'entrée. Le décodage de l'indication du point décimal approprié dans l'affichage est également produit.

IV-2.2.2. Maintien de gamme.

Dans la condition maintien, la sélection de gamme automatique est inhibitée et la position du point décimal dans l'affichage reste fixe.

V. Installation

MODE D'EMPLOI

V-I. ALIMENTATION.

V-1.1. Alimentation alternative.

L'appareil est conçu pour l'usage en 220 V, 50/60 Hz alimentation secteur. Cependant, il peut être utilisé à d'autres tensions secteur en modifiant le câblage du transformateur secteur (voir Fig. 31).

V-1.2. Alimentation continue.

Le fonctionnement à partir d'une alimentation continue externe entre + 10 V et + 15 V est possible. L'accessoire en option PM 9207 est recommandé pour ce mode d'alimentation, car il fail alors partie intégrale de l'appareil. Le coffret de l'appareil peut être mis à la terre par l'intermédiaire d'une borne sur le panneau arrière.

V-2. ORGANES DE REGLAGE ET CONNECTEURS;

Panneau avant Fig. 5		
No	Désignation	Fonction
1	Tubes d'affichage Numérique	affichage numérique à 4 chiffres affichage maximal 9999 point décimal automatiquement positionné
2	Indicateur de polarité	+ ou - automatiquement indiqué en fonction de la polarité du signal d'entrée pour mesure de tension continue et courant continu.
3	Indicateur "OVER"	Indique que le signal d'entrée a dépassé la gamme de mesure.
4	Indicateur "LOW BATT"	Indique que la tension du jeu de batteries (de l'accessoire en option PM9207) est situé entre +5 V et +10 V continu et insuffisante pour obtenir un fonctionnement satisfaisant de l'appareil.
5	Sélecteur de fonction	Sélectionne la fonction de mesure requise
	VDC	mesure de tension continue
	VAC	mesure de tension alternative
	mADC	mesure de courant continu
	maAC	mesure de courant alternatif
	kΩ	mesure de résistance

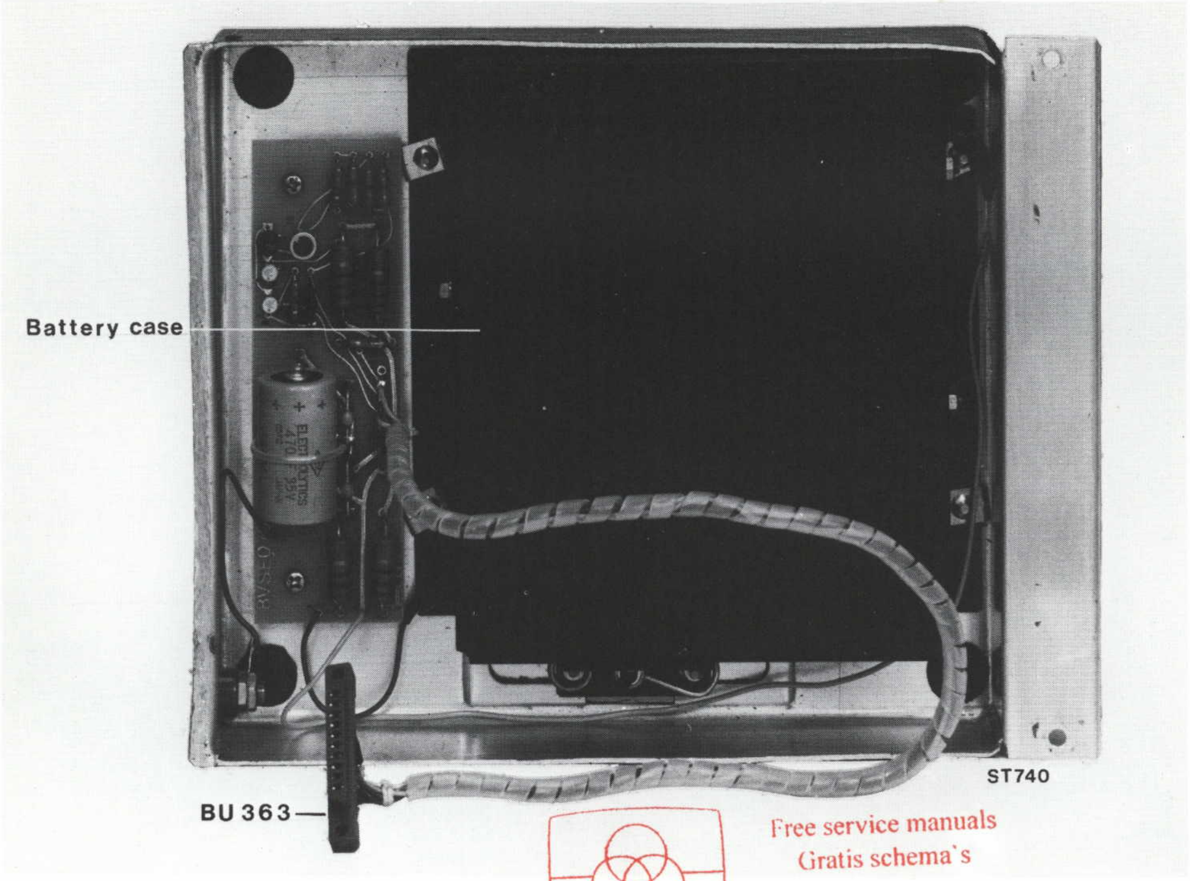


Fig. 1.1

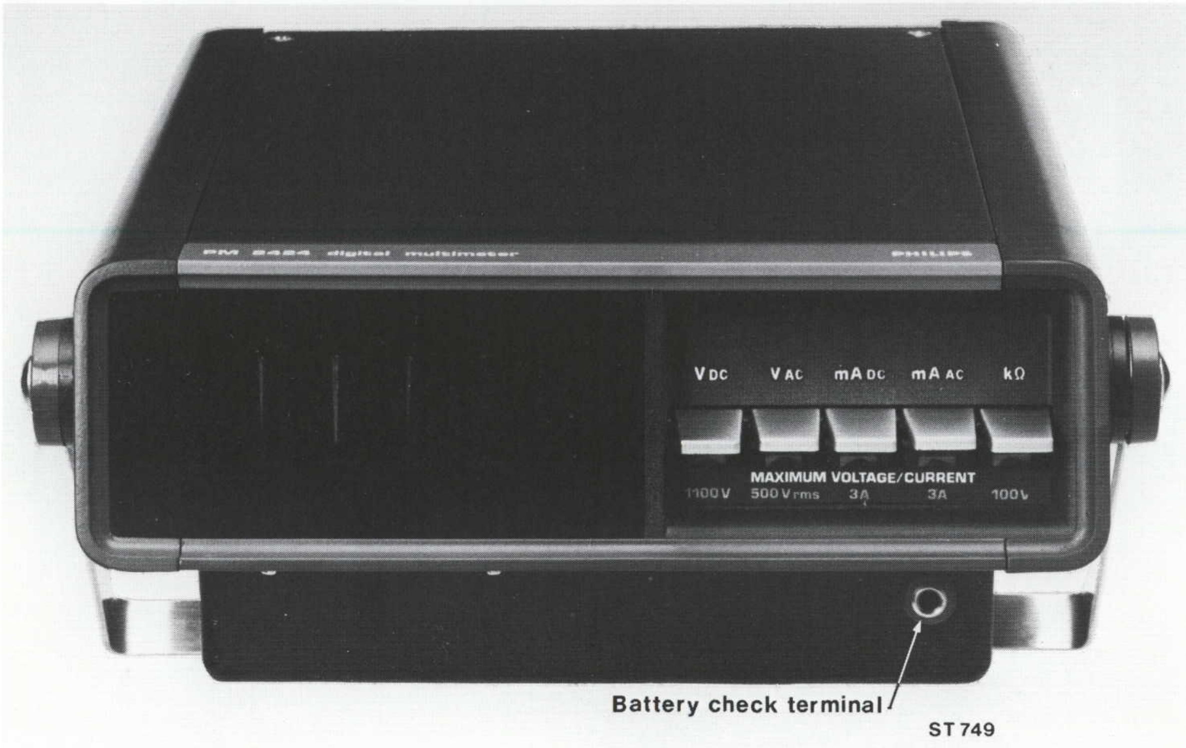


Fig. 1.2

Panneau de droite Fig. 6		
No.	Désignation	Fonction
6	commutateur POWER	commutateur ON/OFF pour fonctionnement en secteur ou en alimentation continue
7	Bornes INPUT	signal d'entrée est connecté à ces bornes par l'intermédiaire du câble d'entrée Borne rouge HI Borne noire LO
8	Bornes SAMPLE HOLD	En cout-circuitant avec la fiche accessoire à deux broches, l'affichage est retenu jusqu'à ce que le court-circuit soit éliminé.
9	Bornes RANGE HOLD	En court-circuitant la fiche accessoire à deux broches, la position du point décimal est maintenue jusqu'à ce que le court-circuit soit éliminé.

Panneau arrière Fig. 7		
No.	Désignation	Fonction
10	connecteur d'alimentation alternative	Entrée secteur par l'intermédiaire du câble accessoire secteur
11	Sélecteur de source de puissance AC-DC	Sélectionne entre sources de puissance alternative ou continue
12	EXT.DC + 12 V	Entrée de source continue externe Remarque· l'entrée pour l'alimentation continue accessoire en option PM 9207 n'est pas faite par ce connecteur.
13	Borne de terre	Cette borne peut être utilisée pour connecter en cas de le coffret à la terre lorsque le fonctionnement à partir d'une source d'alimentation continue.
14	fusible	fusible d'alimentation secteur de 50 mA (à action différée)
15	PROTECTOR	protection contre l'excès de courant en mode de mesure de courant. Pour reprendre la mesure, enfoncer le bouton d'interruption.

VI. Opération

Remarque· Il est important que le processus d'étalonnage (décrit dans la documentation de service) soit effectué dans les six mois précédant l'utilisation de l'appareil.

VI-1.ENCLENCHEMENT

L'appareil peut être alimenté par source continue ou alternative.

VI-1.1. Source alternative.

- Mettre le sélecteur AC-DC en position AC
- Connecter l'appareil à l'alimentation secteur par l'intermédiaire du cordon secteur accessoire.
- Mettre le commutateur POWER sur ON

VI-1.2. Source continue.

Il faut que l'accessoire en option PM 9207 (alimentation continue) soit utilisé. Celui-ci est monté en place de la plaque de base de l'appareil. Le connecteur libre de cet accessoire doit être enfiché dans le connecteur fixe en protubérance de la partie inférieure de la platine U2 avant de monter le boîtier d'accessoire sur l'appareil. Si l'alimentation continue externe est utilisée, elle est connectée au connecteur EXT.DC + 12 V à l'arrière de l'appareil (la broche centrale de ce connecteur est négative).

- Mettre le sélecteur AC-DC en position DC
- Mettre le commutateur POWER sur ON.

Remarque· Il est recommandé de contrôler la tension d'alimentation continue (voir V .2.). Le PM 9207 en option présente une borne externe à cet effet. De plus, l'indicateur LOW BATT de l'affichage est également fonctionnel en cas d'utilisation du présent accessoire et s'illume la tension de batterie est inadéquate (voir III.2).

VI-2 MESURE.

Le fonction requise est réglée à l'aide du sélecteur de fonction.

VDC:	100 µV à 1000 V continu
VAC:	100 µV à 500 V eff
mADC:	100 nA à 1000 mA continu
mAAC:	100 nA à 1000 mA eff
kΩ:	0.1 Ω à 10 MΩ

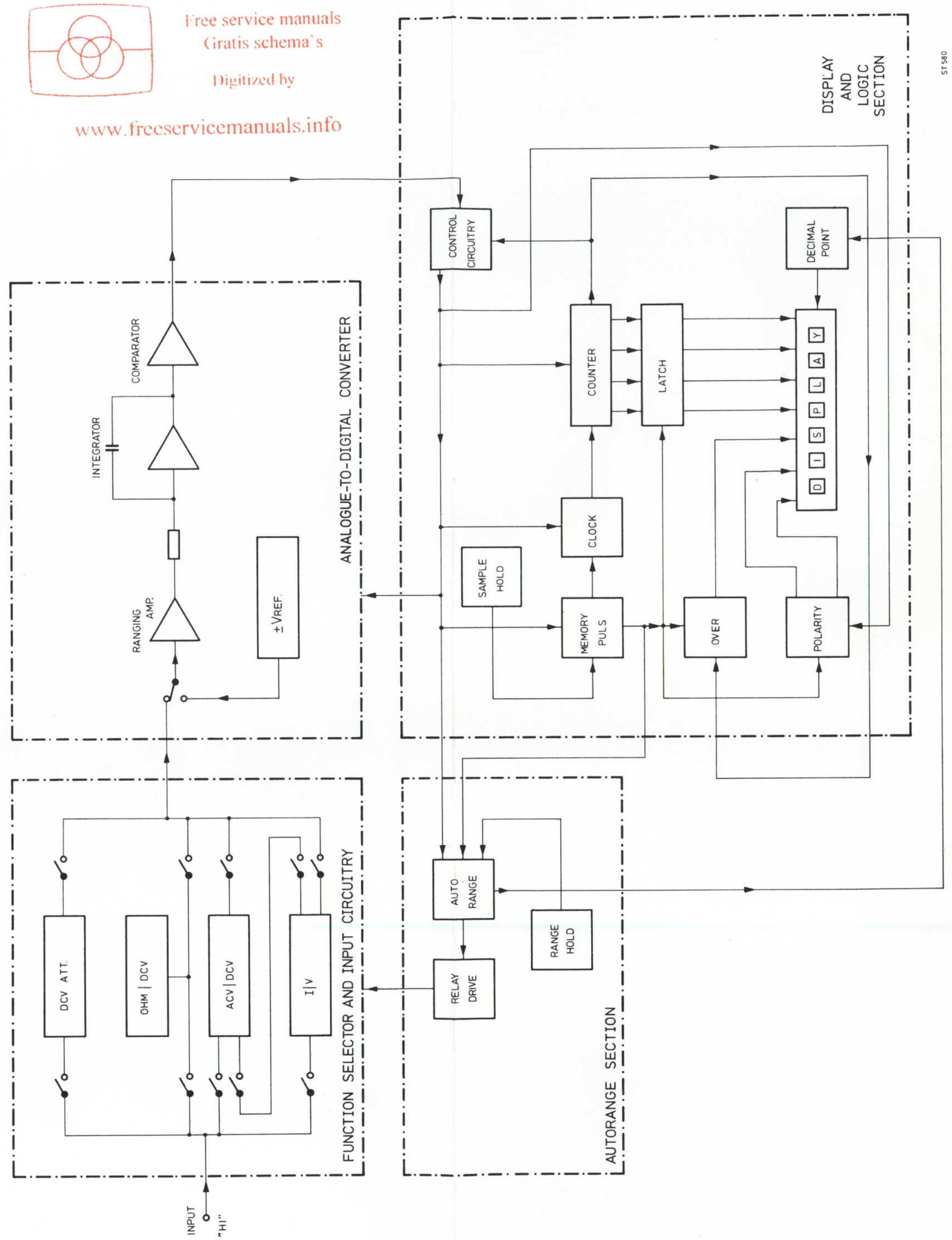


Fig. 2

VI-2.1. Tensions continues

- Enfoncer le commutateur VDC
- Connecter la source de tension aux bornes INPUT par l'intermédiaire du câble d'entrée

Remarques:

- L'entrée maximale admise est de 1100 V.
- La tension maximale admise entre borne noire (LO) et châssis est de 600 V.
- L'indication de polarité est présente
- L'indication de gamme OVER n'est pas présente pour des tensions d'entrée excédant 1000 V continu.

VI-2.2. Tensions alternatives.

- Enfoncer le commutateur VAC
- Connecter la source de tension aux bornes INPUT par l'intermédiaire du câble d'entrée.

Remarques:

- L'indication de gamme OVER n'est pas présente pour des tensions d'entrée excédant 500V

VI-2.3. Courants continus

- Enfoncer le commutateur mADC
- Connecter le circuit de courant aux bornes INPUT par l'intermédiaire du câble d'entrée.

Remarques:

- Le courant d'entrée maximal admis est de 3 A.
- Le courant d'entrée maximal mesurable est de 1 A et une protection de courant en excès est enclenchée pour des courants d'entrée excédant 1,6 A, déconnectant le circuit de mesure. La mesure peut être reprise en enfonçant le bouton PROTECTOR sur le panneau arrière.
- L'indication de gamme OVER est présente pour des courants excédant 1 A, à moins que le PROTECTOR soit actionné.
- L'indication de polarité est présente.

VI-2.4. Courants alternatifs

- Enfoncer le commutateur mAAC
- Connecter le circuit de courant aux bornes INPUT par l'intermédiaire du câble d'entrée.

Remarque: Tout comme pour 2.3. il n'y a pas d'indication de polarité.

VI-2.5. Résistance

- Enfoncer le commutateur kΩ
- Connecter la résistance inconnue aux bornes d'entrée par l'intermédiaire du câble d'entrée.

Remarques:

- La tension maximale admise aix bornes d'entrée est de 100 V (continuellement) ou 200 V (d'une durée de 5 secondes).

- Dans un environnement bruyant, particulièrement pour la mesure de résistance, l'affichage varie considérablement. Dans ce cas, connecter la borne d'entrée LO à la borne de terre (châssis). Autrement, placer la résistance inconnue dans une boîte blindée.

VI-3. INDICATIONS GENERALES

VI-3.1. Indication de polarité

Pour des mesures de tension ou courant continus (VDC, mADC), la polarité du signal d'entrée est indiquée à gauche de l'affichage. La polarité indiquée est celle de la borne d'entrée rouge (HI) par rapport à la borne d'entrée noire (LO).

VI-3.2. Maintien de gamme

Lorsque les bornes RANGE-HOLD sont court-circuitées, la gamme est maintenue avant de procéder au court-circuitage et la position du point décimal doit être fixée. La sélection de gamme automatique est inhibitée.

Exemple.

Entrée	Affichage	Bornes RANGE-HOLD
0 V	.0000	ouvertes
+ 19.19 V	+ 19.19	ouvertes
+ 19.19 V	+ 19.19	court-circuitées
0 V	00.00	court-circuitées

VI-3.3. Maintien d'échantillon

Lorsque les bornes SAMPLE-HOLD sont court-circuitées, l'affichage complet est maintenu avant de procéder au court-circuitage.
L'affichage reste maintenu jusqu'à ce que le court-circuit soit éliminé.

VI-3.4. Indication de gamme en excès.

L'indicateur OVER se trouve au-dessus de l'indicateur de polarité et s'allume lorsque·

- le signal d'entrée excède la gamme de mesure maintenue.
- l'appareil est réglée en kΩ avec bornes INPUT ouvertes et sélection de gamme automatique.

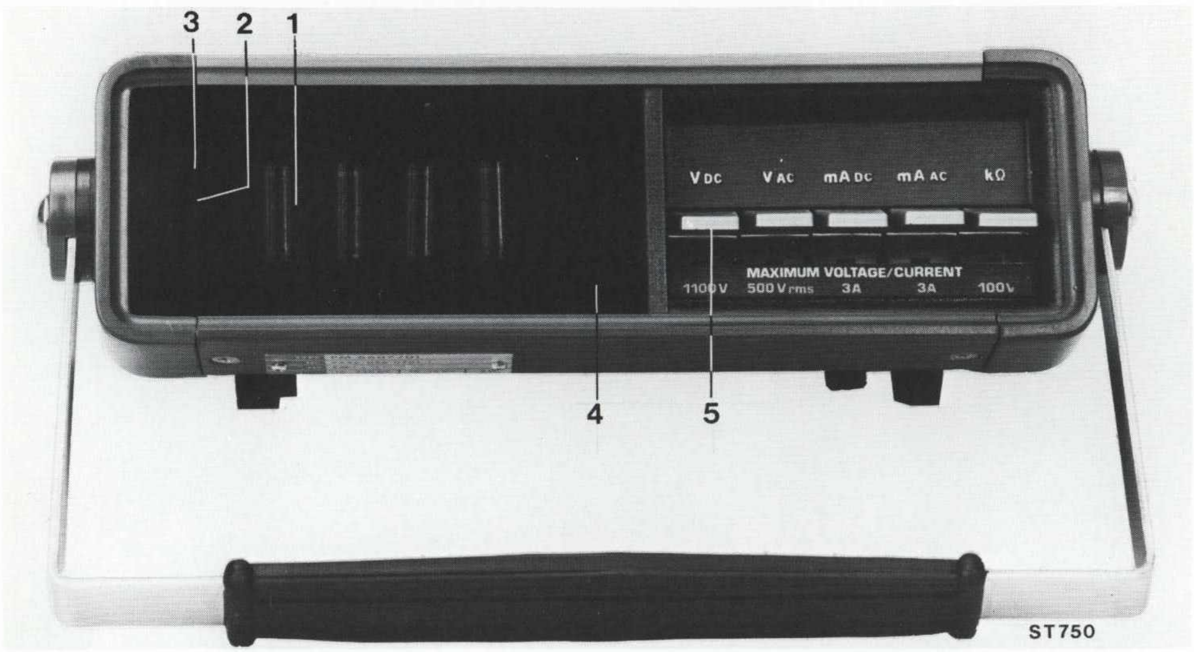


Fig. 5

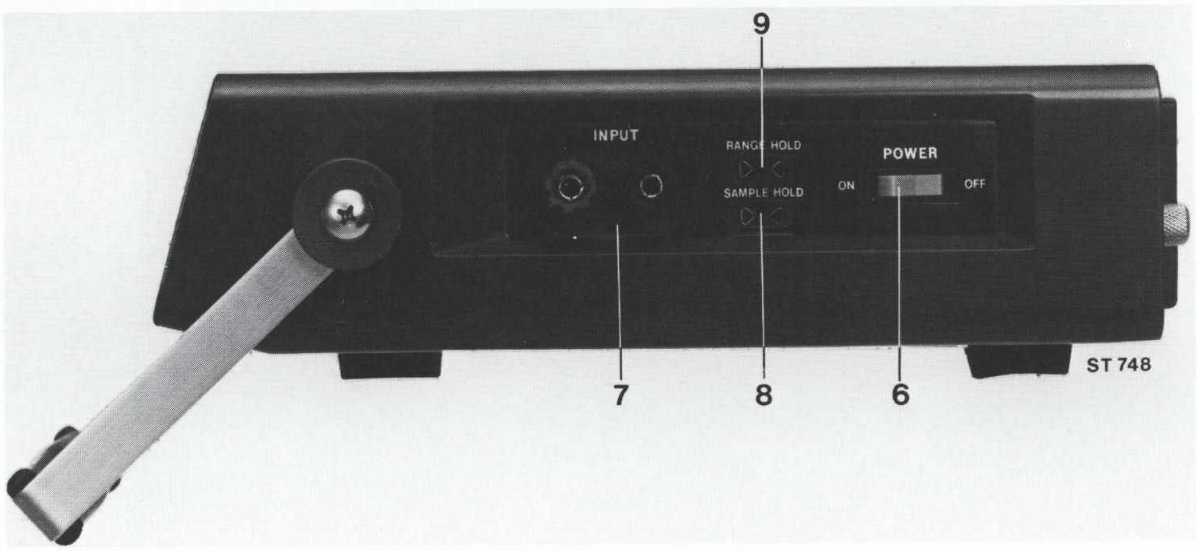


Fig. 6

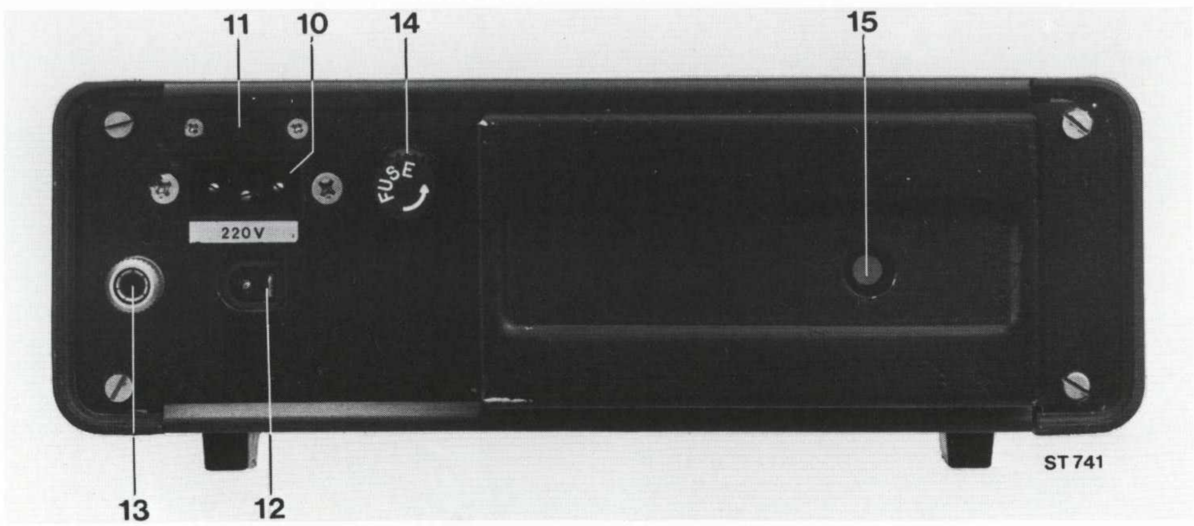


Fig. 7

A detailed block diagram is shown in Fig. 8.

VII-1. ANALOGUE SECTION.

Circuit diagrams of the input circuitry (Fig.41) and the analogue-to-digital converter (Fig.42) are given at the end of the manual.

VII-1.1. DC voltage measurement (Fig. 9).

The d.c. voltage input signal is applied to a d.c. voltage attenuation circuit via the function selector.
Input voltages greater than 10 V in magnitude are attenuated by 100.
The output is applied to the analogue-to-digital converter (ADC) via the function selector.
The neon tube LA 206 provides high voltage protection for the relay RE 192.
The combination of capacitor C 180 and resistor R 134 attenuates any spikes produced during switching.
The relays are drawn in the normal (unenergised) position and TABLE 1 gives the control functions which are generated by the autorange circuit (AR) of the digital section.

TABLE 1. RELAY STATES OF DCV ATTENUATION CIRCUIT.

Control	TS 28 (AR)	TS 29 (AR)	TS 29 (AR)	
Relay	RE 191	RE 192	RE 193	
Range	State	State	State	Gain
1 V	Energised			1
10 V	Energised			1
100 V		Energised	Energised	0.01
1000 V		Energised	Energised	0.01

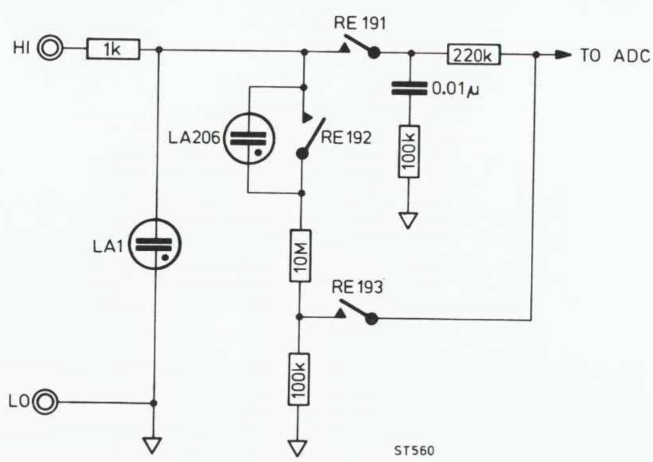


Fig. 9. DC voltage measurement.

VII-1.2. AC voltage measurement (Fig. 10).

The a.c. voltage input signal is switched to the input of the ACV/DCV converter by the function selector. This converter consists of the following circuits:

VII-1.2.1. Attenuator.

The attenuation is set by relays in accordance with the magnitude of the input signal (see Table 2).

VII-1.2.2. Buffer amplifier.

The buffer amplifier A1 has unity gain and consists of a source follower and an emitter follower.

VII-1.2.3. Rectifying amplifier and filter.

The rectifying amplifier employs a half-wave rectification system.

Conversion to a d.c. voltage equal to the r.m.s. value of the buffer amplifier output results by passing the half-wave rectified voltage through a two-stage filter. For r.m.s. voltages in excess of 100 V, RE 197 is energised and an attenuation of 10 is provided by the rectifying amplifier.

TABLE 2. RELAY STATES OF ACV/DCV CONVERTER CIRCUIT.

Control	TS 30 (AR)	TS 31 (AR)	TS 32 (AR)	TS 33 (AR)	
Relay	RE 194	RE 195	RE 196	RE 197	
Range	State	State	State	State	Gain
1 V r.m.s.	Energised				1
10 V r.m.s.		Energised			0.1
100 V r.m.s.		Energised	Energised		0.01
500 V r.m.s.		Energised	Energised	Energised	0.001

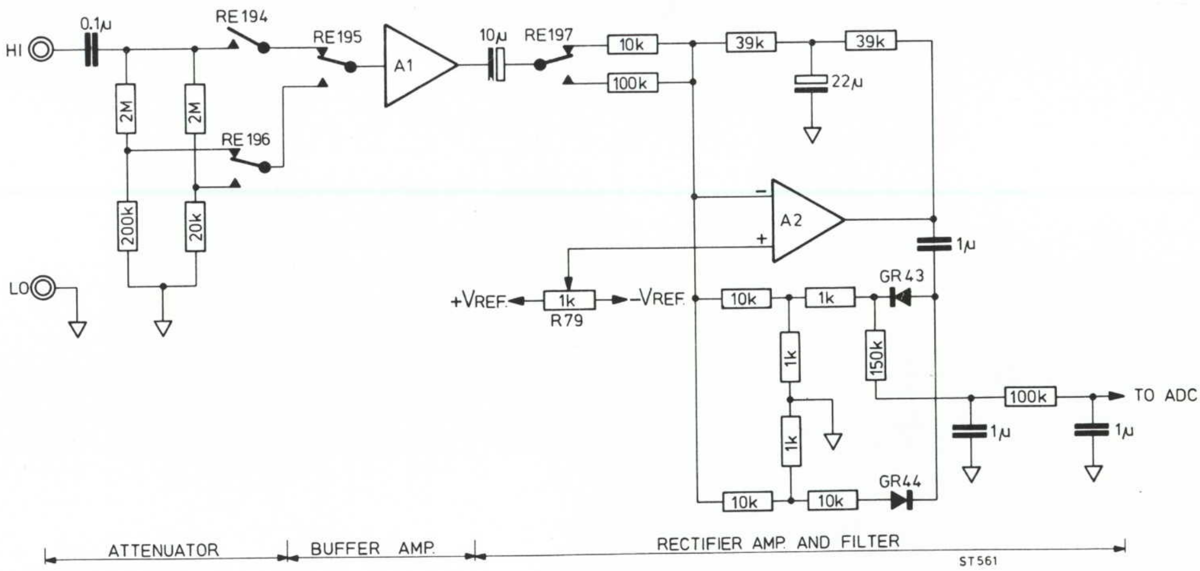


Fig. 10. AC voltage measurement

VII-1.3. AC and DC current measurement (Fig. 11).

The current flows into the I/V converter via the function selector. The shunt resistance is selected in accordance with the magnitude of the current so that a maximum voltage of 1 V is dropped across the shunt resistance.
In Fig. 11 the relays are drawn in the normal (unenergised) position and the range setting states of the relays are given in TABLE 3.
A protector is provided at the input to automatically block the input when an overcurrent exceeding 1.5 A d.c. (or 1 A r.m.s.) flows.
GR 53 and GR 54 act as spike-clamping diodes at the instant of range switching.
For d.c. current, the output of the I/V converter is applied to the ADC via the function selector. However, for a.c. current the output of the I/V converter is applied to the ACV/DCV converter via the function selector.

TABLE 3. RELAY STATES OF THE I/V CONVERTER CIRCUIT.

Control	TS 34 (AR)	TS 35/36 (AR)	
Relay	RE 198	RE 199	
Range	State	State	Shunt resistor
1 mA			1 kΩ
10 mA		Energised	100 Ω
100 mA	Energised		10 Ω
1000 mA	Energised	Energised	1 Ω

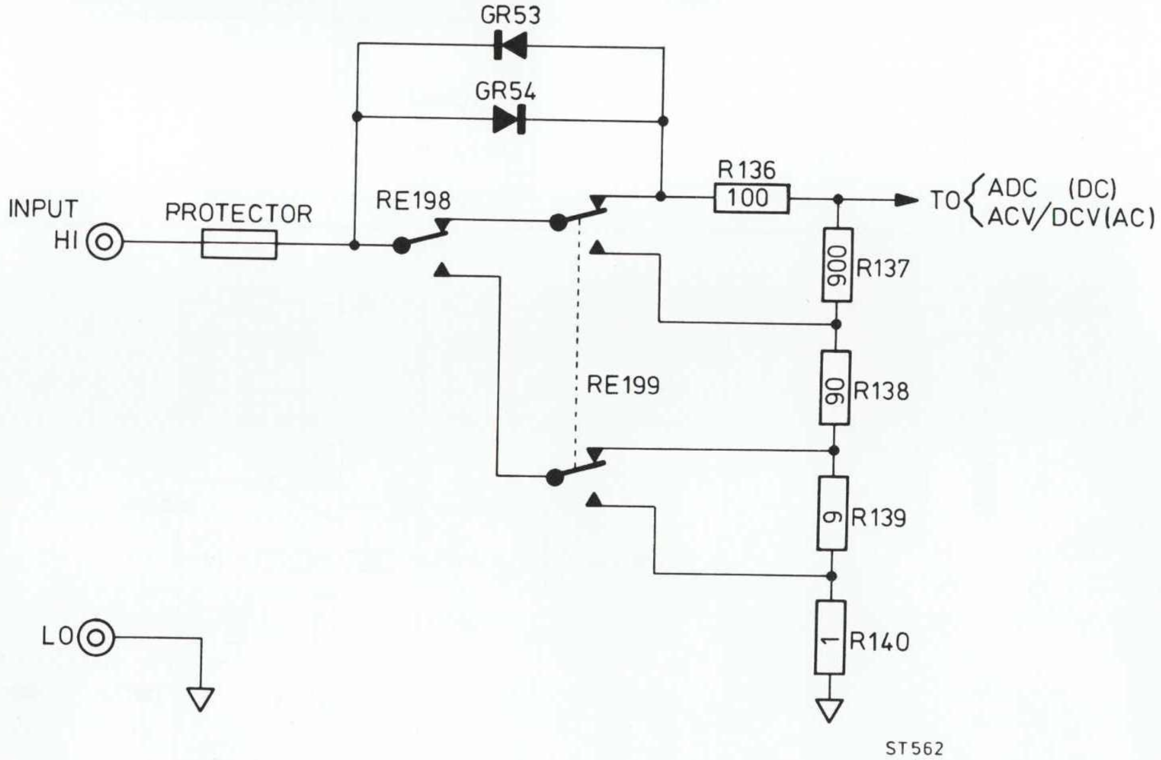


Fig. 11. Current measurement.

VII-1.4. Resistance measurement (Fig. 12).

A fixed source current which differs for each range, is passed through the unknown resistance, Rx, from the OHM/DCV converter via the function selector. The voltage developed across the resistor is detected by the ADC, again via the function selector. The magnitude of the source current is determined by the source resistance, Rs, which is selected by solid-state (FET) switches. The source current is set so that the maximum voltage dropped across the unknown resistance is 1 V. The operating states of the range-switching FET switches are given in TABLE 4. Resistor R 106 and diodes GR 55 and GR 56 provide a protection circuit against voltages being accidently applied to the input terminals when the instrument is set to measure resistance.

TABLE 4. SOURCE CURRENT SELECTION FOR RESISTANCE MEASUREMENT.

Control	IC 8/8	IC 11/11	IC 11/8	IC 9/8	
FET SWITCH	TS 20	TS 21	TS22	TS 23	
Range	State	State	State	State	Is (μA)
1 kΩ	OFF	OFF	OFF	ON	1000
10 kΩ	OFF	OFF	ON	OFF	100
100 kΩ	OFF	ON	OFF	OFF	10
1 MΩ	ON	OFF	OFF	OFF	1
10 MΩ	OFF	OFF	OFF	OFF	0.1

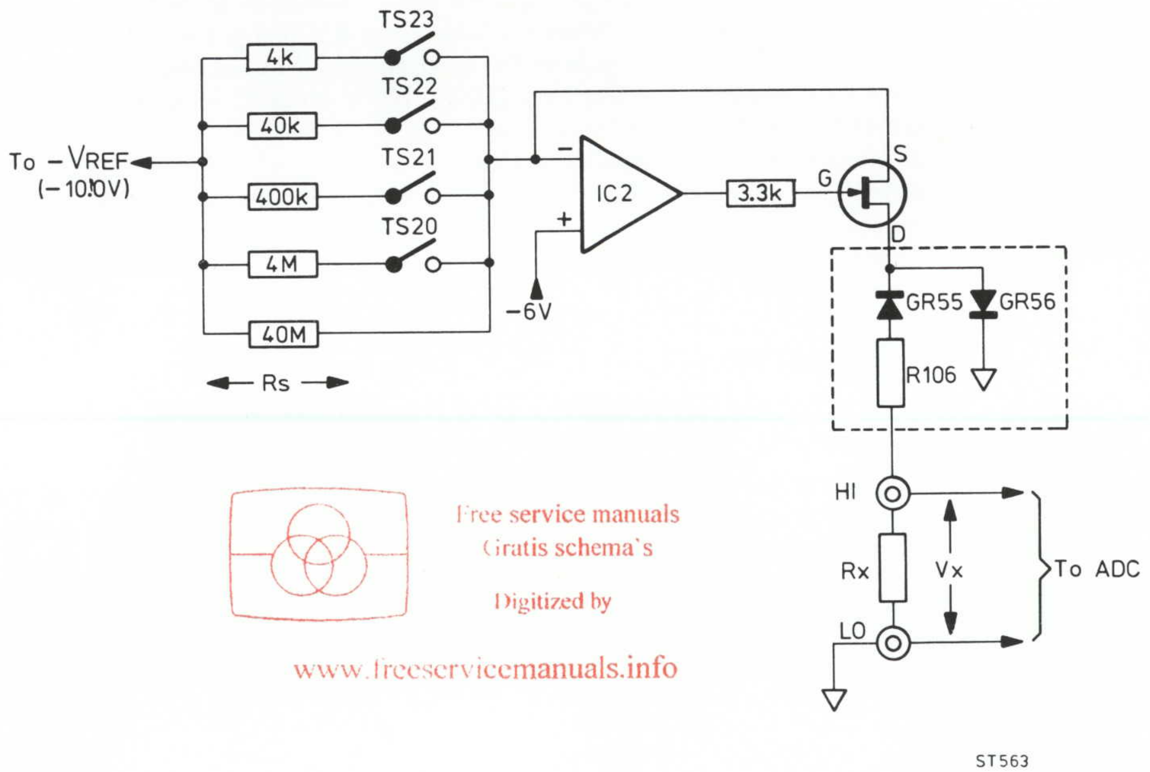


Fig. 12. Resistance measurement.

VII-1.5. Analogue-to-Digital Converter (Fig. 33).

A schematic diagram of the ADC is shown in Fig. 13.
The sequence diagram Fig. 14 is to be read in conjunction with Fig. 13.
The d.c. signal from the input circuitry (± 10 V maximum) is applied to the input of the ADC via the function selector.

Note: If voltages exceeding ± 10 V are applied to the input of the ADC, limiting is provided by TS 26, TS 28 (- 10 V) and TS 27, TS 29 (+ 10 V).

The conversion system of the ADC uses the dual-slope principle.
The conversion time can be considered as 5 distinct periods:

- 1st integration of duration 100 ms.
- 2nd settling time of duration 100 µs.
- 2nd integration. The duration of this period is directly related to the magnitude of the input voltage and a the end-of-range value is 100 ms.
- Auto-zero correction time of duration 80 ms. This period starts 200 ms after the start of the 2nd integration.
- 1st settling time of duration 20 ms following the end of the auto-zero correction time.

The various periods of the conversion time are generated via solid-state switches of the ranging amplifier and the integrator; the control signals being generated by the logic circuitry.

VII-1.5.1. 1st Integration.

TS 31 and TS 37 are turned ON and the input voltage to be measured (Vx) is applied to the integrator. When Vx is between 0 V and ± 1 V (1 V, 100 V ranges) TS 36 is also ON and the gain of the ranging amplifier becomes X10.
When Vx is between 1 V and 10 V (10 V, 100 V ranges), TS36 is OFF and the gain of the ranging amplifier is unity.
All other solid-state switches are OFF.
For positive input voltages, the integrator output decreases from 0 V linearly with time.
For negative input voltages, the integrator output increases from 0 V linearly with time.

VII-1.5.2. 2nd Settling time.

At the end of the 1st integration, TS 31 is turned OFF and TS 33 or TS 34 is turned ON, supplying $-V_{REF}$ or $+V_{REF}$ to the ranging amplifier.

However, if the output of the ranging amplifier is applied to the input of the integrator during this dynamic switching state, the resulting transient waveform will be integrated and hence applied to the comparator.
Therefore, at this time TS 37 is also turned OFF, disconnecting the output of the ranging amplifier from the integrator. TS 37 is turned OFF for 100 µs and this is the 2nd settling time.

VII-1.5.3. 2nd Integration.

When TS 37 is turned ON at the end of the 2nd settling, the 2nd integration starts. The polarity of the reference voltage (being applied to the input of the ranging amplifier since the end of the 1st integration) is opposite to the polarity of the input voltage, so that during the 2nd integration the integrator output slopes towards zero volts.
Moreover, if the input voltage is between 0 V and 1 V, TS 32 is turned ON and the reference voltage applied to the ranging amplifier is attenuated by 10.
The end of the 2nd integration occurs when zero volts is reached.
The number of clock pulses counted during the 2nd integration by the Digital section generates the figures in the numerical display.

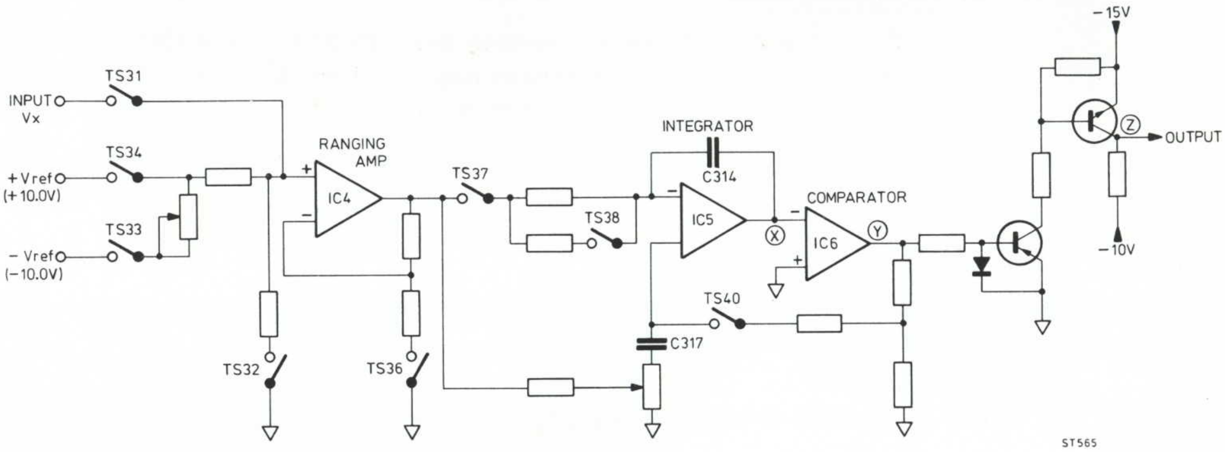


Fig. 13. Analogue-to-digital converter.

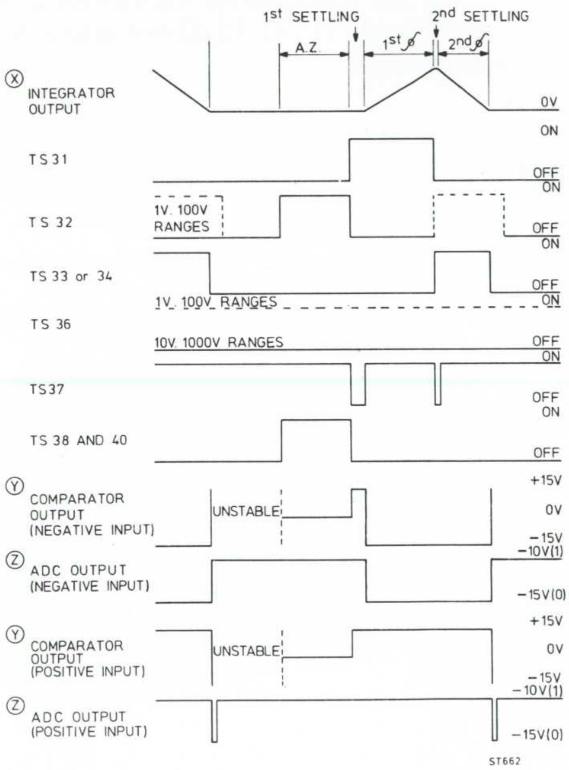


Fig. 14. Sequence diagram ADC.

VII-1.5.4. Auto-zero correction time.

This period starts 200 ms after the start of the 2nd integration (i.e. 100-200 ms after the end of the 2nd integration). TS 38 and TS 40 are turned ON and for 80 ms, capacitor C 317 is charged by the offset voltages of the ranging amplifier, integrating amplifier and comparator. Therefore, at the end of the zero correction time when TS 32, TS 38 and TS 40 are turned OFF, the total offset voltage of the amplifiers in the ADC is stored across capacitor C 317.
This will cancel the offset component of the voltage appearing at the integrator input during the 1st integration. Therefore, only the input voltage signal component effectively charges the integrating capacitor C 314.

VII-1.5.5. 1st Settling time.

At the end of the auto-zero correction time, TS 37 is turned OFF for 20 ms, disconnecting the output of the ranging amplifier from the integrator. This serves the same purpose as the 2nd settling time described in 1.5.2.

General Note: The solid-state switches of the Analogue section are field-effect transistors. They are held OFF by applying - 15 V to the gates.

VII-2. DIGITAL SECTION (Fig. 34).

Reference is made to Fig. 8 - the detailed block diagram. All digital integrated circuits are driven from - 10 V and - 15 V supply voltages.

Logic section
Figs. 15 and 16 are used to explain the operation of the logic section.

VII-2.1. Clock Oscillator.

The clock oscillator produces the time base for the control system and consists of a discrete component astable (TS 50, TS 51, TS 52 and associated components) generating a 100 kHz square wave.

VII-2.2. Counter Driver.

The driver provides the decade counters of the display section with a clock frequency of 100 kHz (IC 12/6). It is inhibited by:

- the clock inhibit pulse H at the end of the 1st integration.
- the memory pulse via IC 7/4 at the end of the 2nd integration.

VII-2.3. Auto-zero (AZ).

This consists of a discrete component monostable (TS 60, TS 61 and associated components) which is triggered 200 ms after the start of the 2nd integration. An 80 ms wide pulse A is generated.

VII-2.4. 1st Settling.

At the end of the AZ pulse, a 20 ms pulse G is produced at IC 12/12 by gating A , E and F . This is the 1st settling pulse.

VII-2.5. 1st Integration.

The 1st integration commences at the end of the 1st settling pulse when the count extend pulse from IC 15/8 results in a clock pulse at IC 13/5 and IC 13/1 D .

- IC 13/9 goes to a logic 0 E and hence IC 13/8 to a logic 1. This clears IC 14/1 via GR 124, TS 62 and ensures that IC 14/6 C is at a logic 1.
- IC 13/12 remains at a logic 1 F .

After a 100 ms, the count extend pulse from IC 15/8 results in the following:

- IC 13/12 goes to a logic 0 F , and hence IC 13/13 to a logic 1. This latter transition clocks IC 14/3 and IC 14/6 C goes to a logic 0. This ends the 1st integration and the clock inhibit monostable is triggered.

VII-2.6. Clock Inhibit.

At the end of the 1st integration this discrete component monostable (TS 55, TS 56, TS 57 and associated components) is triggered producing a 200 µs pulse H which:

- inhibits the counter driver.
- triggers the 2nd settling monostable.

VII-2.7. 2nd Settling time.

At the end of the 1st integration there is a period of 100 µs I before the 2nd integration begins. This period is the 2nd settling time and is generated by a discrete component monostable (TS 53, TS 54 and associated components) which is triggered by the clock inhibit monostable at the end of the 1st integration.

VII-2.8. Select Reference Voltage $\pm V_{REF}$.

At the end of the 1st integration, TS 43 or TS 44 is turned ON depending upon the polarity of the input signal.

For positive or a.c. input voltages / positive or a.c. input current, TS 43 is turned OFF and hence TS 33 (ADC) is biassed ON, resulting in $-V_{REF}$ being selected.

For negative input voltages or currents TS 44 is turned OFF and hence TS 34 (ADC) biassed ON, resulting in $+V_{REF}$ being selected.

Note: Except during the 2nd integration, C is a logic 1 and consequently TS 43 and TS 44 are both ON and apply - 15 V to the gates of TS 33 and TS 34 (ADC), so biassing them OFF and neither $\pm V_{REF}$ being selected.

VII-2.9. 2nd Integration.

The 2nd integration starts at the end of the 2nd settling period when $\pm V_{REF}$ is applied to the input of the integrator via the ranging amplifier. However, the clock signal to IC 15/7 is inhibited for a further 100 µs by the clock inhibit signal H . This period is the zero-dead-band period and partially compensates for the "over" counting at the end of the 2nd integration arising from the hysteresis within the comparator (ADC). The 2nd integration is ended by the zero detect signal clearing IC 14/1 taking IC 14/6 C to a logic 1.

VII-2.10. Zero Detect (ZD).

The comparator output (ADC) changes state when the integrator output reaches zero volts. This results in a ZD pulse being produced via TS 62. This brings the 2nd integration to an end.

VII-2.11. Memory.

The memory pulse (J) is generated at the end of the 2nd integration.

- IC 14/6 (C) goes to a logic 1 and hence IC 14/5 to a logic 0. However, the delay introduced by resistor R 246 and capacitor C 341 enables a pulse of a few µs width to be generated at IC 12/8.

The memory pulse inhibits the count via IC 7/4 and transfers the contents of the latches to the multiplexer (IC 15) via IC 7/2. Also polarity and OVER indications for the sample are initiated by the memory pulse.

Note: The memory pulse can be inhibited by the SAMPLE HOLD control applying - 15 V to IC 12/11.

VII-2.12. Polarity Detect.

During the periods of integration IC 14/12 is at a logic 0 / logic 1 for negative / positive input voltages respectively.
IC 14/11 is clocked at the end of the 1st integration when IC 13/12 (F) goes to a logic 0. Therefore at the end of the 2nd integration IC 11/2 is at a logic 0 / logic 1 for negative / positive input voltages respectively.
The memory pulse clocks IC 11/3 at the end of the 2nd integration and IC 11/5 becomes a logic 0 / logic 1 for negative / positive input voltages.
Consequently TS 86 / TS 87 of the display section is turned ON for positive / negative input voltages and (+) / (-) indication is made.

Note: For settings of the function selector other than VDC and mADC IC 11/1 is permanently cleared.
In this case TS 86 and TS 87 are biassed OFF via IC 11/5 and GR 127 respectively. Therefore, no polarity indication is made.

VII-2.13. OVER Detection.

When the memory pulse is generated within 100 ms after the start of the 2nd integration, IC 11/11 is clocked with IC 11/12 (E) at a logic 0. Therefore IC 11/9 is at a logic 0 and TS 85 of the display section is not turned ON via IC 11/9 and OVER indication is not made.
However, if the memory pulse does not occur within the 100 ms period after the start of the 1st integration then IC 11/12 is at a logic 1 when IC 11/11 is clocked. TS 85 is turned ON via IC 11/9 and OVER indication.
If the latter condition occurs when the range is held, then the OVER indicator will be permanently lit.

VII-2.14. Control Functions for FET switches.

This circuitry generates the control functions for the ADC so that the various periods of the conversion time are correctly performed.
When transistors TS 43-TS 49 are turned ON the appropriate FET switches of the ADC are biassed OFF.

Note: The (x10) gain control is at a logic 1 for the 10 V d.c. and 1000 V d.c. ranges only.

VII-2.15. DOWN.

The DOWN signal is a pulse of 9 ms width generated at the end of the 1st integration. The pulse is produced by a discrete component monostable (TS 58, TS 59 and associated components) when triggered via IC 14/6 (G) .
It is used in conjunction with the memory pulse to generate a range-down signal if a more sensitive range setting is possible.

VII-2.16. UP.

The UP signal is generated 100 ms after the end of the 1st integration.
It is used in conjunction with the memory pulse to generate a range-up signal if a less sensitive range setting is required.

VII-2.17. Auto-Range section.

When the contents of the decade counters at the end of the 2nd integration are under 900, range-down is performed.
When the contents are over 10000, range-up is performed.
Otherwise, range-switching is not performed and the range-hold condition is generated.
Refer Fig. 17.

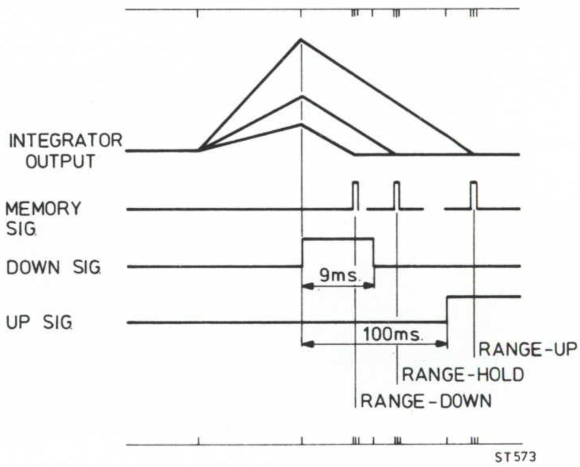


Fig. 17. Up-down timing.

VII-2.18. Up-down counter (Fig. 18).

The UP and DOWN signals from the logic section are gated with the inhibit functions before being applied to the up-down counter.
The J-K flip-flops are clocked by the memory signal and the outputs change state if the appropriate J-K input are at a logic 1. Table 5 explains the arithmetic operation of the circuit.

TABLE 5. Up-DOWN OPERATION.

Control Signals When clocked			JK inputs		
Up	Down	Operation	FF1	FF2	FF3
0	0	Range Hold	0	0	0
0	1	Range Down	1	$\overline{2}^0$	$\overline{2}^0 . \overline{2}^1$
1	0	Range Up	1	2^0	$\overline{2}^0 . 2^1$
1	1				

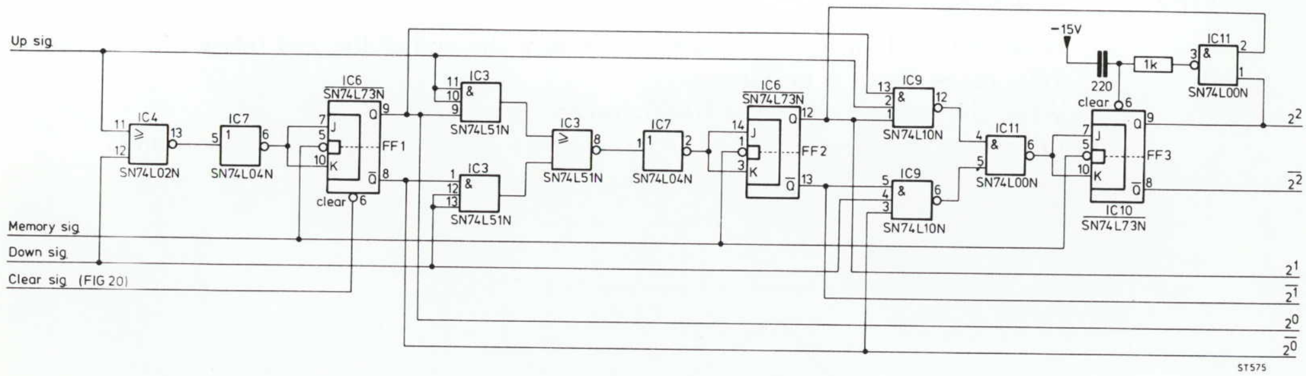


Fig. 18. Up-down Counter.

VII-2.19. Matrix (Fig. 19).

The range-matrix circuit decodes the decimal point position from the binary count signals of the up-down counter. The decoded states are given in Table 6.
The decimal point decodes are also used for the control of the FET switches in the OHM/DCV converter.

TABLE 6. RANGING.

Up -Down Counter output	Range	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^{0}
2^0		1	0	1	0	1
$\overline{2}^0$		0	1	0	1	0
2^1		0	1	1	0	0
$\overline{2}^1$		1	0	0	1	1
2^2		0	0	0	1	1
$\overline{2}^2$		1	1	1	0	0

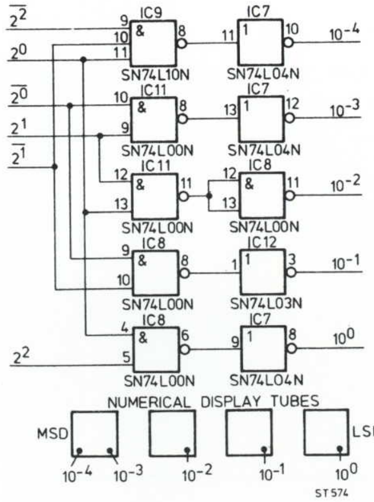


Fig. 19. Range matrix and decimal point positions.

VII-2.20 Inhibit (Fig.20)

This circuitry inhibits the UP signal, DOWN signal or memory signal in order to prevent unnecessary range switching.

The inhibit conditions are:

(a) When a DOWN signal arrives on the 10^{-4} range.

(b) When an UP signal arrives on the 10^{-1} range (with the exception of the kΩ setting)

(c) When an UP signal arrives on the 10^{0} range when set to kΩ.

(d) When the RANGE HOLD terminals are shorted, the memory signal is inhibited via IC 4/8 and the up-down counter is not clocked.

Note: If the 10^{0} range does occur for settings of the function selector other than kΩ, then a clear signal is generated for IC 6/6 via IC 5/3. This action decodes the 10^{-1} range immediately.

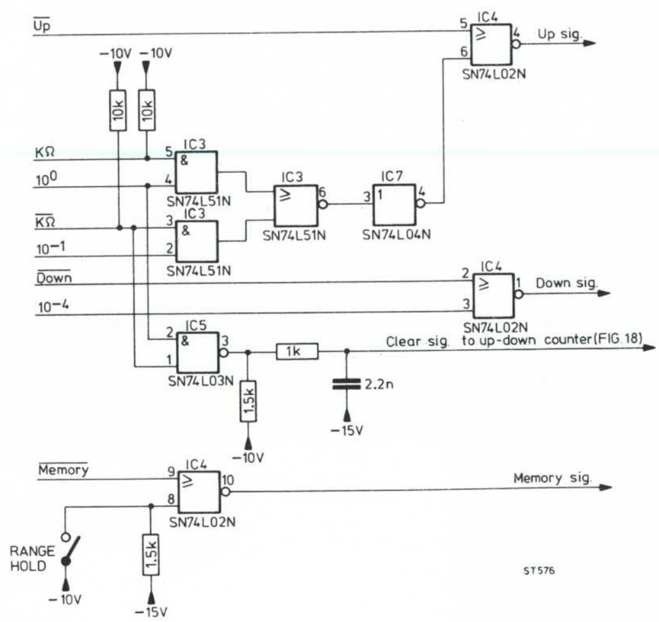


Fig. 20. Inhibit.

VII-2.21. Range control (Fig. 21).

Control functions for the switching of the relays in the input circuitry (Analogue Section) are generated from the matrix outputs.

VII-2.22. Relay drive (Fig. 21).

Table 7 shows the states of the relays of the input circuitry for the various functions and ranges.

TABLE 7. INPUT CIRCUIT RELAY STATES.

Function Selector	Range	DCV Atten.		ACV/DCV					I/V		Gain of input CCT /
		RE191	RE192	RE193	RE194	RE195	RE196	RE197	RE198	RE199	Shunt resistor
VDC	0 - 1 V (10^{-4})	ON	OFF	→	→	→	→	→	→	→	1
	1 - 10 V (10^{-3})	ON	OFF	→	→	→	→	→	→	→	1
	10 - 100 V (10^{-2})	OFF	ON	ON	OFF	→	→	→	→	→	0.01
	100 - 1000 V (10^{-1})	OFF	ON	ON	OFF	→	→	→	→	→	0.01
	1000 - (10^{0})	OFF	→	→	→	→	→	→	→	→	0 (Open Circuit)
VAC	0 - 1 V (10^{-4})	OFF	→	→	ON	OFF	→	→	→	→	1
	1 - 10 V (10^{-3})	OFF	→	→	→	ON	OFF	→	→	→	0.1
	10 - 100 V (10^{-2})	OFF	→	→	→	ON	ON	OFF	→	→	0.01
	100 - 500 V (10^{-1})	OFF	→	→	→	ON	→	→	OFF	OFF	0.001
	500 - (10^{0})	OFF	→	→	→	→	→	→	→	→	0 (Open Circuit)
mADC	0 - 1 mA (10^{-4})	OFF	→	→	→	→	→	→	→	→	1 kΩ
	1 - 10 mA (10^{-3})	OFF	→	→	→	→	→	→	→	ON	100 Ω
	10 - 100 mA (10^{-2})	OFF	→	→	→	→	→	→	ON	OFF	10 Ω
	100 - 1000 mA (10^{-1})	OFF	→	→	→	→	→	→	ON	ON	1 Ω
mAAC	0 - 1 mA (10^{-4})	OFF	→	→	ON	OFF	→	→	→	→	1 kΩ
	1 - 10 mA (10^{-3})	OFF	→	→	ON	OFF	→	→	→	ON	100 Ω
	10 - 100 mA (10^{-2})	OFF	→	→	ON	OFF	→	→	ON	OFF	10 Ω
	100 - 1000 mA (10^{-1})	OFF	→	→	ON	OFF	→	→	ON	ON	1 Ω

- ON means the corresponding relay is energised.
- OFF means the corresponding relay is unenergised.

They determine the attenuation at the input circuitry for voltage measurements and select the required shunt resistor for current measurements.

VII-2.23. OHM-FET switch drive (Fig. 21).

The range decodes (10^{-4} ..... 10^{0}) generated by the range-matrix control the FET switches of the OHM/DCV converter. These select the source current for resistance measurements.

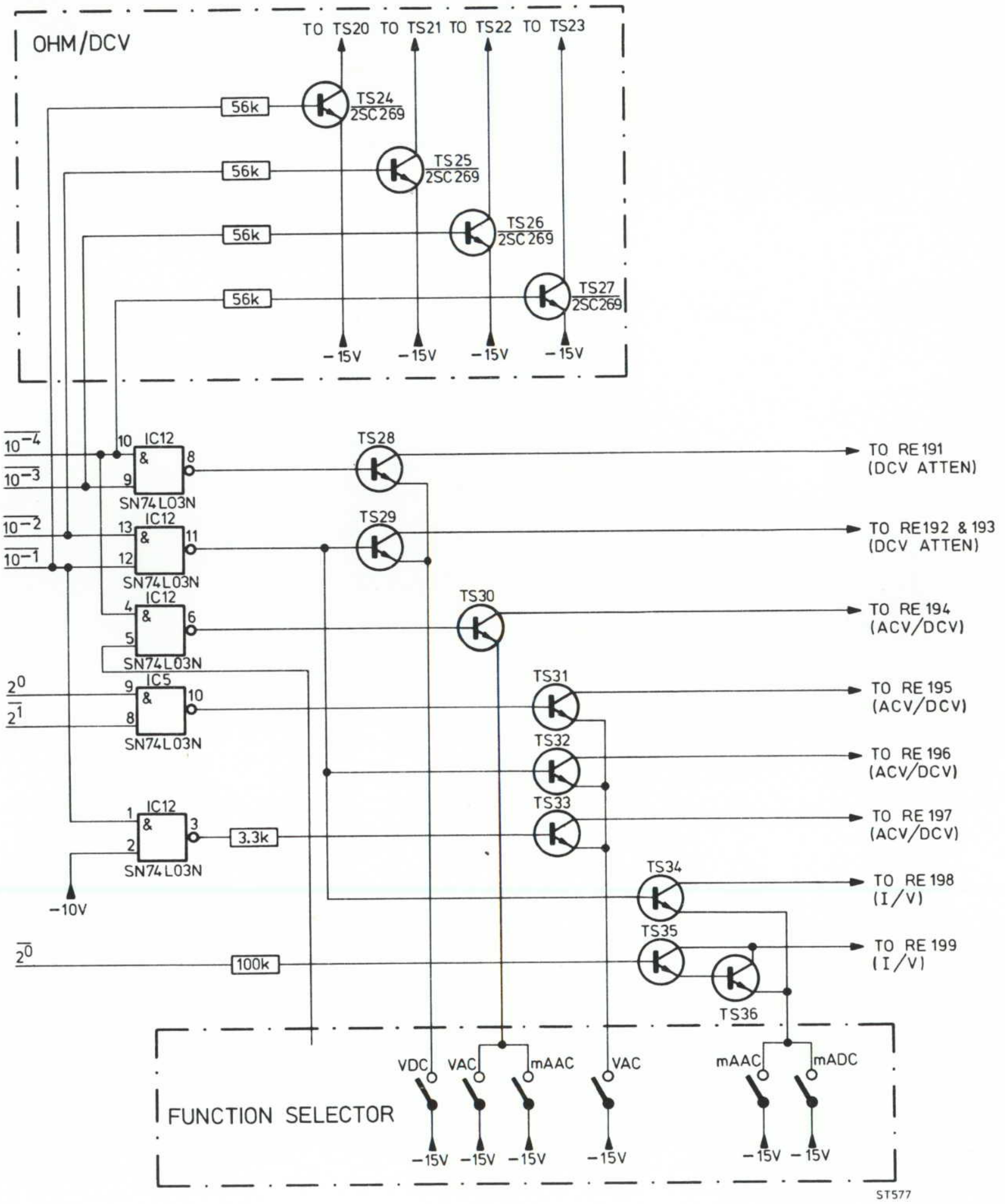


Fig. 21. Range control.

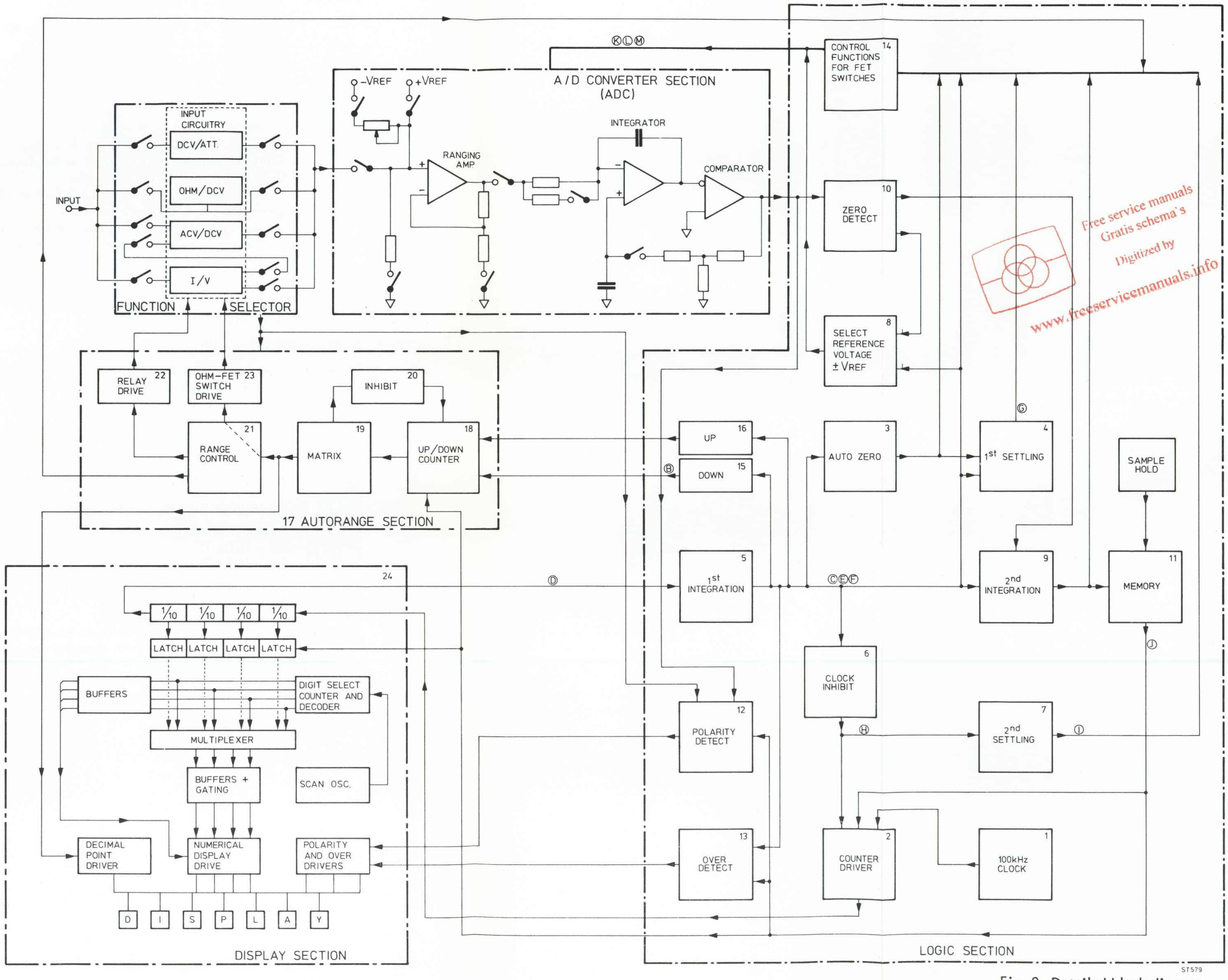


Fig. 8. Detailed block diagram

VII-2.24. Display section (Fig. 22).

The numerical display consists of 4 tubes operating in a dynamic mode where only one of the tubes is ON at any time.
The digit selection signal is generated within IC 15 by an internal 400 Hz oscillator. This scans the digit selection outputs taking them in turn to a logic 1 for 0.6 ms.
The display tube enable pulses are derived from the digit selection outputs.
Synchronisation between the numerical information and the display tube enable pulses is obtained by the digit selection signal enabling the appropriate contents of the multiplexer to be fed to the BCD output terminals.
The BCD outputs are transferred to the display tubes via transistor inverters and a BCD-to-Decimal Decoder/driver.
The BCD counters of IC 15 are clocked at 100 kHz and a count extend pulse is generated after 10^4 clock pulses.
The contents of the counters are transferred to the latches (and therefore to the multiplexer) on the occurrence of the memory signal (waveform M).
The BCD counters and digit select counter/decoder of IC 15 are reset by the clear signal (waveform F).

Display tubes B 373 and B 370 display the most significant (MSD) and least significant (LSD) digits respectively.

VII-3. POWER SUPPLY (Fig. 40).

The voltages required by the instrument are derived via a series regulator and a DC/DC inverter. The DC/DC inverter operates in the self-oscillating mode and the various voltages are derived via the secondary windings of the transformer.

The voltages are:

+ 180 V and + 90 V for the display tubes.

+ 30 V for the series regulator operational amplifier.

+ 15 V for the amplifiers (with - 15 V).

- 10 V for the logic circuitry.
- 15 V (-10 V - logic 1)
  (-15 V - logic 0)

The reference voltages $+V_{REF}$ (+ 10.00 V) and $-V_{REF}$ (- 10.00 V) are generated in the ADC section.
Since the stability of the reference voltages has a direct effect upon the accuracy of the measurements, the design of this circuitry ensures stability against environmental changes.

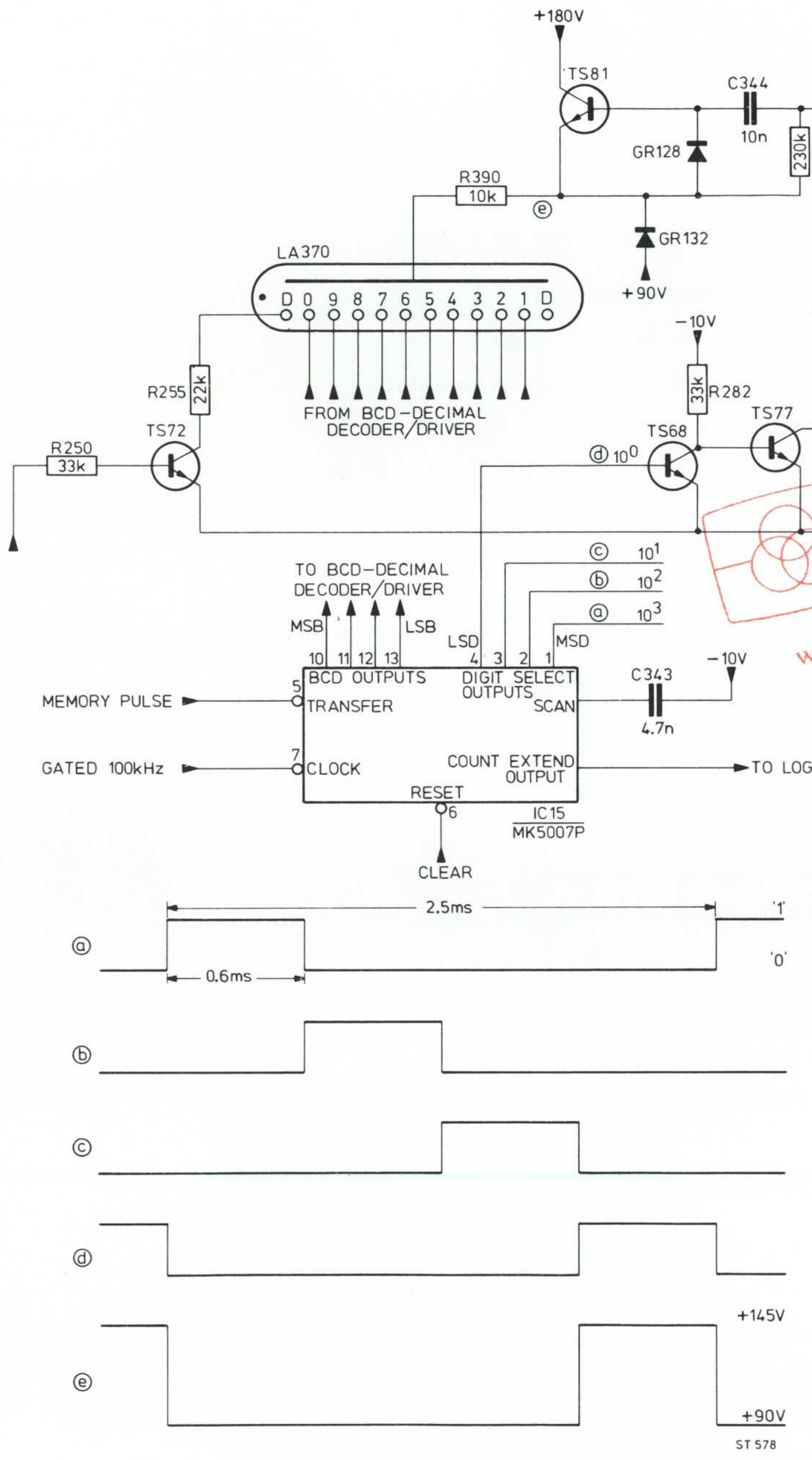


Fig. 22. Plate control and digit selection signal timing.

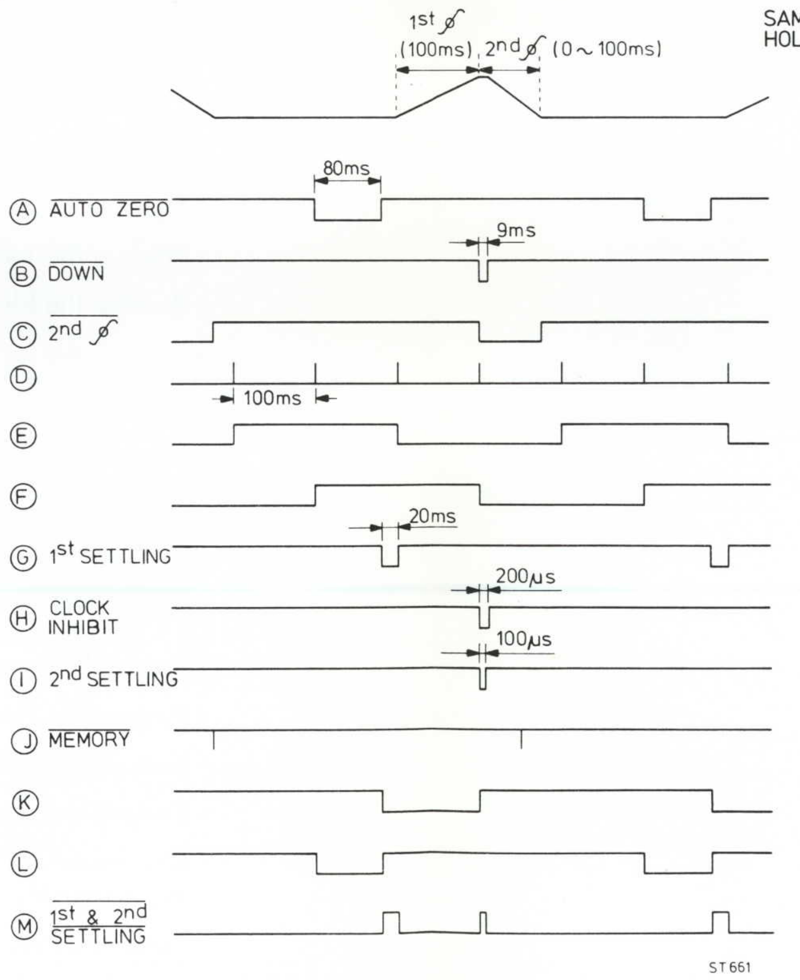


Fig. 15. Timing sequence chart (logic section)

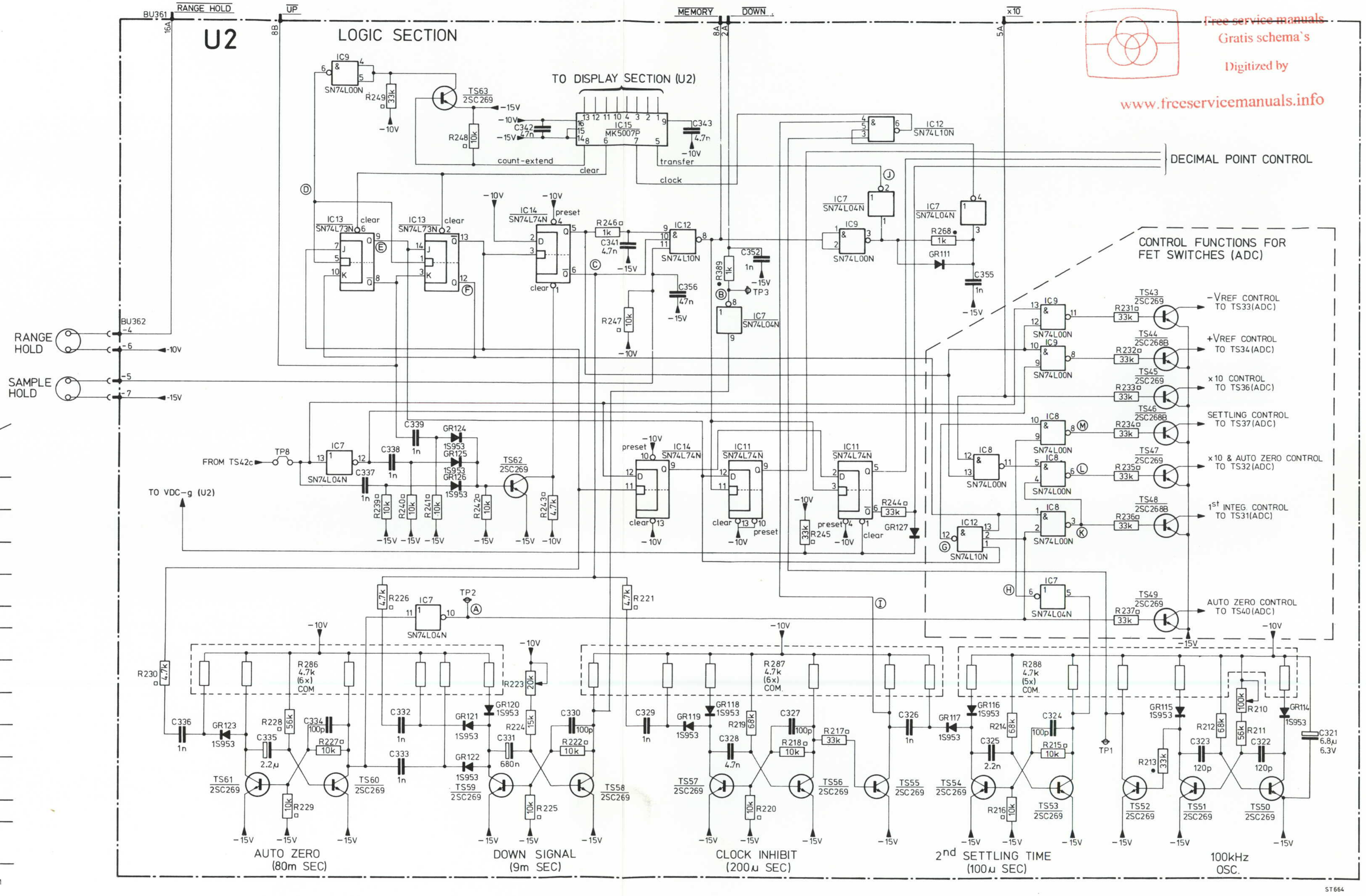


Fig. 16. Circuit diagram of logic section

VIII. Access

VIII-1. CALIBRATION CONTROLS.

By removing the top plate all calibration adjusters are accessible.

VIII-2. BOARD U1 (input circuitry and autorange section).

- Remove the top plate (two screws on the back edge).

  Note: All test points and adjusters on U1 are now accessible.

- Remove the handle and associated parts.
- Remove the left-side section (two screws in rear section; two screws in the base; one screw in blue identification strip).
- Unsolder the wires from the on-board connectors (BU 251-BU 257).
- Remove the three screws from board U1.
- Carefully pull board U1 from connector BU 361 fixed to the lower board (U2).
- Remove board U1.

  Note: The bracket is fixed to board U2.

VIII-3. BOARD U2 (power supply, ADC, logic and display section, function selector).

- Remove the handle and associated parts.
- Remove the top plate (two screws on back edge).
- Remove the blue identification strip on the top front edge (two screws).
- Remove the left-side section (two screws in rear section).
- Unsolder the wires from the on-board connectors (BU 251-BU 257).
- Remove the three screws from board U1.
- Carefully pull board U1 from connector BU 361 fixed to board U2.
- Remove board U1.

  Note: The bracket is fixed to board U2.

The screening card is now exposed.

- Remove the three spacer studs and the screw near the slot in the screening card.
- Remove the screening card with the bracket attached.
- Remove the transparent display cover.
- Disconnect the right-hand section (two screws in rear section; one screw in base) from the main assembly, gently pulling aside as far as the wiring allows.

  Note: All test points and adjusters on U2 are now accessible.

Servicing is made easier by the following actions:

- Remove the function selector surround.
- Remove the base plate (two screws on the back edge).
- Remove the screw passing through the back edge of U2 and pull away the rear section as far as the wiring allows.
- Remove the right-hand section by disconnecting BU 362 and unsoldering from the right-hand section the three wires which are hard-wired from U2.

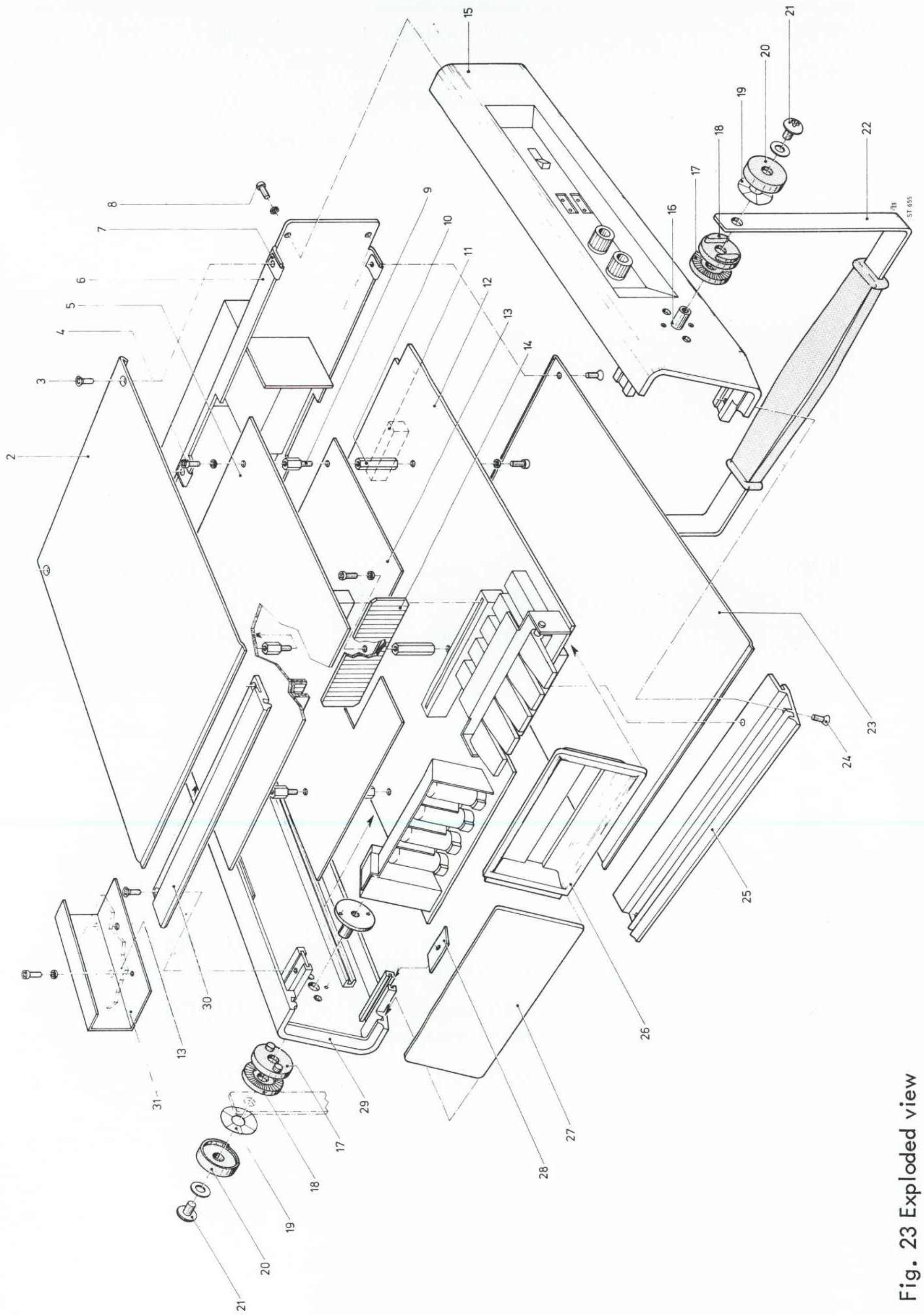


Fig. 23 Exploded view

IX. Checking and calibration

The table below gives a review of the adjustments which can be made to the PM 2424 multimeter.

Control Element	Control Function	Board and Fig.
R 146	Supply voltages	U2
R 210	Clock oscillator frequency 100 kHz	U2
R 223	Pulse width (of Down signal, 9 ms)	U2
R 198	offset corrections	U2 Fig. 24
C 372		U2
	d.c. voltages	
R 171	10 V range (+V_{REF}) (negative voltages)	U2, Fig. 24
R 162	10 V range (-V_{REF}) (positive voltages)	U2, Fig. 24
R 180	1 V range (negative voltages)	U2, Fig. 24
R 174	1 V range (positive voltages)	U2, Fig. 24
R 132	100 V range	U1, Fig. 24
	a.c. voltages	
R 79	Zero	U1, Fig. 24
R 77	1 V range	U1, Fig. 24
R 65	10 V range (low frequency)	U1, Fig. 24
C 168	10 V range (high frequency)	U1, Fig. 24
R 66	100 V range (low frequency)	U1, Fig. 24
C 169	100 V range (high frequency)	U1, Fig. 24
R 78	500 V range	U1, Fig. 24

Control Element	Control Function	Board and Fig.
	Resistance	
R 120	1 kΩ range	U1, Fig. 24.
R 119	10 kΩ range	U1, Fig. 24
R 102	100 kΩ range	U1, Fig. 24
R 118	1 MΩ range	U1, Fig. 24
R 117	10 MΩ range	U1, Fig. 24

The tolerances stated in this section correspond to the factory data and only apply to a recently adjusted instrument.
When individual components, especially semi-conductors are replaced, the relevant section should be completely readjusted.

Required Test-Equipment.

It is important that the reference equipment used meets the accuracy requirements quoted in the table below.

Test	Required Equipment	Required Performance
Supply voltages	Digital voltmeter Eg. PM 2421	
Clock frequency	Frequency counter Eg. Hewlett-Packard HP5301A	
Pulse width	Oscilloscope Eg. PM 3330	
DC voltage	Standard DC voltage generator	0 - ± 1000 V d.c.
Calibration	Eg. PM 2480	± 0.005% accuracy
AC voltage	Standard AC voltage generator	0 - 500 V r.m.s.
Calibration	Eg. Hewlett-Packard HP745A	± 0.005% accuracy
Resistance measurement	Standard Resistors	900 Ω ± 0.01%
Calibration	Eg. Metal film or Guidline type 9330	9 kΩ ± 0.01% 90 kΩ ± 0.02% 900 kΩ ± 0.1 % 9 MΩ ± 0.2 %

IX-1. CHECKING PROCEDURE.

The test points and adjusters of this section are only accessible when board U1 and the screening card have been removed.
Refer to Access, VIII.2.
Great care must be taken when the instrument is switched ON in this state.

IX-1.1. Supply Voltages.

- Observe the voltage at the - 10 V test point (U 2) and adjust R 146 if necessary to give - 10 V ± 1%.

IX-1.2. Clock Frequency.

- Observe the output at TP1 (U 2) with the frequency counter and adjust R 210 (U 2) if necessary to give 100 kHz ± 0.05%.

IX-1.3. Pulse Width.

- Observe the output at TP3 (U 2) with the oscilloscope and adjust R 223 (U 2) if necessary to give a pulse of 9 ms width.

IX-2. CALIBRATION.

By removing the top plate all calibration adjusters are accessible (Fig. 24), although care is required when adjusting R 162, R 171, R 174 and R 180. Calibration should take place at an ambient temperature of 23°C ± 5°C in a humidity of less than 75%.
Mains or d.c. supply can be used as the power source.
A warm-up period of approximately one hour is required before calibration is made.

Notes:

- Adjustments must be made in the RANGE HOLD mode and not on AUTO RANGE.
- It is important that calibration is carried out in the order as described.
- It may be necessary to temporarily reduce the required input signal in order for the auto-ranging to give the correct range i.e. when -9 V applied at the input, the display may read - 9.00 instead of - 9.000 V. If so, then reduce the input voltage (e.g. to - 8 V) and then increase to - 9 V.

IX-2.1. d.c. voltage (VDC).

- Depress the switch VDC.
- Connect the standard DV voltage generator to the INPUT terminals via the input cable.
- Set the output of the DC voltage generator as given in the table below.
- Apply the RANGE HOLD shorting-plug when the required display format has been obtained.

Order	Range	Input	Adjuster	Display
1	10 V	- 9.000 V	R 171	- 9.000 ± 1 digit
2	10 V	+ 9.000 V	R 162	+ 9.000 ± 1 digit
3	1 V	- 0.9000 V	R 180	- .9000 ± 1 digit
4	1 V	+ 0.9000 V	R 174	+ .9000 ± 1 digit
5	100 V	- 90.00 V	R 132	- 90.00 ± 1 digit

- Disconnect the RANGE HOLD plug and the DC voltage generator.

IX-2.2. a.c. voltage (VAC).

- Depress the switch VAC.
- Connect the standard AC voltage generator to the INPUT terminals via the input cable.
- Set the output of the AC voltage generator as given in the table below.
- Apply the RANGE HOLD shorting-plug when the required display format has been obtained.

Order	Range	Input	Adjuster	Display
1	1 V	0 V	R 79	.0000 ± 1 digit
2	1 V	0.9000 V (400 Hz)	R 77	.9000 ± 1 digit
3	10 V	9.000 V (400 Hz)	R 65	9.000 ± 1 digit
4	10 V	9.000 V (40 kHz)	C 168	9.000 ± 1 digit
5	100 V	90.00 V (400 Hz)	R 66	90.00 ± 1 digit
6	100 V	90.00 V (40 kHz)	C 169	90.00 ± 1 digit
7	600 V	500.0 V (400 Hz)	R 78	500.0 ± 1 digit

- Disconnect the RANGE HOLD plug and AC voltage generator.

IX.2.3. Resistance (kΩ).

- Depress the switch kΩ.
- Connect the standard resistors to the INPUT terminals via the input cable as given in the table below.

Order	Range	Input	Adjuster	Display
1	100 kΩ	90 kΩ	R 102	Standard resistor calibrated value ± 1 digit
2	10000 kΩ	9 MΩ	R 117	Standard resistor calibrated value ± 1 digit
3	1000 kΩ	900 kΩ	R 118	Standard resistor calibrated value ± 1 digit
4	10 kΩ	9 kΩ	R 119	Standard resistor calibrated value ± 1 digit
5	1 kΩ	900 Ω	R 120	Standard resistor calibrated value ± 1 digit

- Disconnect the RANGE HOLD plug and resistor.

IX.2.4. d.c. current (mADC) and a.c. current (mAAC).

d.c. and a.c. current calibration adjusters do not exist.
The measurement accuracy stipulated in the Technical Data (Section II) of this manual is obtained after the completion of the previous adjustments.

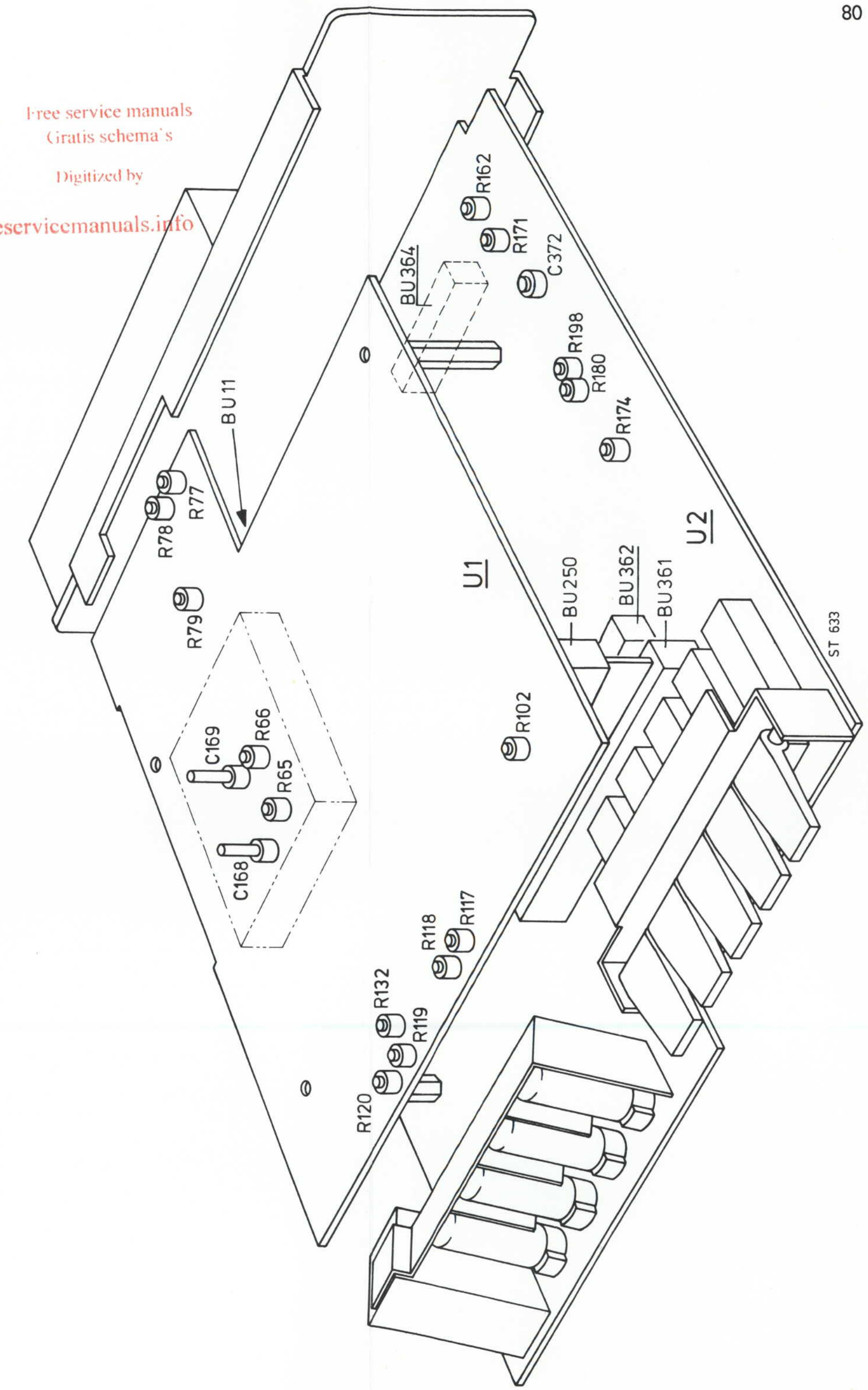


Fig. 24. Location of calibration controls for PM 2424

X. Maintenance and servicing

The Digital Multimeter PM 2424 does not require any maintenance as the instrument does not contain any components which are subject to excessive wear.
However, this does not apply if the instrument is operated in an environment of excessive heat, moisture, corrosive vapours or excessive dust.

X-1. SERVICE HINTS.

If servicing has to be carried out the following points should be taken into account in order to avoid damaging the instrument.

- Take great care to avoid short-circuits with measuring clips and hooks if the instrument is switched-on, especially near the display section where high voltages are present.
- Use a miniature soldering iron (35 W max.) with a tin cleaner or a vacuum soldering iron.
- Use an acid-free solder.

It is advisable to make an extension connector board for board U1, so that the components of board U2 are accessible with board U1 connected to the instrument.

Notes:

- The use of an extension card requires that the flying-leads to board U1 are extended.
- Components on board U2 are only accessible when the screening card is removed.

X-2. TESTS.

In the following table and oscillograms, voltages and waveforms are given for certain (the more relevant) points of the instrument.

General conditions:

- Nominal mains voltage (220 V, 50 Hz).
- A recently calibrated instrument.
- Voltages measured with respect to 0 V (Black INPUT terminal).
- Oscillograms made with oscilloscope PM 3330.
- Frequency measurements made with Hewlett-Packard HP5301A 10 MHz Counter.
- The data recorded represents the performance of a typical instrument and should serve as a guide only.
- Board U1 connected to board U2 via a suitable extension card.

The table is provided as a general guide to fault finding, but for more specific problems e.g. range switching not performed from 10^{-3} to 10^{-4}, the following TROUBLE SHOOTING section should be consulted.
Moreover, the detailed circuit description of Section VII should enable any fault to be isolated and rectified with ease.

TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
0 V	U2	A circuit zero		0 V	If an extension card is not used the wires originally connected to BU 256 must be connected to BU 361/10A
BU 250/ 10A		A circuit zero		0 V	
BU 361/ 12A		A circuit zero		0 V	
		POWER SUPPLY			
'c' of TS 24	U2	DC/DC Inverter Frequency		4.45 kHz 0 V to + 17.5 V SQ. WAVE	
TP 9 (+ 30 V)	U2	Supply Voltage to Series Regulator (IC1)		+ 29.95 V	
TP 10 (+ 9.0 V nominal)	U2	Output of Series Regulator		+ 8.8 V	
TP 11 (- 15 V)	U2	Supply Voltage to OP. AMPS. and Digital I.C.'s		- 14.9 V	
TP 12 (+ 15 V)	U2	Supply Voltage to OP. AMPS.		+ 14.9 V	
- 10 V	U2	Supply Voltage to Digital I.C.'s		- 9.95 V	
+ 180 V (nominal)	U2	Supply Voltage to Indicators		+ 173.5 V	
+ 90 V (nominal)	U2	Supply Voltage to Indicators		+ 84.5 V	

Note: If an extension card is not used board U1 should be completely removed.

TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
		INPUT CIRCUITRY			
BU 253	U1	Output of DCV Attenuator	Switch VDC depressed. Supply respectively to the INPUT terminals:		
			+ 0.5 V d.c.	+ 0.5 V	
			+ 5.0 V d.c.	+ 5.0 V	
			+ 50 V d.c.	+ 0.5 V	
			+ 500 V d.c.	+ 5.0 V	

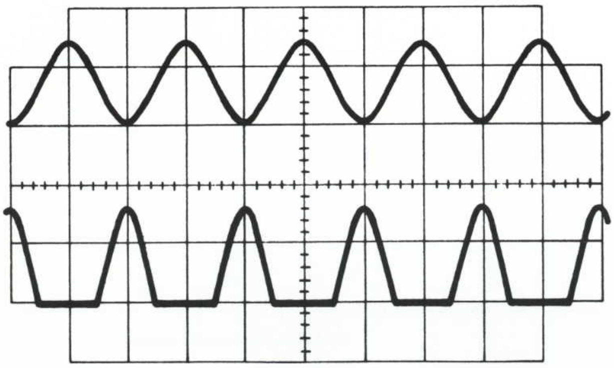
TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
BU 255	U1	Output of ACV/ DCV Converter	Switch VAC depressed. Supply respectively to the INPUT terminals:		
			0.5 V r.m.s.	+ 0.5 V	
			5.0 V r.m.s.	+ 0.5 V	
			50 V r.m.s.	+ 0.5 V	
			500 V r.m.s. at 1 kHz	+ 0.5 V	
Junction of R 136 and R 137	U1	Output of I/V Converter	Switch mADC depressed. Supply respectively to the INPUT terminals via a 10 kΩ resistor:		(Resistor value: 10.2 kΩ)
			+ 5 V d.c.	440 mV	
			+ 50 V d.c.	480 mV	
			Supply to the INPUT terminals via a 100 Ω resistor:		(Resistor value: 101 Ω)
			+ 5 V d.c.	450 mV	
			Switch mAAC depressed. Supply respectively to the INPUT terminals via a 10 kΩ resistor:		(Resistor value: 10.2 kΩ)
			5 V r.m.s.	1.2 V pk/pk	use oscilloscope
			50 V r.m.s.	1.4 V pk/pk	for measurements
			Supply to the INPUT terminals via a 100 Ω resistor:		(Resistor value: 100 Ω)
			5 V r.m.s.	1.4 V pk/pk	
BU 251	U1	Output of OHM-to DCV Converter	Switch kΩ depressed. Connect between the INPUT terminals respectively:		
			900 Ω	0.9 V	
			9 kΩ	0.9 V	
			90 kΩ	0.9 V	
			900 kΩ	0.9 V	
			5 MΩ	0.5 V	

TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
'S' of TS 15	U1	ACV/DCV Converter	Switch VAC depressed. Supply to the INPUT terminals 5 V r.m.s. at 1 kHz	Oscillogram Fig. 27.1a	
Cathode of GR 43	U1	ACV/DCV Converter	Switch VAC depressed. Supply to the INPUT terminals 5 V r.m.s. at 1 kHz	Oscillogram Fig. 27.1b	
		ANALOGUE-TO-DIGITAL CONVERTER			If an extension card is not used, BU 256 must be connected to BU 361/10A.
TP 4 (+10.00 V)	U2	$+V_{REF}$		+ 9.994 V	
TP 5 (-10.00 V)	U2	$-V_{REF}$		- 9.994 V	If an extension card is not used, the input signal should be applied to the input of the ADC at R 157 (100 kΩ).
'G' of TS 31	U2	Input of Ranging Amp.	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.3	Oscillogram shows the comparison with the integrator output, IC 5/6.
'G' of TS 31	U2	1st integration control	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.4	Oscillogram shows the comparison with the integrator output, IC 5/6.
'G' of TS 34	U2	$+V_{REF}$ control	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.5	Oscillogram shows the comparison with the integrator output, IC 5/6.
'G' of TS 32	U2	x10 and auto - zero control	Switch VDC depressed. Supply to the INPUT terminals - 0.5 V d.c.	Refer to Fig. 14 (Section VII)	

TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
'G' of TS 32	U2	x10 and auto - zero control	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Refer to Fig. 14 (Section VII)	
'G' of TS 37	U2	Settling times control	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.6	Oscillogram shows the comparison with the integrator output, IC 5/6.
'G' of TS 38	U2	Auto-zero control	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Refer to Fig. 14 (Section VII)	
'G' of TS 40	U2	Auto-zero control	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Refer to Fig. 14 (Section VII)	
TP 6	U2	Ranging Amp. Output	Switch VDC depressed. Supply to the INPUT terminals + 5.0 V d.c.	Oscillogram Fig. 27.7	Oscillogram shows the comparison with the integrator output, IC 5/6.
TP 7	U2	Comparator Output	Switch VDC depressed. Supply to the INPUT terminals + 5.0 V d.c.	Refer to Fig. 14 (Section VII)	
TP 8	U2	Output of ADC	Switch VDC depressed. Supply to the INPUT terminals + 5.0 V d.c.	Oscillogram Fig. 27.9	Oscillogram shows the comparison with the integrator output, IC 5/6.
TP 6	U2	Ranging Amp. Output	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.8	Oscillogram shows the comparison with the integrator output, IC 5/6.
TP 7	U2	Comparator Output	Switch VDC depressed. Supply to the INPUT terminals - 5.0 V d.c.	Refer to Fig. 14 (Section VII)	

TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
TP 8	U2	Output of ADC	Switch VDC de-pressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.10	Oscillogram shows the comparison with the integrator output, IC 5/6.
		DIGITAL SECTION			If an extension card is not used, BU 256 must be connected to BU 361/10 A.
TP 1	U2	Clock Oscillator 100 kHz		Oscillogram Fig. 27.2	If an extension card is not used, the input signal should be applied to the input of the ADC at R 157 (100 kΩ).
TP 2	U2	$\overline{\text{AUTO-ZERO}}$ Pulse	Switch VDC de-pressed. Supply to the INPUT terminals - 5.0 V d.c.	Refer to Fig. 15 (Section VII)	
TP 3	U2	$\overline{\text{DOWN}}$ Pulse	Switch VDC de-pressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.11	Oscillogram shows the comparison with the integrator output, IC 5/6.
BU 361/ 8 B	U2	$\overline{\text{UP}}$ Pulse	Switch VDC de-pressed. Supply to the INPUT terminals - 5.0 V d.c.	Oscillogram Fig. 27.12	Oscillogram shows the comparison with the integrator output, IC 5/6.
BU 361/ 8 B	U2	$\overline{\text{UP}}$ Pulse	Switch VDC de-pressed. Supply to the INPUT terminals approx. - 10.0 V d.c. in order to give an end-of-range value	Oscillogram Fig. 27.13	Oscillogram shows the comparison with the integrator output, IC 5/6.
'c' of TS 63	U2	Count Extend Output	Switch VDC de-pressed. Supply to the INPUT terminals - 0.5 V d.c.	Oscillogram Fig. 27.14	Oscillogram shows the comparison with the integrator output, IC 5/6.

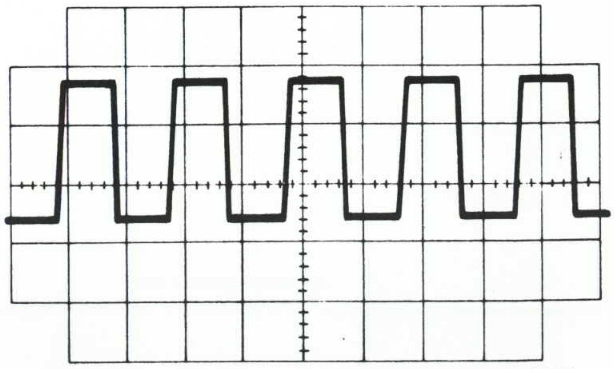
TEST POINT	UNIT	FUNCTION	CONDITION	VALUE	COMMENTS
IC 12/4	U2	Clock Inhibit Pulse	Switch VDC depressed. Supply to the INPUT terminals - 0.5 V d.c.	Oscillogram Fig. 27.15	Oscillogram shows the comparison with the integrator output, IC 5/6.
BU 361/ 8A	U2	Memory Pulse	Switch VDC depressed. Supply to the INPUT terminals - 0.5 V d.c.	Oscillogram Fig. 27.16	Oscillogram shows the comparison with the integrator output, IC 5/6.
IC 8/8	U2	Settling Pulses	Switch VDC depressed. Supply to the INPUT terminals - 0.5 V d.c.	Oscillogram Fig. 27.17	Oscillogram shows the comparison with the integrator output, IC 5/6.



ST 671

Fig. 27.1

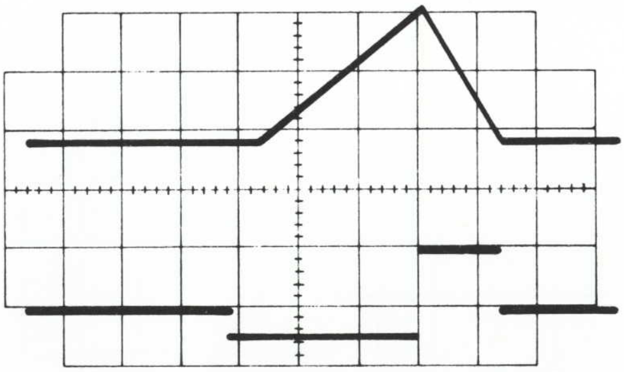
Oscilloscope settings		Comments
Time:	0.5 ms/cm	ACV/DCV
Volts:	a. 1 V/cm	Converter
	b. 1 V/cm	



ST 672

Fig. 27.2

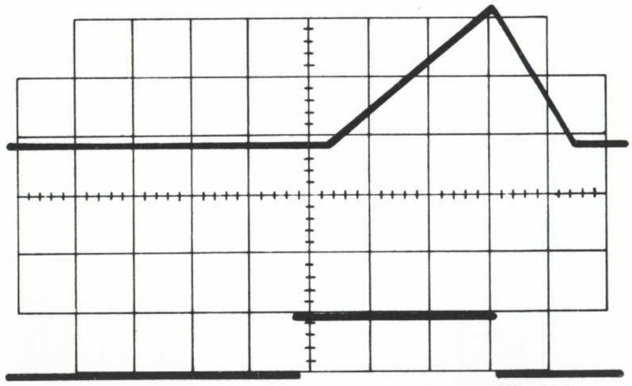
Oscilloscope settings		Comments
Time:	5 μs/cm	100 Khz
Volts:	2 V/cm	Clock oscillator



ST 673

Fig. 27.3

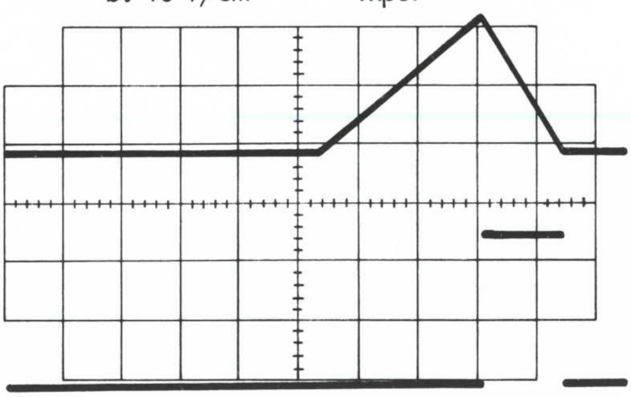
Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm	b. Ranging amp. input
	b. 10 V/cm	



ST 674

Fig. 27.4

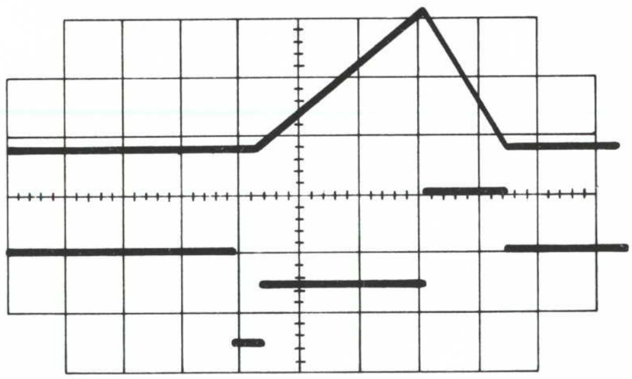
Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm	b. 1st Integration control
	b. 10 V/cm	



ST 675

Fig. 27.5

Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm	b. $+V_{REF}$ select control
	b. 10 V/cm	



ST 676

Fig. 27.6

Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm	b. Settling times control

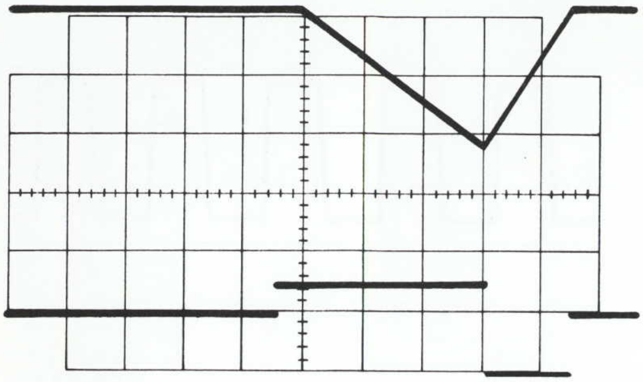


Fig. 27.7 ST 677

Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm b. 10 V/cm	b. Ranging amp. output (+5.0 V input)

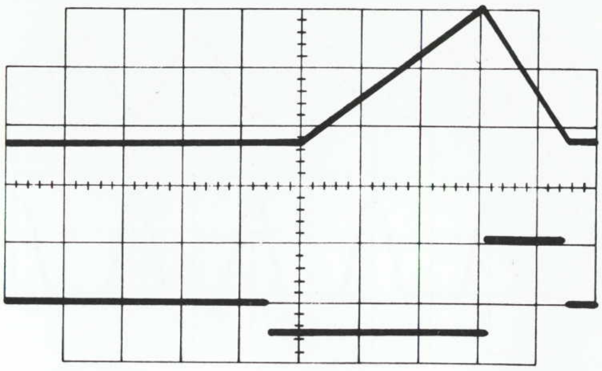


Fig. 27.8 ST 678

Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm b. 10 V/cm	b. Ranging amp. output (-5.0 V input)

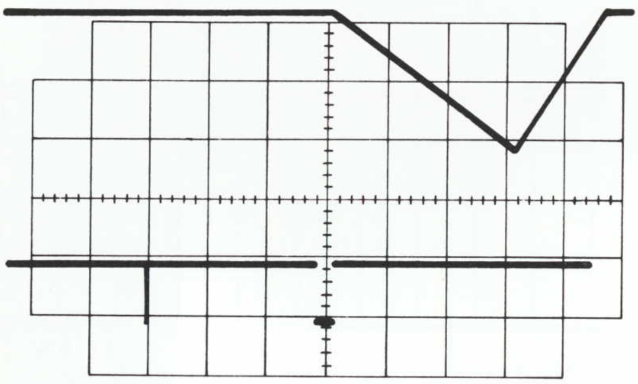


Fig. 27.9 ST 679

Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm b. 5 V/cm	b. Output of ADC (+5.0 V input)

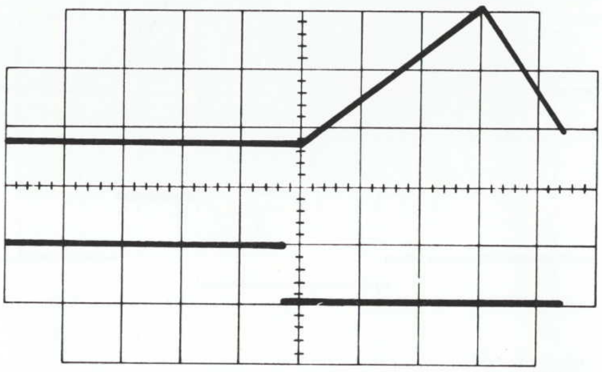


Fig. 27.10 ST 680

Oscilloscope settings		Comments
Time:	100 ms/3 cm	a. Integrator
Volts:	a. 2 V/cm b. 5 V/cm	b. Output of ADC (-5.0 V input)

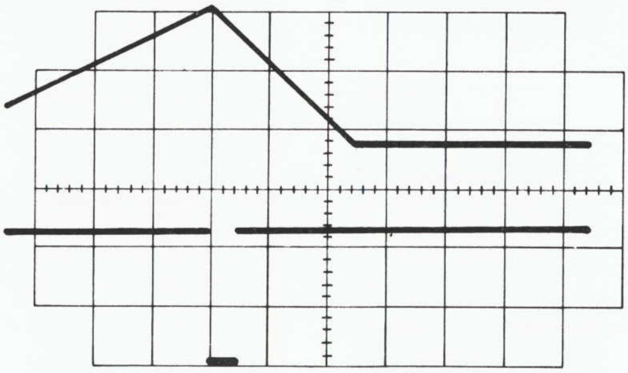


Fig. 27.11 ST 681

Oscilloscope settings		Comments
Time:	20 ms/cm	a. Integrator
Volts:	a. 2 V/cm b. 2 V/cm	b. Down pulse

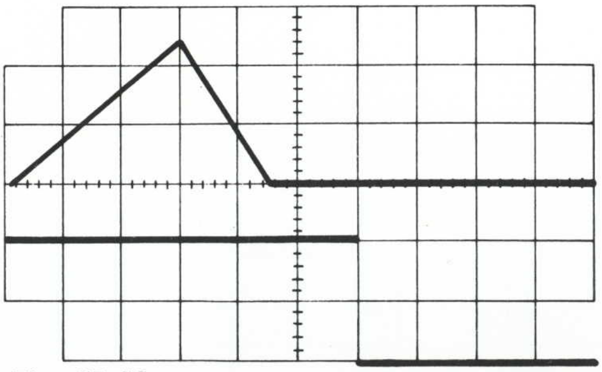


Fig. 27.12 ST 682

Oscilloscope settings

Time: 100 ms/3 cm

Volts: a. 2 V/cm
b. 2 V/cm

Comments

a. Integrator

b. Up signal
(-5.0 V input)

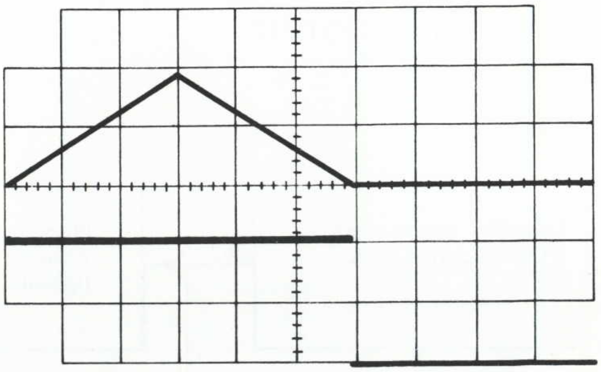


Fig. 27.13 ST 683

Oscilloscope settings

Time: 100 ms/3 cm

Volts: a. 5 V/cm
b. 2 V/cm

Comments

a. Integrator

b. Up signal
(at end-of-range)

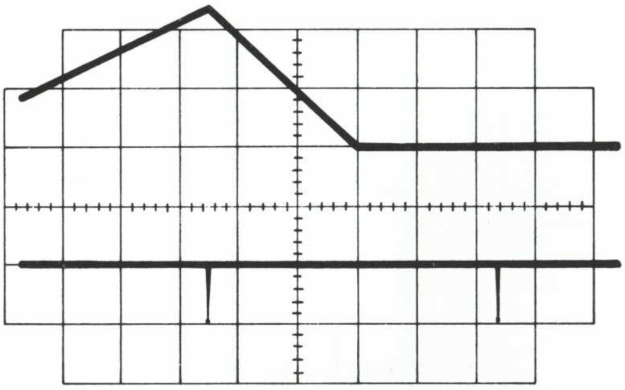


Fig. 27.14 ST 684

Oscilloscope settings

Time: 20 ms/cm

Volts: a. 2 V/cm
b. 5 V/cm

Comments

a. Integrator

b. "Count extend"
output

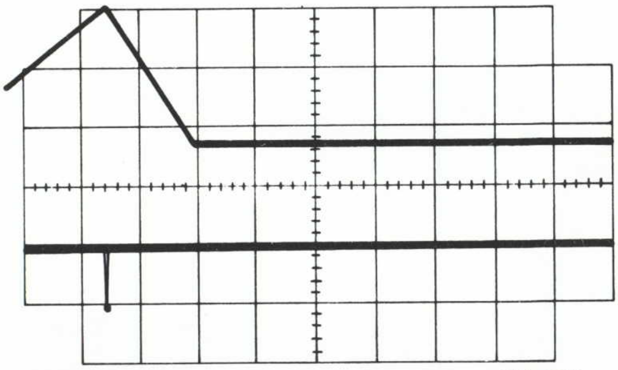


Fig. 27.15 ST 685

Oscilloscope settings

Time: 100 ms/3 cm

Volts: a. 2 V/cm
b. 5 V/cm

Comments

a. Integrator

b. Clock inhibit pulse

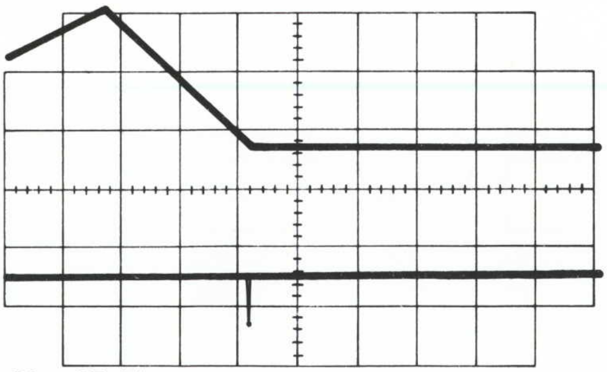


Fig. 27.16 ST 686

Oscilloscope settings

Time: 20 ms/cm

Volts: a. 2 V/cm
b. 5 V/cm

Comments

a. Integrator

b. Memory (transfer)
pulse

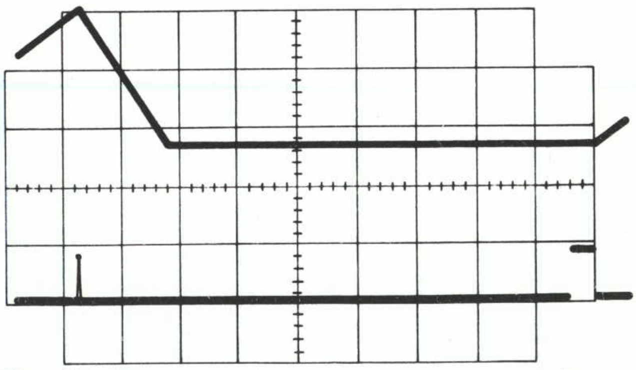


Fig. 27.17 ST 687

Oscilloscope settings

Time: 100 ms/3 cm

Volts: a. 2 V/cm
b. 5 V/cm

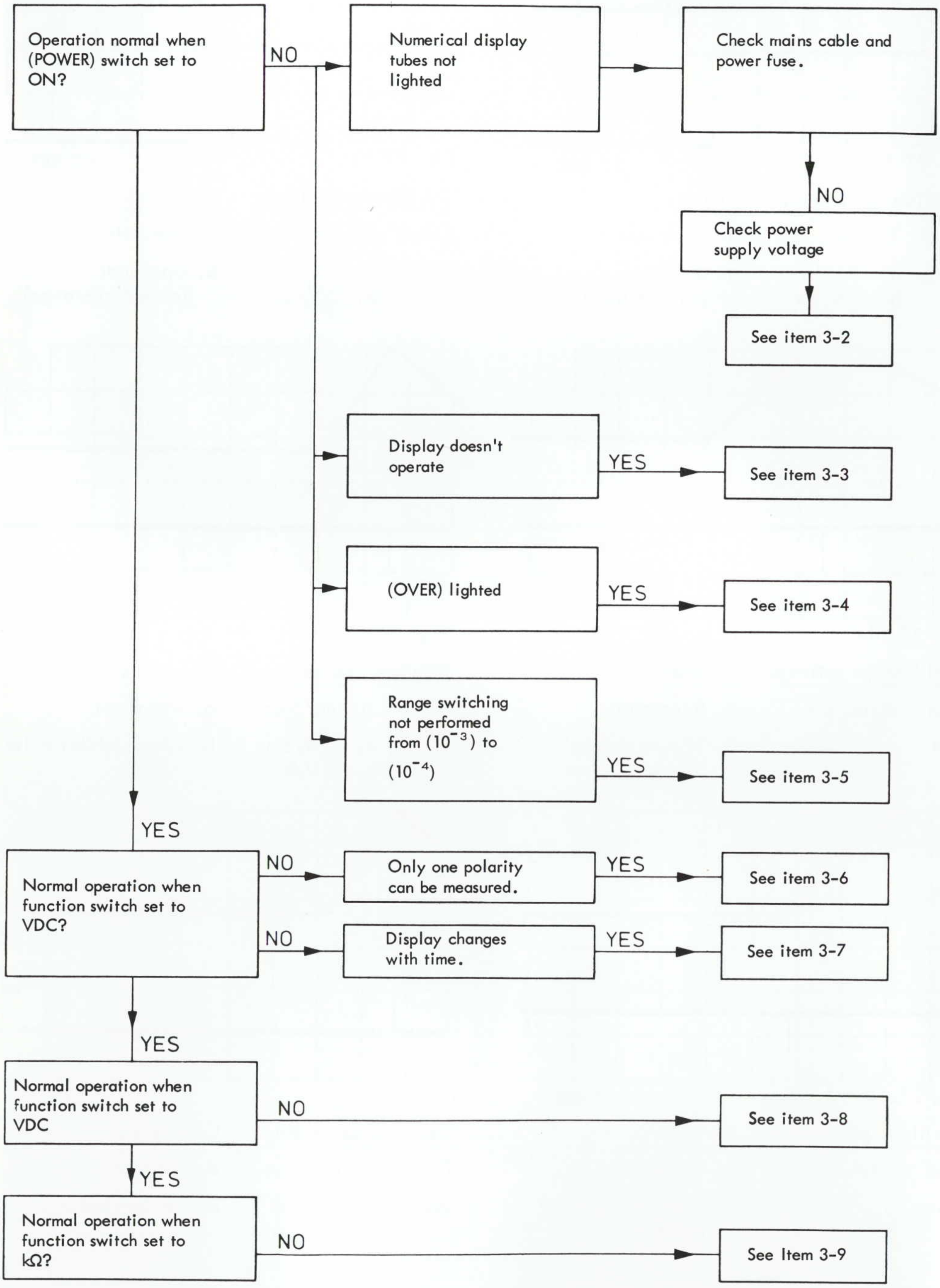
Comments

a. Integrator

b. Settling pulse

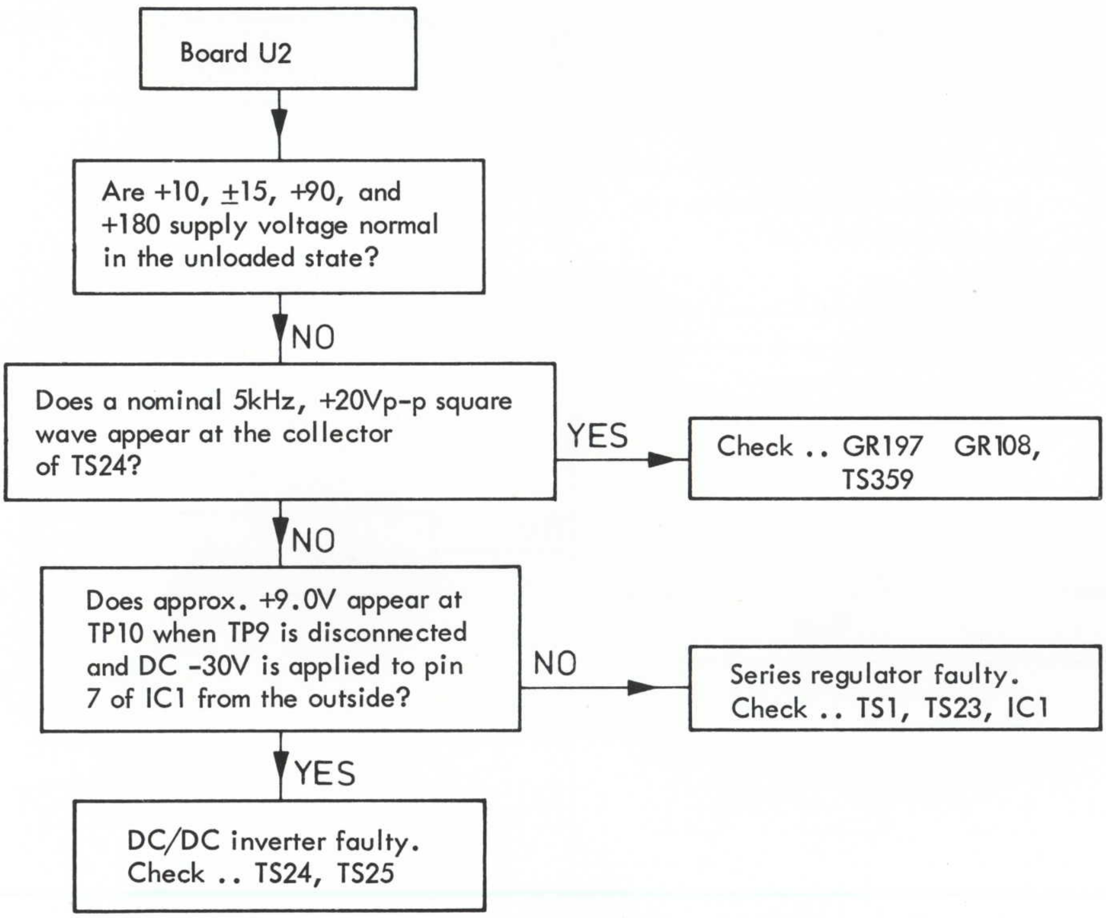
X-3 TROUBLESHOOTING

X-3.1.

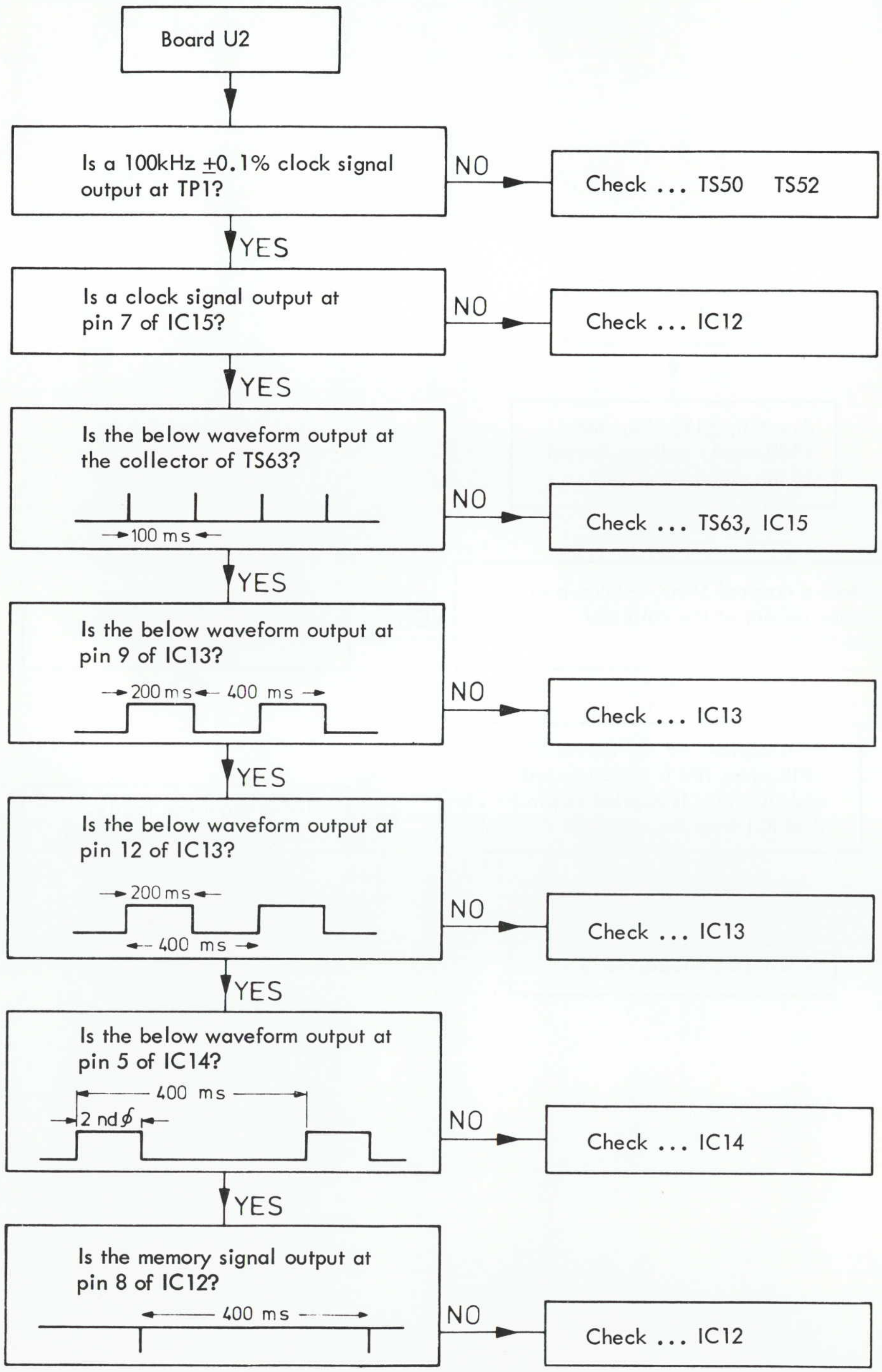


ST 688

X-3.2 Power supply voltage check



X-3.3 A certain value is displayed continually



X-3.4. (OVER) Lighted even when all the function switches are OFF

Board U2

↓

Is the source of TS31 0V during the 1st integration?
- NO → Check ... TS26 TS29
- YES ↓

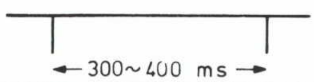
Is pin 6 of IC4 approx. 0V during the 1st integration?
- NO → Check ... IC4
- YES ↓

Is pin 6 of IC5 saturated at +13V or -13V?
- YES → Check ... IC5
- NO ↓

Is pin 1 of IC6 -15V when the output of pin 6 of IC5 is positive and +15V when it is negative?
- NO → Check ... IC6
- YES ↓

Is pin 12 of IC7 logic 1 when the output of pin 6 of IC5 is positive and when logic 0 when it is negative?
- NO → Check ... IC7, TS41, TS42
- YES ↓

Is the below waveform output at the collector of TS62?



- NO → Check ... TS62, GR124 GR126
- YES ↓

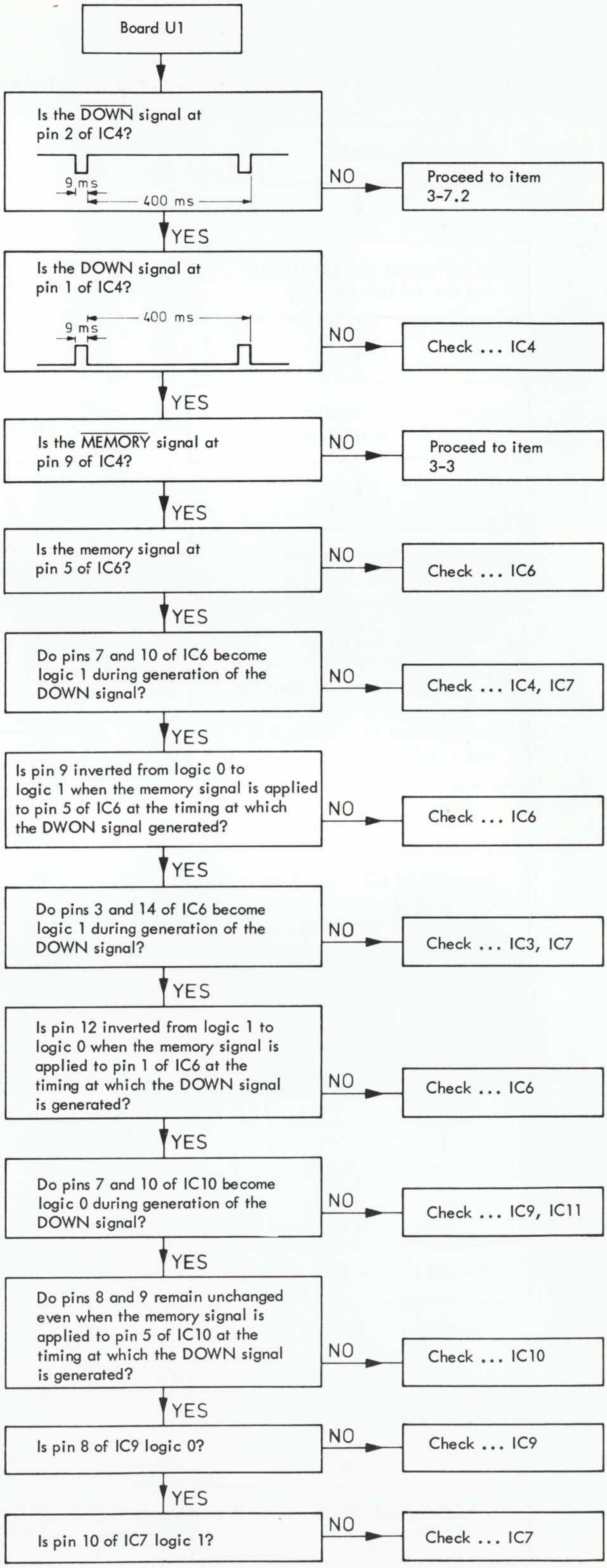
Proceed to item 3-3

- YES ↓

Is pin 9 of IC11 logic 1?
- YES → Check ... IC11
- NO ↓

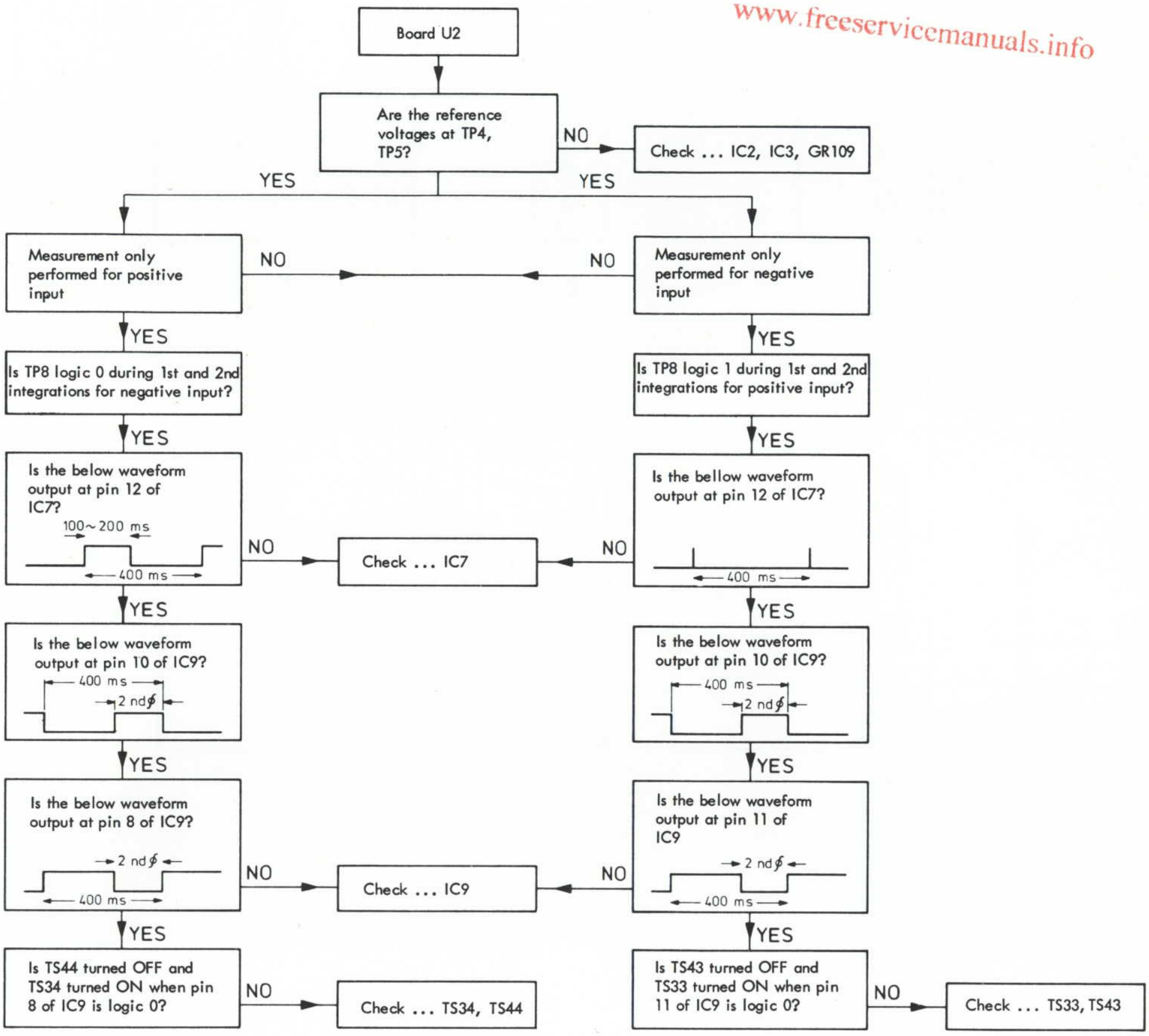
Is TS85 turned ON when pin 9 of IC11 is logic 0?
- YES → Check ... TS85

X-3.5. Range switching is not performed from (10^{-3}) to (10^{-4})



ST 691

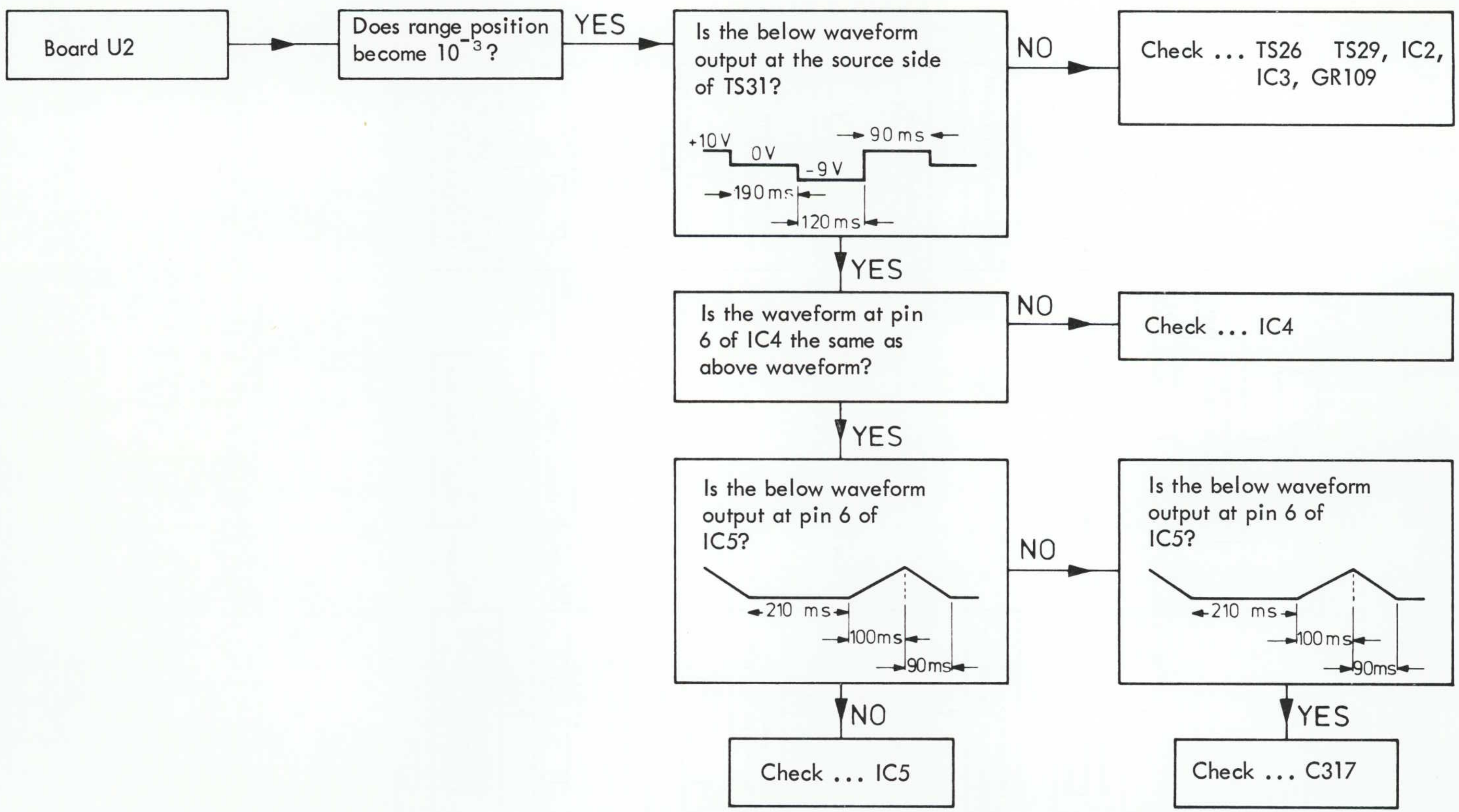
X-3.6. Only one polarity can be measured



X-3.7 Display changes with time.

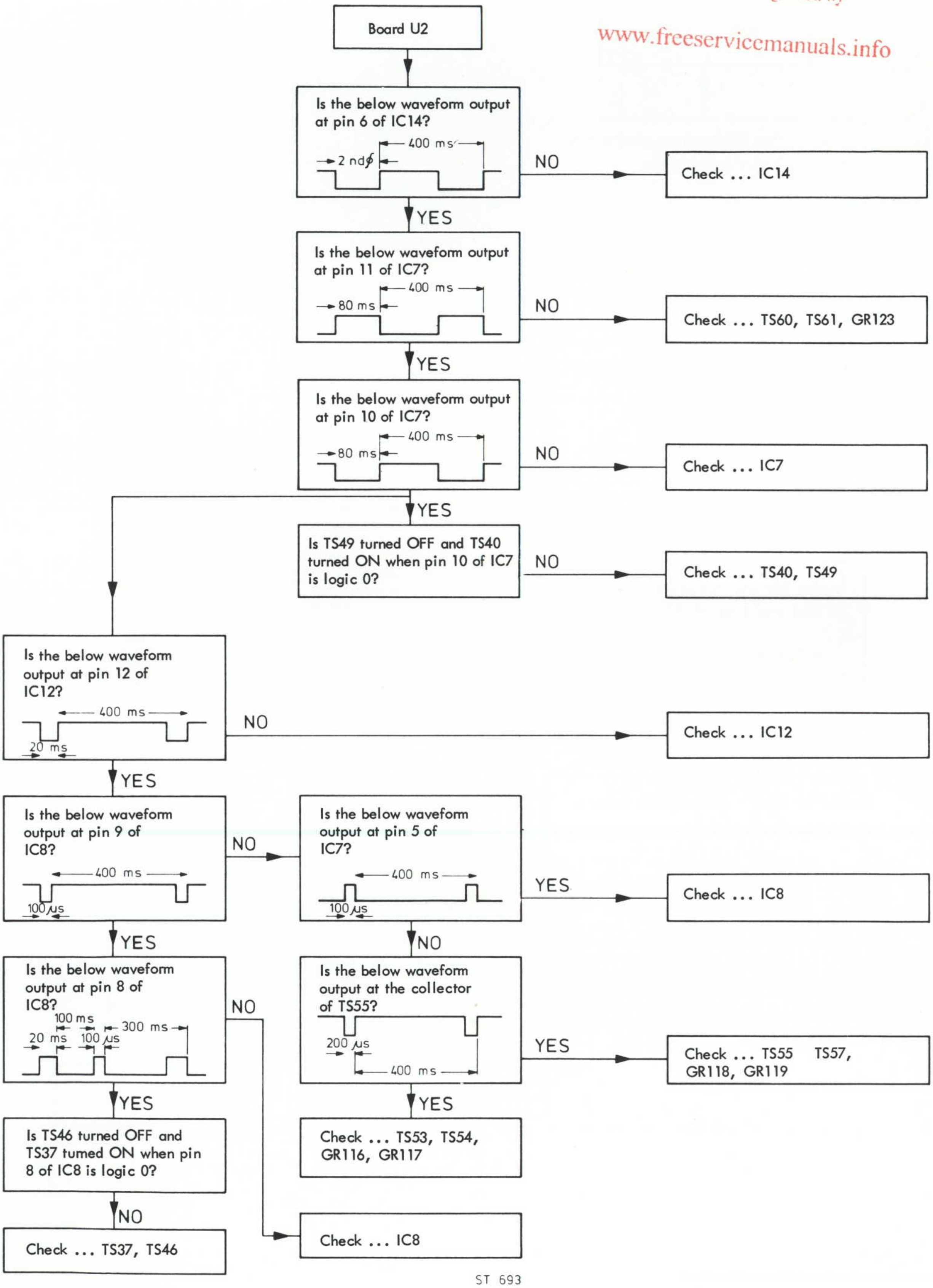
X-3.7.1 Analogue Section.

-9V applied to input terminals

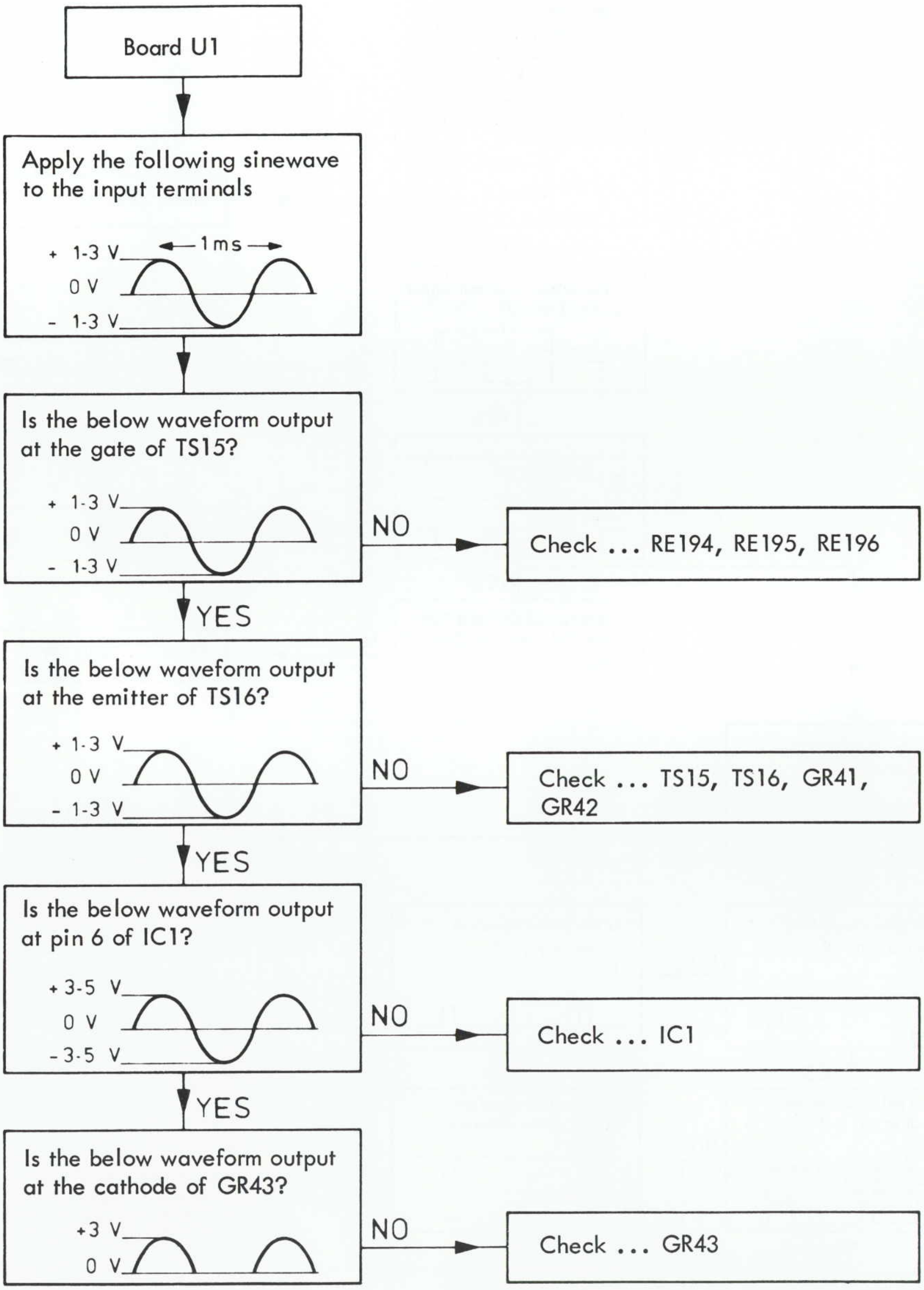


ST 692

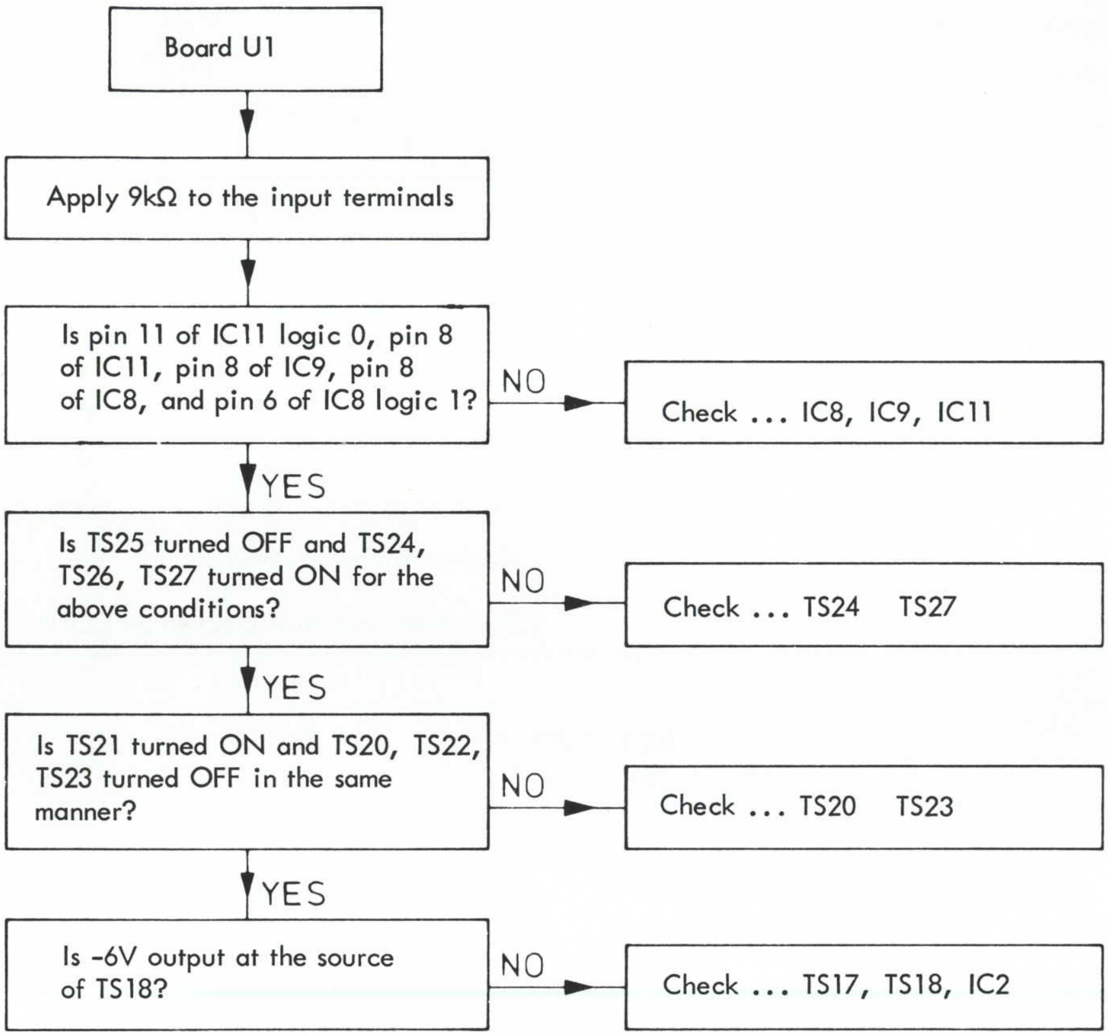
X-3.7.2. Logic Section



X-3.8 Correct measurement is not performed when measuring AC voltage



X-3.9 Correct measurement is not performed in resistance measurement.



ST 694

X-4. SEMICONDUCTORS.

Integrated circuit IC 15 is an LSI MOS 4-digit counter/display decoder (type MK 5007 P).
The pin connections of this device are given in Fig. 28.
The truth tables below explain the behaviour of the device.

INPUT TRUTH TABLE	
INPUT	LOGIC CONDITION TO ACTIVATE
$\overline{\text{COUNT}}$	NEGATIVE EDGE
$\overline{\text{RESET}}$	0
$\overline{\text{TRANSFER}}$	0
SCAN	1 (POSITIVE EDGE)

OUTPUT TRUTH TABLE		
OUTPUT	TRUE LOGIC STATE	TIME OF OCCURRENCE
DIGIT SELECT	1	One-of-four, following SCAN input rising edge; all off when SCAN input is 0.
COUNT EXTEND	1	Occurs each time the counter state attains 9999 count. Remains true only until the next COUNT INPUT or RESET occurs (when the counter returns to 0000).
BCD		BCD count sequence clocked by COUNT INPUT.

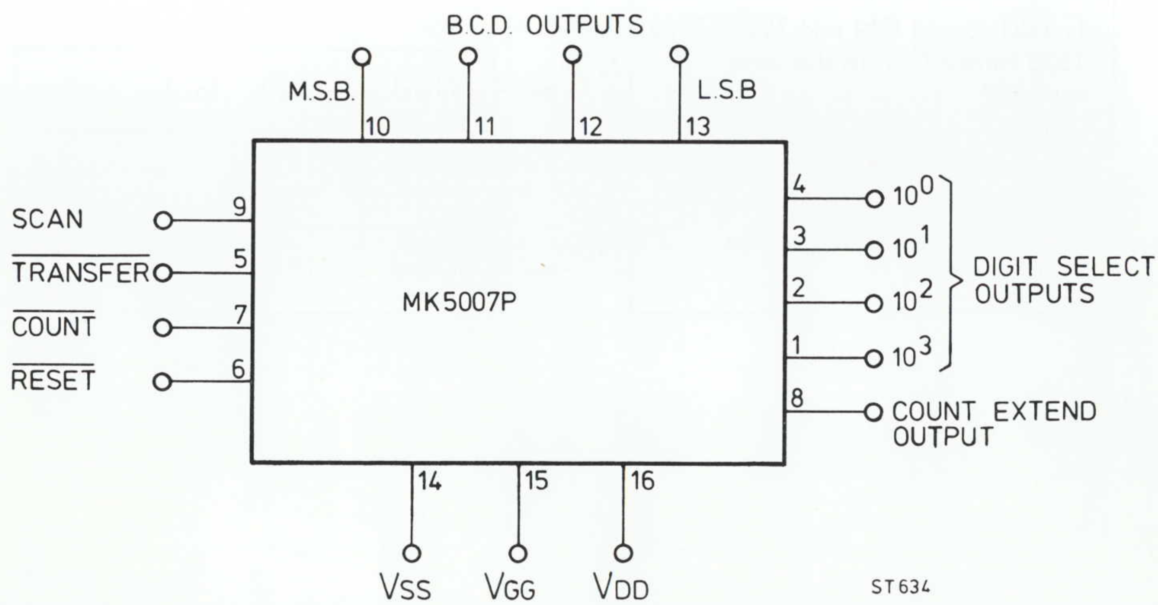


Fig. 25. Pin connections of MK 5007 P.

XI. List of parts

XI-1 MECHANICAL.

Item	Fig.	Qty.	Ordering number	Description
6	6	1	5322	Power switch
11	7	1	5322 277 24009	Slide switch
10	7	1		Power connector
8/9	6	2	5322 277 34021	Connector 2 pole
7	6	1	5322	Input connector red.
7	6	1	5322	Input connector black
13	7	1	5322 290 40065	Earth terminal
12	7	1	5322	Battery connector
BU 362	26	1	5322	Connector 7 pins
BU9	-	1	5322	Connector
BU11	24	1	5322	Connector 10 pole
BU12		1	5322	Connector
14	7	1	5322 256 34023	Fuse holder.
26	23	2	5322	Text plate
5	5	1	5322	Mode switch
	-	1	5322	Cap.
27	23	1	5322	Window
		4	5322 462 54072	Foot
17	23	2	5322 528 34089	Fixed part
18	23	2	5322 528 34091	Movable part
19	23	2	5322 492 64345	Wave spring
20	23	2	5322 462 44132	Cover
16	23	2	5322 502 64026	Shaft

Item	Fig.	Qty.	Ordering number	Description
22	23	1	5322 498 54037	Handle
		1	5322	Heat sink
BU362	24	1	5322	Connector 7 pole female
BU363	1-1	1	5322	Connector
BU364	24	1	5322	Connector
BU250/361	24	2	5322	Connector
		1	5322	Mains cable
15	7	1	5322	Current protector

XI-2 MISCELLANEOUS

Item	Fig.	Ordering number	Description
T1			Mains transformer
T359			Transformer
VL1			Mains fuse, 50mA, d.a.
B370	5	5322 131 94017	Display tube
B371	5	5322 131 94017	Display tube
B372	5	5322 131 94017	Display tube
B373	5	5322 131 94017	Display tube
LA1			Neon lamp
LA206		5322 134 24011	Neon lamp
LA365			Neon lamp
LA366			Neon lamp
LA367			Neon lamp
RE191		5322 280 24034	Reed switch
RE192		5322 280 24035	Reed switch
RE193		5322 280 24035	Reed switch
RE194		5322 280 24034	Reed switch
RE191*			Coil
RE192*			Coil
RE193*			Coil
RE194*			Coil

Item	Fig.	Qty.	Ordering number	Description
RE195				Relay
RE196				Relay
RE197				Relay
RE198				Relay
RE199				Relay
L201			5322 158 14059	Filter coil
L202			5322 158 14059	Filter coil
L353			5322 158 14059	Filter coil
L354			5322 158 14059	Filter coil
TS1	26			2SC 1014

XI-3 ELECTRICAL

XI-3.1 Resistors

Item	Ordering number	Value		%	Series	
R61		2	kΩ	0.1	1 W	Metal film
R62		2	kΩ	0.1	1 W	Metal film
R63		221.3	kΩ	0.1	0.25 W	Metal film
R64		20.16	kΩ	0.1	0.25 W	Metal film
R65		2	kΩ	20		Potentiometer
R66	5322 100 10138	100	kΩ	20		Potentiometer
R73	5322 116 50904	100	Ω	1	MR25	
R74	5322 116 54549	1	kΩ	1	MR25	
R75		9.2	kΩ	0.1	MR31C	
R76		9.2	kΩ	0.1	MR31C	
R77		200	Ω	20		Potentiometer
R78		2	kΩ	20		Potentiometer
R79	5322 101 14041	1	kΩ	20		Potentiometer
R86	5322 116 54619	10	kΩ	1	MR25	
R88		1	kΩ	0.1	MR31C	

No	Ordering number	Value	%	Series	
R90		1 kΩ	0.1	MR31C	
R98		30.1 kΩ	0.1	MR31C	
R99		19.1 kΩ	0.1	MR31C	
R100	5322 116 54006	392 kΩ	1	MR25	
R101	5322 116 54534	681 kΩ	1	MR25	
R102	5322 101 14037	500 Ω	20		Potentiometer
R107		38 MΩ	2		Metal glaze
R108		4.35 MΩ	0.5		Metal film
R109		404 kΩ	0.1		Metal film
R110		39.5 kΩ	0.1		Metal film
R111	5322 116 54513	332 Ω	1	MR25	
R115	5322 116 50527	33.2 Ω	1	MR25	
R116	5322 116 54087	39.2 Ω	1	MR25	
R117		500 kΩ	20		Potentiometer
R118		50 kΩ	20		Potentiometer
R119	5322 101 14037	500 Ω	20		Potentiometer
R120		50 Ω	20		Potentiometer
R129		9.9 MΩ	0.25	1W	Metal film
R130		9.9 MΩ	0.25	1W	Metal film
R131		99.45 kΩ	0.25	0.25W	Metal film
R132	322 101 14041	1 kΩ	20		Potentiometer
R137		90 Ω	0.1	0.25W	Metal film
R138					
R139		9 Ω	0.1	0.25W	Metal film
R140		1 Ω	0.1	0.25W	Metal film
R144	5322 116 54005	3.32 kΩ	1	MR25	
R145	5322 116 54005	3.32 kΩ	1	MR25	

No.	Ordering number	Value	%	Series	
R146		2 kΩ	20		Potentiometer
R147	5322 116 54011	5.62 kΩ	1	MR25	
R149		6x4,7 k		MR6-2	Composite
R152	5322 116 54525	511 Ω	1	MR25	
R153	5322 116 54615	9.09 kΩ	1	MR25	
R154	5322 116 54003	22.1 kΩ	1	MR25	
R155	5322 116 54615	9.09 kΩ	1	MR25	
R156	5322 116 54003	22.1 kΩ	1	MR25	
R158	5322 116 54007	475 Ω	1	MR25	
R159	5322 116 54038	221 kΩ	1	MR25	
R160	5322 116 54725	196 kΩ	1	MR25	
R161	5322 116 54007	475 Ω	1	MR25	
R162		200 Ω	20		Potentiometer
R163	5322 116 54486	150 Ω	1	MR25	
R164		19.8 kΩ	0.5	MR31C	
R165		20.0	0.5	MR31C	
R168		8.8 kΩ	0.25	0.25W	Metal film
R171		200 Ω	20		Potentiometer
R172		16.5 kΩ	0.25	MR31C	
R174		200 Ω	20		Potentiometer
R178		180 kΩ	0.5	MR31C	
R179		19.6 kΩ	0.25	MR31C	
R180		200 Ω	20		Potentiometer
R181	5322 116 54486	150 Ω	1	MR25	
R182	5322 116 54486	150 Ω	1	MR25	
R183	5322 116 54486	150 Ω	1	MR25	
R198	5322 101 14037	500 Ω	20		Potentiometer
R210	5322 101 14038	10 kΩ	20		Potentiometer
R211	5322 116 54676	56.2 kΩ	1	MR25	

No.	Ordering number	Value	%	Series	
R212	5322 116 54683	68.1 kΩ	1	MR25	
R214	5322 116 54683	68.1 kΩ	1	MR25	
R219	5322 116 54683	68.1 kΩ	1	MR25	
R223	5322 101 14042	20 kΩ	20		Potentiometer
R224	5322 116 54001	15 kΩ	1	MR25	
R286		6x4.7 kΩ		MR6-2	Composite
R287		6x4.7 kΩ		MR6-2	Composite
R288		6x4.7 kΩ		MR6-2	Composite
R289		10x47 kΩ		MR13-2	Composite

XI-3.2 Capacitors

No.	Ordering number	Value	%	V	Description
C161		100 nF		400	Metal film
C163		47 pF	5	500	Mica
C165		430 pF	5	300	Mica
C166		7 pF	10	500	Mica
C167		430 pF	5	100	Mica
C168		6 pF		250	Var. Ceramic
C169		6 pF		250	Var. Ceramic
C170		10 μF	20	25	Electrolytic
C171		10 μF	20	25	Electrolytic
C172		10 μF	20	16	Electrolytic
C173		22 μF		16	Electrolytic
C174	5322 122 30002	150 pF	10	50	Ceramic
C175		1 μF		100	Film
C176		1 μF		100	Film
C177		330 nF		100	Film

No.	Ordering number	Value	%	V	Description
C178	5322 122 34021	47 nF	-0 +100	50	Ceramic
C179	5322 122 30101	220 pF	10	50	Ceramic
C180		4.7 nF		400	Polyester
C181		4.7 nF		400	Polyester
C182	5322 122 30101	220 pF	10	50	Ceramic
C183	5322 122 34021	47 nF	-0 +100	50	Ceramic
C184		10 μF	-0 +100	25	Electrolytic
C185		10 μF	-0 +100	25	Electrolytic
C186		22 μF		16	Electrolytic
C187		12 pF	-0 +100	50	Ceramic
C189		10 pF	10	300	Mica
C190		4 pF	0.5	500	Mica
C191	5322 122 31167	2.2 nF	-0 +100	50	Ceramic
C290	4822 124 20533	470 μF		25	Electrolytic
C291	4822 124 20533	470 μF		25	Electrolytic
C292	5322 122 34021	47 nF	-0 +100	50	Ceramic
C293	5322 122 30016	33 pF	10	50	Ceramic
C294	5322 122 31169	2.2 nF	-0 +100	50	Ceramic
C295		33 μF		16	Electrolytic
C296		33 μF		25	Electrolytic
C297	4822 124 20575	100 μF		25	Electrolytic
C298	4822 124 20575	100 μF		25	Electrolytic
C299		22 μF		50	Electrolytic
C300	4822 124 20488	100 μF		16	Electrolytic
C301		100 nF		200	Mylar
C302		1 μF		350	Electrolytic
C303		1 μF		160	Electrolytic
C304		1 nF		50	Mylar
C305	5322 122 34021	47 nF	-0 +100	50	Ceramic

No.	Ordering number	Value	%	V	Description
C306	5322 122 30016	33 pF	10	50	Ceramic
C308	5322 122 34021	47 nF	-0 +100	50	Ceramic
C309	5322 122 30016	33 pF	10	50	Ceramic
C310	5322 122 30016	33 pF	10	50	Ceramic
C311	5322 122 34021	47 nF	-0 +100	50	Ceramic
C312		4.7 µF		25	Electrolytic
C313		4.7 µF		25	Electrolytic
C314		220 nF	10	100	Mylar
C315	5322 122 30016	33 pF	10	50	Ceramic
C316	5322 122 34021	47 nF	-0 +100	50	Ceramic
C317		1 µF	10	100	Mylar
C318	5322 122 30027	1 nF	-0 +100	50	Ceramic
C319	5322 122 34021	47 nF	-0 +100	50	Ceramic
C320		2 pF	1	50	Ceramic
C321		6.8 µF		6.3	Electrolytic
C322		120 pF		100	Mica
C323		120 pF		100	Mica
C324	5322 122 30021	100 pF	10	50	Ceramic
C325		2.2 nF	10	50	Mylar
C326	5322 122 30027	1 nF	-0 +100	50	Ceramic
C327	5322 122 30021	100 pF	10	50	Ceramic
C328		4.7 nF	10	50	Mylar
C329	5322 122 30027	1 nF	-0 +100	50	Ceramic
C330	5322 122 30021	100 pF	10	50	Ceramic
C331		680 nF		35	Electrolytic
C332	5322 122 30027	1 nF	-0 +100	50	Ceramic
C334	5322 122 30021	100 pF	10	50	Ceramic
C335		2.2 µF	10	20	Electrolytic
C336	5322 122 30027	1 nF	-0 +100	50	Ceramic
C337	5322 122 30027	1 nF	-0 +100	50	Ceramic

No.	Ordering number	Value	%	V	Description
C338	5322 122 30027	1 nF	-0 +100	50	Ceramic
C339	5322 122 30027	1 nF	-0 +100	50	Ceramic
C341	5322 122 30129	4.7 nF	-0 +100	50	Ceramic
C342	5322 122 34021	47 nF	-0 +100	50	Ceramic
C343	5322 122 30129	4.7 nF	-0 +100	50	Ceramic
C344		10 nF	10	200	Mylar
C345		10 nF	10	200	Mylar
C346		10 nF	10	200	Mylar
C347		10 nF	10	200	Mylar
C348	5322 122 34021	47 nF	-0 +100	50	Ceramic
C349	5322 122 34021	47 nF	-0 +100	50	Ceramic
C350	5322 122 34021	47 nF	-0 +100	50	Ceramic
C352	5322 122 30027	1 nF	-0 +100	50	Ceramic
C356	5322 122 34021	47 nF	-0 +100	50	Ceramic
C355	5322 122 30027	1 nF	-0 +100	50	Ceramic
C371		330 pF	5	300	Mica
C372		70 pF			Trimmer

XI-3.3Transistors

No.	Ordering number	Type	
TS15		2SK-12 (Y)	Located on printed circuit board U1
TS16	5322 130 44168	2SC269	
TS17		IMF3958	
TS18		ITS30088	
TS20		2N4393	

No.	Ordering number	Type	
TS21		2N4393	Located on printed circuit board U1
TS22		2N4393	
TS23		2N4393	
TS24 to TS36	5322 130 44168	2SC269	
TS22	5322 130 44168	2SC269	
TS23	5322 130 44168	2SC269	
TS24		2SD220	
TS25		2SD220	
TS26		2SA495G	
TS27	5322 130 44168	2SC269	
TS28		ITS30088	
TS29		ITS30088	
TS30		IMF3958	
TS31 to TS34		2N4393	
TS35	5322 130 44166	ITS3948	
TS36 toTS38		2N4393	
TS39		IMF3955	
TS40		ITS30088	
TS41		2SA495G	
TS42	5322 130 44168	2SC269	
TS43	5322 130 44168	2SC269	
TS44		2SC268B	
TS45	5322 130 44168	2SC269	
TS46		2SC268B	
TS47	5322 130 44168	2SC269	
TS48		2SC268B	
TS49 to TS71	5322 130 44168	2SC269	
TS72 to TS84		2SC268B	
TS85 to TS87	5322 130 44169	2SC268A	

XI-3.4 Diodes

No.	Ordering number	Type	
GR1		F14-C	Located on printed circuit board U1.
GR41	5322 130 34216	WG713	
GR42	5322 130 34216	WG713	
GR43	5322 130 34199	1S953	
GR44	5322 130 34199	1S953	
GR45 to GR52	5322 130 34216	WG713	
GR53 to GR55		F14-C	
GR56		1S1544A	
GR93	5322 130 34204	1S1850R	
GR94	5322 130 34205	1S1850	
GR95		RD6A	Zener
GR96 to GR100	5322 130 34199	IS953	
GR101		F14-C	
GR102		F14-C	
GR103 to GR105		F14-E	
GR106	5322 130 34199	1S953	
GR107	5322 130 34199	1S953	
GR108		02Z7.5A	Zener
GR109		ZD-2	Zener
GR110	5322 130 34199	IS953	
GR111	5322 130 34199	IS953	
GR113 to GR121	5322 130 34199	IS953	
GR123 to GR131	5322 130 34199	IS953	
GR132 to GR135		F14-C	
GR136	5322 130 34199	IS953	

No.	Ordering number	Type
GR137		SLP20B
GR138 to GR140	5322 130 34199	1S953

XI-3.5Integrated circuits

No.	Ordering number	Type	Manufacturer	
IC1		LM301A	National	Located on Printed wiring board U1
IC2		LM301A	"	
IC3		SN74L51	Texas Instr.	
IC4	5322 209 84193	SN74L02N	"	
IC5		SN74L03N	"	
IC6	5322 209 84196	SN74L73N	"	
IC7	5322 209 84189	SN74L04N	"	
IC8	5322 209 84187	SN74L00N	"	
IC9		SN74L10N	"	
IC10	5322 209 84196	SN74L73N	"	
IC11	5322 209 84187	SN74L00N	"	
IC12		SN74L03N	"	
IC1		LM301A	National	Printed on printed circuit board U2
IC2		LM301A	"	
IC3		LM709C	"	
IC4		LM301A	"	
IC5		LM301A	"	
IC6	5322 209 84241	LM311	"	
IC7	5322 209 84189	SN74LO4N	Texas Instr.	
IC8	5322 209 84187	SN74L00N	"	
IC9	5322 209 84187	SN74L00N	"	

No.	Ordering number	Type	Manufacturer	
IC11	5322 209 84191	SN74L74N	Texas Instr.	Located on printed circuit board U2
IC12		SN74L10N	"	
IC13	5322 209 84196	SN74L73N	"	
IC14	5322 209 84191	SN74L74N	"	
IC15		MK5007P		
IC16	5322 209 80141	SN7414IN	Texas Instr.	

XI-4 OPTIONAL ACCESSORY PM 9207

No.	Ordering number	Type		
TS1	5322 130 44168	2SC269		
TS2		2SA495G		
TS3	5322 130 44168	2SC269		
GR5		F14-C		
GR6		F14-C		
GR7		RD6A		Zener
R25		2 kΩ	20%	Potentiometer
C31		470 µF	35V	Electrolytic
C32	5322 122 30027	1 nF	50V	Ceramic

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

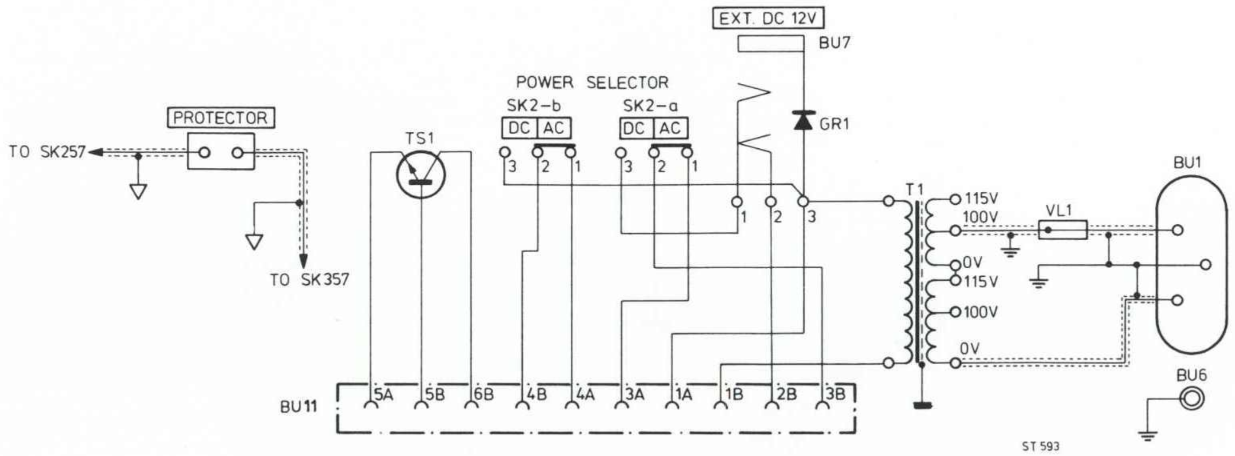


Fig. 26. Rear panel wiring

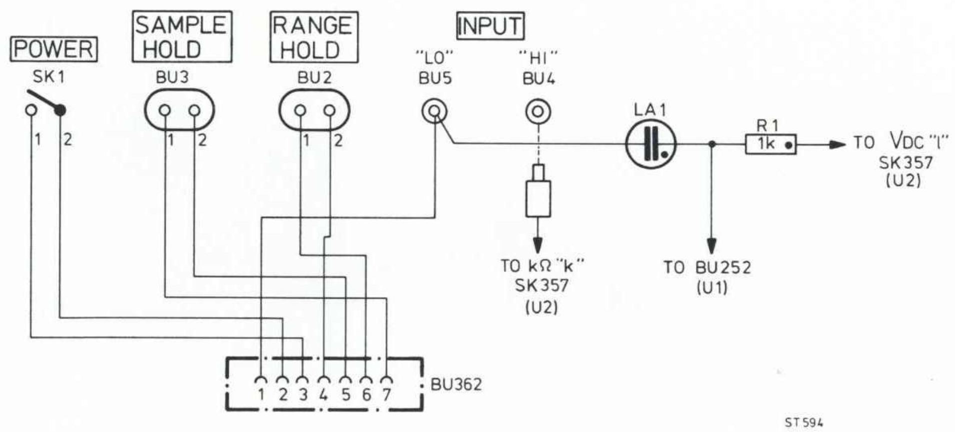


Fig. 28. Right-side wiring

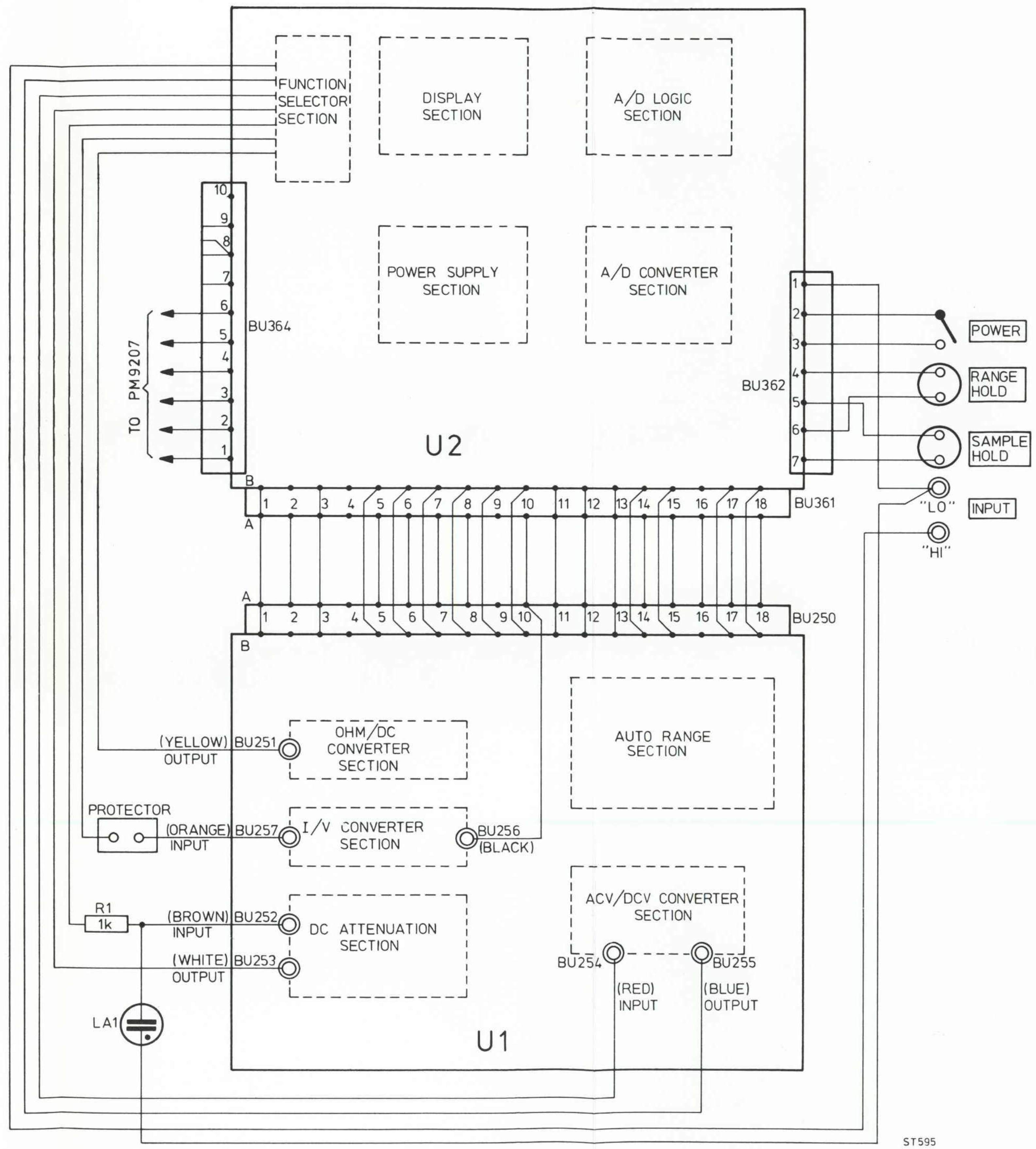


Fig. 29. Wiring diagram board to board

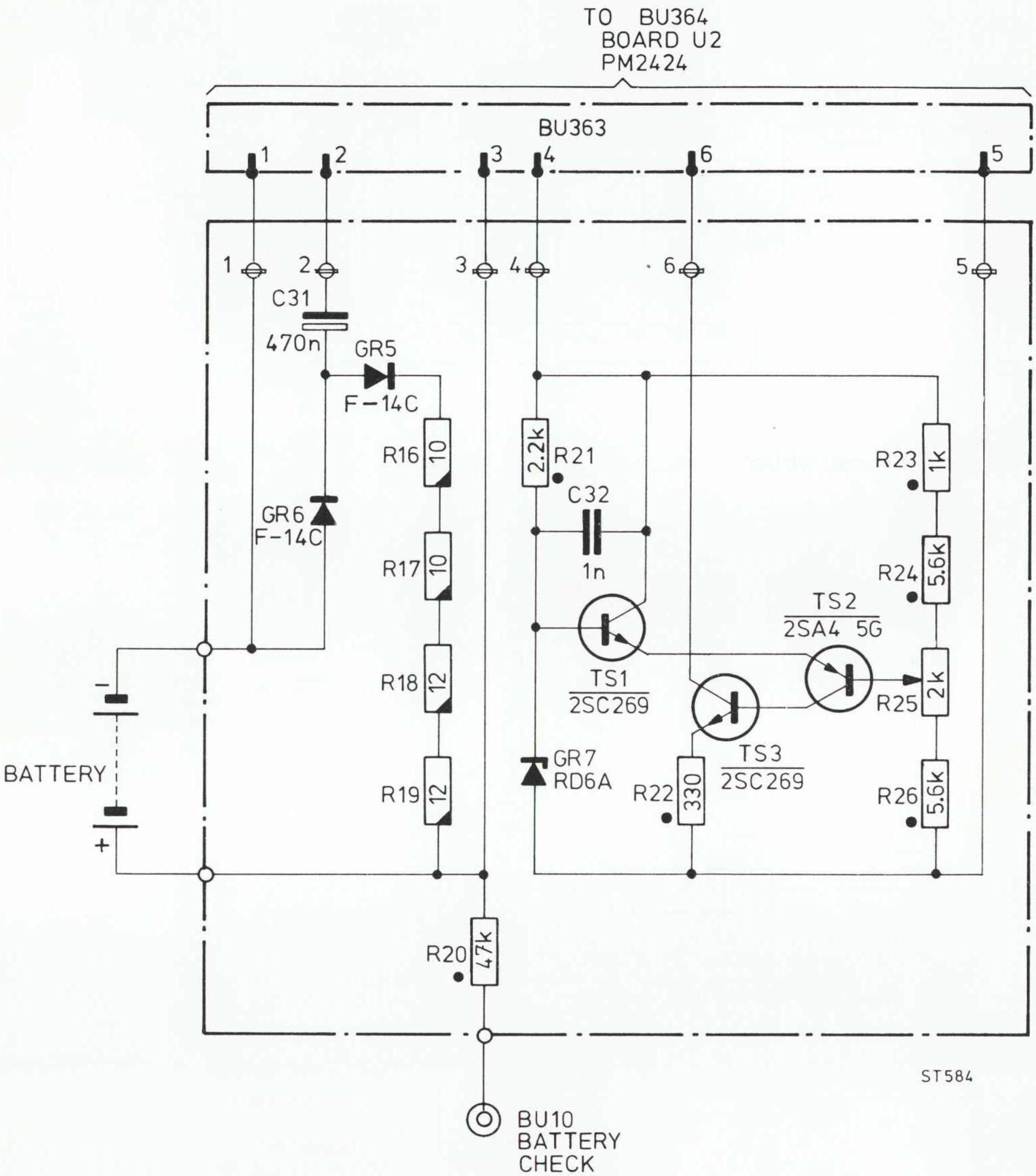


Fig. 30. Circuit diagram of optional accessory PM 9207

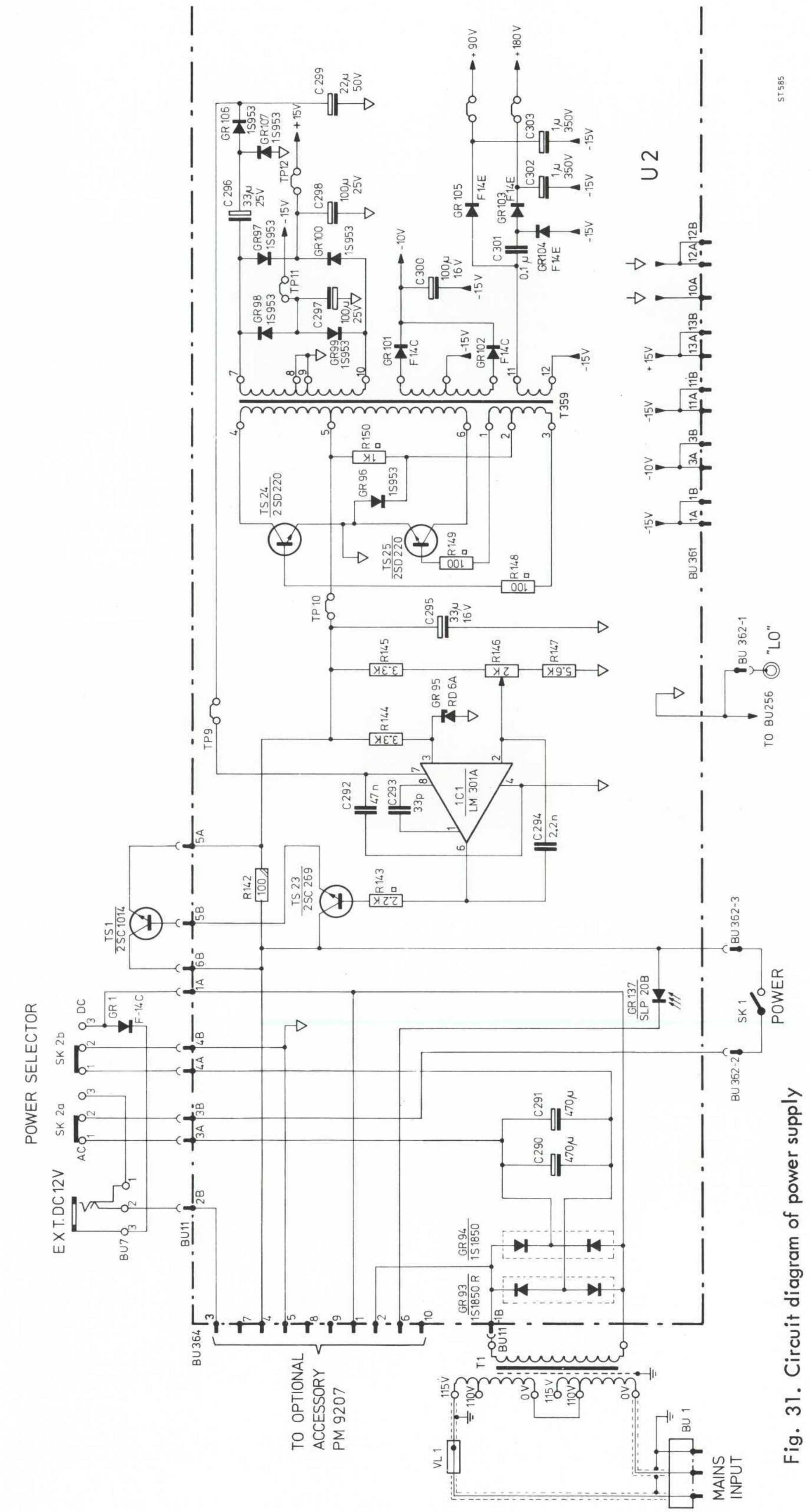


Fig. 31. Circuit diagram of power supply

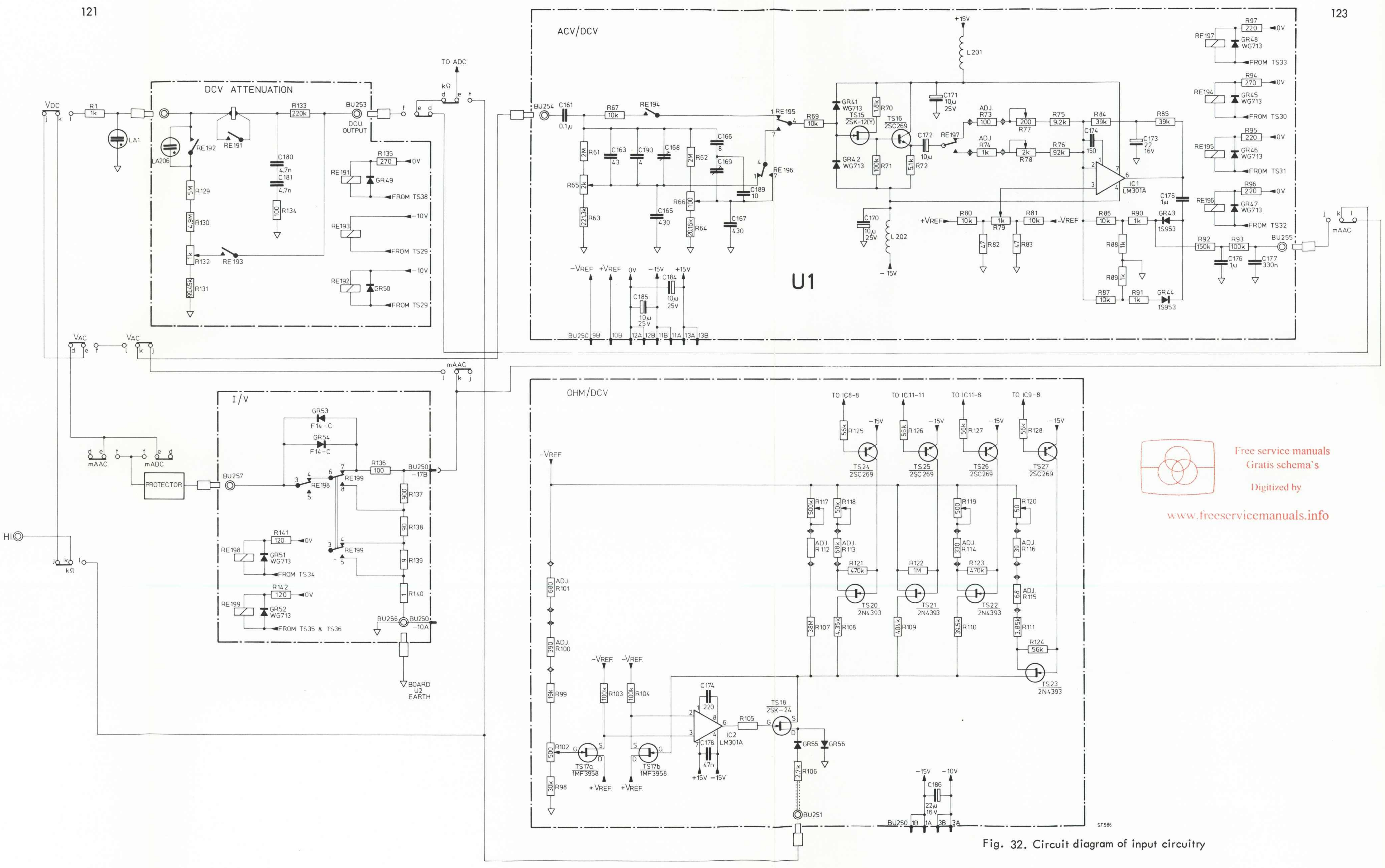


Fig. 32. Circuit diagram of input circuitry

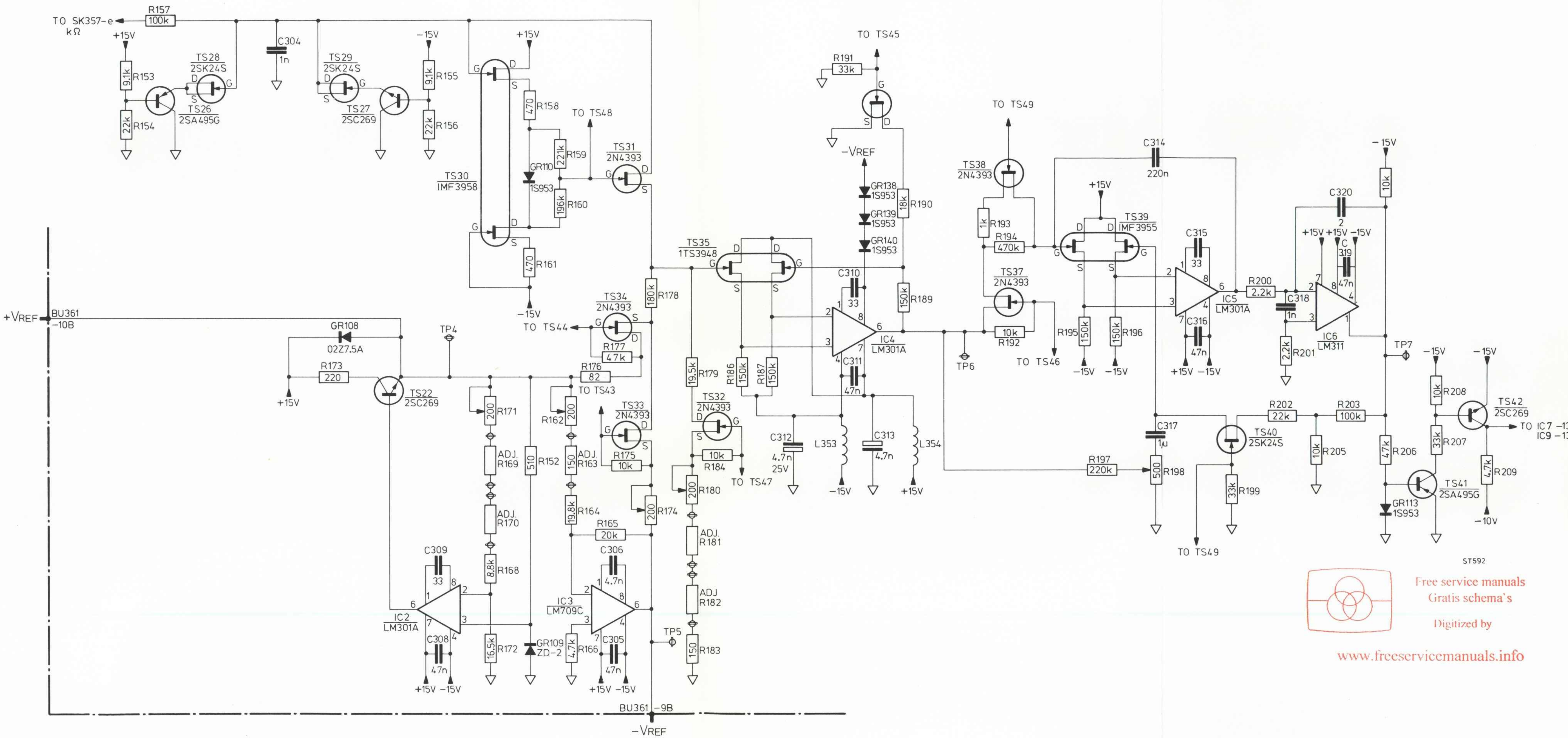


Fig. 33. Circuit diagram of analogue-to-digital converter

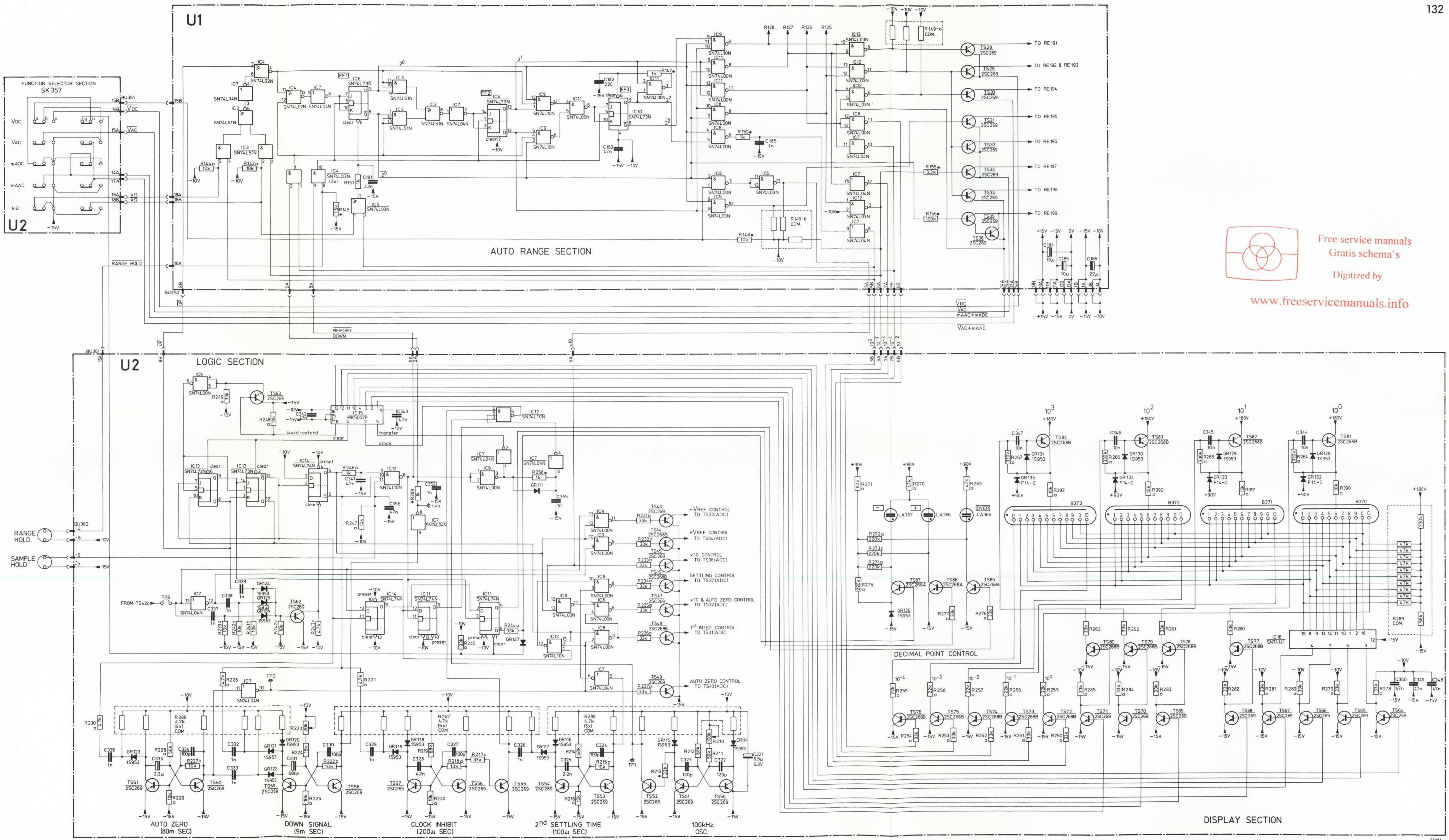


Fig. 34. Circuit diagram of digital section

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

CATEGORY

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

COMPONENT/SEQUENCE NUMBER

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

GR1003	Diode GR1003
TS0023	Transistor TS23
IC0101	Integrated circuit IC101
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

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 Chiléna 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. 48300

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, Lidingövägen 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

PHILIPS

SERVICE

Cryogenic Equipment / Electro Analytical Equipment / Electronic Weighing / Electron Optics / Industrial Data Processing systems / Numerical Control / Radiation Measuring Equipment / Test and Measuring Equipment / Welding Equipment / X-Ray Analysis

equipment for science and industry

740402 PM 2424 SME29

Already issued: SME25
Re : To complete List of parts / Correction type number d.c. power supply.

In this issue the complete list of parts of the PM 2424 is given.
For item numbers and figures see manual 9499 470 07301.
The correct type number of the d.c. power supply is PM 9215 instead of PM 9207.

LIST OF PARTS

MECHANICAL.

Item	Fig.	Qty.	Ordering number	Description
6	6	1	5322 277 14066	Power switch
11	7	1	5322 277 24009	Slide switch
10	7	1	5322 321 14023	Power connector
8/9	6	2	5322 277 34021	Connector 2 pole
7	6	1	5322 267 34039	Input connector red.
7	6	1	5322 267 34038	Input connector black
13	7	1	5322 290 40065	Earth terminal
12	7	1	5322 265 24024	Battery connector
BU362	26	1	5322 266 44016	Connector 7 pins
BU11	24	1	5322 266 34024	Connector 10 pole
14	7	1	5322 256 34023	Fuse holder
26	23	2	5322 456 14033	Text plate
5	5	1	5322 276 44035	Mode switch
-	-	1	5322 456 14034	Cap
27	23	1	5322 450 74006	Window
-	-	4	5322 462 54072	Foot
17	23	2	5322 528 34089	Fixed part
18	23	2	5322 528 34091	Movable part
19	23	2	5322 492 64345	Wave spring
20	23	2	5322 462 44132	Cover
16	23	2	5322 502 64026	Shaft
22	23	1	5322 498 54037	Handle
-	-	1	5322 255 40044	Heat sink
BU362	24	1	5322 265 44041	Connector 7 pole female
BU363	1-1	1	5322	Connector
BU364	24	1	5322 265 44039	Connector
BU250/361	24	2	5322 267 54091	Connector
-	-	1	5322 321 14023	Mains cable
15	7	1	5322 280 34002	Current protector

9499 478 04011

MISCELLANEOUS

Item	Fig.	Ordering number	Description
T1		5322 146 34044	Mains transformer
T359		5322 142 64016	Transformer
VL1			Mains fuse, 63 mA, d.a.
B370	5	5322 131 94017	Display tube
B371	5	5322 131 94017	Display tube
B372	5	5322 131 94017	Display tube
B373	5	5322 131 94017	Display tube
LA1		5322 134 24017	Neon lamp
LA206		5322 134 24011	Neon lamp
LA365		5322 134 24018	Neon lamp
LA366		5322 134 24018	Neon lamp
LA367		5322 134 24018	Neon lamp
RE191		5322 280 24034	Reed switch
RE192		5322 280 24035	Reed switch
RE193		5322 280 24035	Reed switch
RE194		5322 280 24034	Reed switch
RE191*		5322 281 64153	Coil
RE192*		5322 281 64153	Coil
RE193*		5322 281 64153	Coil
RE194*		5322 281 64153	Coil
RE195		5322 280 24053	Relay
RE196		5322 280 24053	Relay
RE197		5322 280 24053	Relay
RE198		5322 280 84053	Relay
RE199		5322 280 84053	Relay
L201		5322 158 14059	Filter coil
L202		5322 158 14059	Filter coil
L353		5322 158 14059	Filter coil
L354		5322 158 14059	Filter coil
TS1	26	5322 130 44309	2SC 1014

ELECTRICAL

Resistors

Item	Ordering number	Value (Ω)		%	Series	
R61	5322 116 54864	2	k	0.1	1 W	Metal film
R62	5322 116 54864	2	k	0.1	1 W	Metal film
R63	5322 116 54862	221.3	k	0.1	0.25 W	Metal film
R64	5322 116 54861	20.16	k	0.1	0.25 W	Metal film
R65	5322 100 10144	2	k	20		Potentiometer
R66	5322 100 10138	100	k	20		Potentiometer
R73	5322 116 50904	100		1	MR25	
R74	5322 116 54549	1	k	1	MR25	
R75	5322 116 54874	9.2	k	0.1	MR31C	
R76	5322 116 54875	9.2	k	0.1	MR31C	
R77	5322 100 10133	200		20		Potentiometer
R78	5322 100 10144	2	k	20		Potentiometer
R79	5322 101 14041	1	k	20		Potentiometer
R86	5322 116 54619	10	k	1	MR25	
R88	5322 116 50747	1	k	0.1	MR31C	

No.	Ordering number	Value	%	Series	
R90	5322 116 50747	1 k	0.1	MR31C	
R98	5322 116 54201	30.1 k	0.1	MR31C	
R99	5322 116 54868	19.1 k	0.1	MR31C	
R100	5322 116 54006	392 k	1	MR25	
R101	5322 116 54534	681 k	1	MR25	
R102	5322 101 14037	500	20		Potentiometer
R107	5322 111 34164	38 M	2		Metal glaze
R108	5322 116 54866	4.35 M	0.5		Metal film
R109	5322 116 54873	404 k	0.1	MR31C	
R110	5322 116 54872	39.5 k	0.1	MR31C	
R111	5322 116 54513	3.85 k	0.1	MR31C	
R114	5322 116 54513	332	1	MR25	
R115	5322 116 50527	33.2	1	MR25	
R116	5322 116 54087	39.2	1	MR25	
R117	5322 101 14037	500 k	20		Potentiometer
R118	5322 101 14056	50 k	20		Potentiometer
R119	5322 101 14037	500	20		Potentiometer
R120	5322 100 10134	50	20		Potentiometer
R129	5322 116 54865	9.9 M	0.25	1 W	Metal film
R130	5322 116 54865	9.9 M	0.25	1 W	Metal film
R131	5322 116 54863	99.45 k	0.25	0.25 W	Metal film
R132	5322 101 14041	1 k	20		Potentiometer
R137	5322 116 50942	900	0.1	MR31C	
R138	5322 116 50944	90	0.1	MR31C	
R139	5322 114 14005	9	0.1		Wire wound
R140	5322 114 14004	1	0.1		Wire wound
R144	5322 116 54005	3.32 k	1	MR25	
R145	5322 116 54005	3.32 k	1	MR25	
R146	5322 100 10144	2 k	20		Potentiometer
R147	5322 116 54011	5.62 k	1	MR25	
R149	5322 111 94009	6x4.7 k		MR6-2	Composite
R152	5322 116 54525	511	1	MR25	
R153	5322 116 54615	9.09 k	1	MR25	
R154	5322 116 54003	22.1 k	1	MR25	
R155	5322 116 54615	9.09 k	1	MR25	
R156	5322 116 54003	22.1 k	1	MR25	
R158	5322 116 54007	475	1	MR25	
R159	5322 116 54038	221 k	1	MR25	
R160	5322 116 54725	196 k	1	MR25	
R161	5322 116 54007	475	1	MR25	
R162	5322 100 10133	200	20		Potentiometer
R163	5322 116 54486	150	1	MR25	
R164	5322 116 50049	19.8 k	0.5	MR31C	
R165	5322 116 54329	20.0	0.5	MR31C	
R168	5322 116 54869	8.8 k	0.25	MR31C	
R171	5322 100 10133	200	20		Potentiometer
R172	5322 116 50988	16.5 k	0.25	MR31C	
R174	5322 100 10133	200	20		Potentiometer
R178	5322 116 50306	180 k	0.5	MR31C	
R179	5322 116 54867	19.6 k	0.25	MR31C	
R180	5322 100 10133	200	20		Potentiometer
R181	5322 116 54486	150	1	MR25	
R182	5322 116 54486	150	1	MR25	
R183	5322 116 54486	150	1	MR25	
R198	5322 101 14037	500	20		Potentiometer

No.	Ordering number	Value	%	Series	
R210	5322 101 14038	10 k	20		Potentiometer
R211	5322 116 54676	56.2 k	1	MR25	
R212	5322 116 54683	68.1 k	1	MR25	
R214	5322 116 54683	68.1 k	1	MR25	
R219	5322 116 54683	68.1 k	1		
R223	5322 101 14042	20 k	20		Potentiometer
R224	5322 116 54001	15 k	1	MR25	
R286	5322 111 94009	6x4.7 k		MR6-2	Composite
R287	5322 111 94009	6x4.7 k		MR6-2	Composite
R288	5322 111 94009	6x4.7 k		MR6-2	Composite
R289	5322 111 94011	10x47 k		MR13-2	Composite

CAPACITORS

No.	Ordering number	Value	%	V	Description
C161	4822 121 40036	100 nF		400	Polyester foil
C163	4822 122 31205	47 pF	5	500	Mica
C165	4822 121 50552	430 pF	5	300	Mica
C166	4822 122 31192	7 pF	10	500	Mica
C167	4822 122 30034	430 pF	5	100	Mica
C168	5322 125 50053	6 pF		250	Var. Ceramic
C169	5322 125 50053	6 pF		250	Var. Ceramic
C170	5322 124 14033	10 µF	20	25	Electrolytic
C171	5322 124 10174	10 µF	20	25	Electrolytic
C172	5322 124 10174	10 µF	20	16	Electrolytic
C173	5322 124 14038	22 µF		16	Electrolytic
C174	5322 122 30002	150 pF	10	50	Ceramic
C175	5322 121 40176	1 µF		100	Polyester foil
C176	5322 121 40176	1 µF		100	Polyester foil
C177	4822 121 40009	330 nF		100	Polyester foil
C178	5322 122 34021	47 nF	-0 +100	50	Ceramic
C179	5322 122 30101	220 nF	10	50	Ceramic
C180	4822 121 40298	4.7 nF		400	Polyester foil
C181	4822 121 40298	4.7 nF		400	Polyester foil
C182	5322 122 30101	220 pF	10	50	Ceramic
C183	5322 122 34021	47 nF	-0 +100	50	Ceramic
C184	5322 124 10433	10 µF	20	25	Electrolytic
C185	5322 124 14033	10 µF	20	25	Electrolytic
C186	5322 124 14038	22 µF		16	Electrolytic
C187	5322 122 30027	12 pF	-0 +100	50	Ceramic
C189	4822 122 31195	10 pF	10	300	Mica
C190	4822 122 31217	4 pF	0.5	500	Mica
C191	5322 122 31167	2.2 nF	-0 +100	50	Ceramic
C290	4822 124 20533	470 µF		25	Electrolytic
C291	4822 124 20533	470 µF		25	Electrolytic
C292	5322 122 34021	47 nF	-0 +100	50	Ceramic
C293	5322 122 30016	33 nF	10	50	Ceramic
C294	5322 122 31169	2.2 nF	-0 +100	50	Ceramic
C295	5322 124 20439	33 µF		16	Electrolytic
C296	4822 124 20485	33 µF		25	Electrolytic

No.	Ordering number	Value	%	V	Description
C297	4822 124 20575	100 µF		25	Electrolytic
C298	4822 124 20575	100 µF		25	Electrolytic
C299	4822 124 20499	22 µF		50	Electrolytic
C300	4822 124 20488	100 µF		16	Electrolytic
C301	4822 121 40036	100 nF		200	Mylar
C302	4822 121 40013	1 µF		350	Electrolytic
C303	5322 124 24113	1 µF		160	Electrolytic
C304	4822 122 30027	1 nF		50	Mylar
C305	5322 122 34021	47 nF	-0 +100	50	Ceramic
C306	5322 122 30016	33 pF	10	50	Ceramic
C308	5322 122 34021	47 nF	-0 +100	50	Ceramic
C309	5322 122 30016	33 pF	10	50	Ceramic
C310	5322 122 30016	33 pF	10	50	Ceramic
C311	5322 122 34021	47 nF	-0 +100	50	Ceramic
C312	5322 124 20594	4.7 µF		25	Electrolytic
C313	5322 124 20594	4.7 µF		25	Electrolytic
C314	4822 121 40194	220 nF	10	100	Mylar
C315	5322 122 30016	33 pF	10	50	Ceramic
C316	5322 122 34021	47 nF	-0 +100	50	Ceramic
C317	5322 121 40176	1 µF	10	100	Mylar
C318	5322 122 30027	1 nF	-0 +100	50	Ceramic
C319	5322 122 34021	47 nF	-0 +100	50	Ceramic
C320	5322 122 14006	2 pF	1	50	Ceramic
C321	5322 124 14055	6.8 µF		6.3	Electrolytic
C322	4822 122 31218	120 pF		100	Mica
C323	4822 122 31218	120 pF		100	Mica
C324	5322 122 30021	100 pF	10	50	Ceramic
C325	4822 122 30104	2.2 nF	10	50	Mylar
C326	5322 122 30027	1 nF	-0 +100	50	Ceramic
C327	5322 122 30021	100 pF	10	50	Ceramic
C328	4822 122 30128	4.7 nF	10	50	Mylar
C329	5322 122 30027	1 nF	-0 +100	50	Ceramic
C330	5322 122 30021	100 pF	10	50	Ceramic
C331	5322 124 14024	680 nF		35	Electrolytic
C332	4822 122 30027	1 nF	-0 +100	50	Ceramic
C334	4822 122 30021	100 pF	10	50	Ceramic
C335	5322 124 14028	2.2 µF	10	20	Electrolytic
C336	5322 122 30027	1 nF	-0 +100	50	Ceramic
C337	5322 122 30027	1 nF	-0 +100	50	Ceramic
C338	5322 122 30027	1 nF	-0 +100	50	Ceramic
C339	5322 122 30027	1 nF	-0 +100	50	Ceramic
C341	5322 122 30129	4.7 nF	-0 +100	50	Ceramic
C342	5322 122 34021	47 nF	-0 +100	50	Ceramic
C343	5322 122 30129	4.7 nF	-0 +100	50	Ceramic
C344	4822 122 41134	10 nF	10	200	Mylar
C345	4822 121 41134	10 nF	10	200	Mylar
C346	4822 121 41134	10 nF	10	200	Mylar
C347	4822 121 41134	10 nF	10	200	Mylar
C348	5322 122 34021	47 nF	-0 +100	50	Ceramic
C349	5322 122 34021	47 nF	-0 +100	50	Ceramic
C350	5322 122 34021	47 nF	-0 +100	50	Ceramic
C352	5322 122 30027	1 nF	-0 +100	50	Ceramic
C356	5322 122 34021	47 nF	-0 +100	50	Ceramic
C355	5322 122 30027	1 nF	-0 +100	50	Ceramic
C371	4822 122 31165	330 pF	5	300	Mica
C372	5322 125 54014	70 pF			Trimmer

TRANSISTORS

No.	Ordering number	Type	
TS15	5322 130 44312	2SK-12 (Y)	Located on printed circuit board U1
TS16	5322 130 44168	2SC269	
TS17	5322 130 44305	IMF3958	
TS18	5322 130 44313	ITS30088	
TS20	5322 130 44306	2N4393	
TS21	5322 130 44306	2N4393	
TS22	5322 130 44306	2N4393	
TS23	5322 130 44306	2N4393	
TS24 to TS36	5322 130 44168	2SC269	
TS22	5322 130 44168	2SC269	
TS23	5322 130 44168	2SC269	
TS24	5322 130 44311	2SD220	
TS25	5322 130 44311	2SD220	
TS26	5322 130 44307	2SA495G	
TS27	5322 130 44168	2SC269	
TS28	5322 130 44313	ITS30088	
TS29	5322 130 44313	ITS30088	
TS30	5322 130 44305	IMF3958	
TS31 to TS34	5322 140 44306	2N4393	
TS35	5322 130 44166	ITS3948	
TS36 to TS38	5322 130 44306	2N4393	
TS39	5322 130 44305	IMF3955	
TS40	5322 130 44313	ITS30088	
TS41	5322 130 44307	2SA495G	
TS42	5322 130 44168	2SC269	
TS43	5322 130 44168	2SC269	
TS44	5322 130 44308	2SC268B	
TS45	5322 130 44168	2SC269	
TS46	5322 130 44308	2SC268B	
TS47	5322 130 44168	2SC269	
TS48	5322 130 44308	2SC268B	
TS49 to TS71	5322 130 44168	2SC269	
TS72 to TS84	5322 130 44308	2SC268B	
TS85 to TS87	5322 130 44169	2SC268A	

DIODES

No.	Ordering number	Type	
GR1	5322 130 34314	F14-C	Located on printed circuit board U1
GR41	5322 130 34216	WG713	
GR42	5322 130 34216	WG713	
GR43	5322 130 34199	1S953	
GR44	5322 130 34199	1S953	
GR45 to GR52	5322 130 34216	WG714	
GR53 to GR55	5322 130 34314	F14-C	
GR56	5322 130 34319	1S1544A	
GR93	5322 130 34204	1S1850R	
GR94	5322 130 34205	1S1850	

No.	Ordering number	Type	
GR95	5322 130 34315	RD6A	Zener
GR96 to GR100	5322 130 34199	1S953	
GR101	5322 130 34314	F14-C	
GR102	5322 130 34314	F14-C	
GR103 to GR105	5322 130 34314	F14-E	
GR106	5322 130 34199	1S953	
GR107	5322 130 34199	1S953	
GR108	5322 130 34318	02Z7.5A	Zener
GR109	5322 130 34317	ZD-2	Zener
GR110	5322 130 34199	1S953	
GR111	5322 130 34199	1S953	
GR113 to GR121	5322 130 34199	1S953	
GR123 to GR131	5322 130 34199	1S953	
GR132 to GR135	5322 130 34314	F14-C	
GR136	5322 130 34199	1S953	
GR137	5322 130 34316	SLP20B	Led
GR138 to GR140	5322 130 34199	1S953	

INTEGRATED CIRCUITS

No.	Ordering number	Type	Manufacturer	
IC1	5322 209 84445	LM301A	National	
IC2	5322 209 84445	LM301A	"	
IC3	5322 209 84451	SN74L51	Texas Instr.	
IC4	5322 209 84193	SN74L02N	"	
IC5	5322 209 84448	SN74L03N	"	
IC6	5322 209 84196	SN74L73N	"	Located on printed wiring board U1
IC7	5322 209 84189	SN74L04N	"	
IC8	5322 209 84187	SN74L00N		
IC9	5322 209 84045	SN74L10N	"	
IC10	5322 209 84196	SN74L73N	"	
IC11	5322 209 84187	SN74L00N	"	
IC12	5322 209 84448	SN74L03N	"	
IC1	5322 209 84445	LM301A	National	
IC2	5322 209 84445	LM301A	"	
IC3	5322 209 84446	LM709C	"	
IC4	5322 209 84445	LM301A	"	
IC5	5322 209 84445	LM301A	"	
IC6	5322 209 84241	LM311	"	
IC7	5322 209 84189	SN74L04N	Texas instr.	
IC8	5322 209 84187	SN74L00N	"	
IC9	5322 209 84187	SN74L00N	"	Printed on printed circuit board U2
IC11	5322 209 84191	SN74L74N	Texas instr.	
IC12	5322 209 84045	SN74L10N	"	
IC13	5322 209 84196	SN74L73N	"	
IC14	5322 209 84191	SN74L74N	"	
IC15	5322 209 84447	MK5007P		
IC16	5322 209 80141	SN74141N	Texas instr.	

PHILIPS

SERVICE

Cryogenic Equipment / Electro Analytical Equipment / Electronic Weighing / Electron Optics / Industrial Data Processing systems / Numerical Control / Radiation Measuring Equipment / Test and Measuring Equipment / Welding Equipment / X-Ray Analysis

equipment for science and industry

74 02 15 PM 2424 SME 25

Already issued:...

Re: Altering mains transformer wiring

For a mains voltage of 115 V ± 10%, the wiring of the mains transformer should be altered according fig. 1.

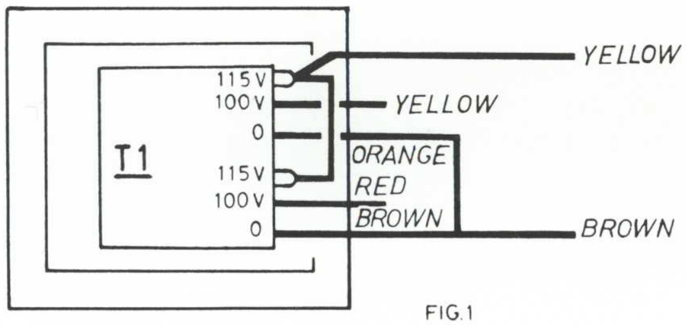


FIG.1

Mains voltage 115 V ± 10%
Fuse 0.125 A slow blow

Warning: All connections and not used wires should be insulated properly.
Also the delivered stickers (125 V, 0.125 mA) must be glued on the rear of the instrument.

9499 478 03711