M3618-308010

digitest 500

TECHNICAL MANUAL

SCHNEIDER ELECTRONIQUE

INSTRUMENTATION DEPARTMENT

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M3618-308010

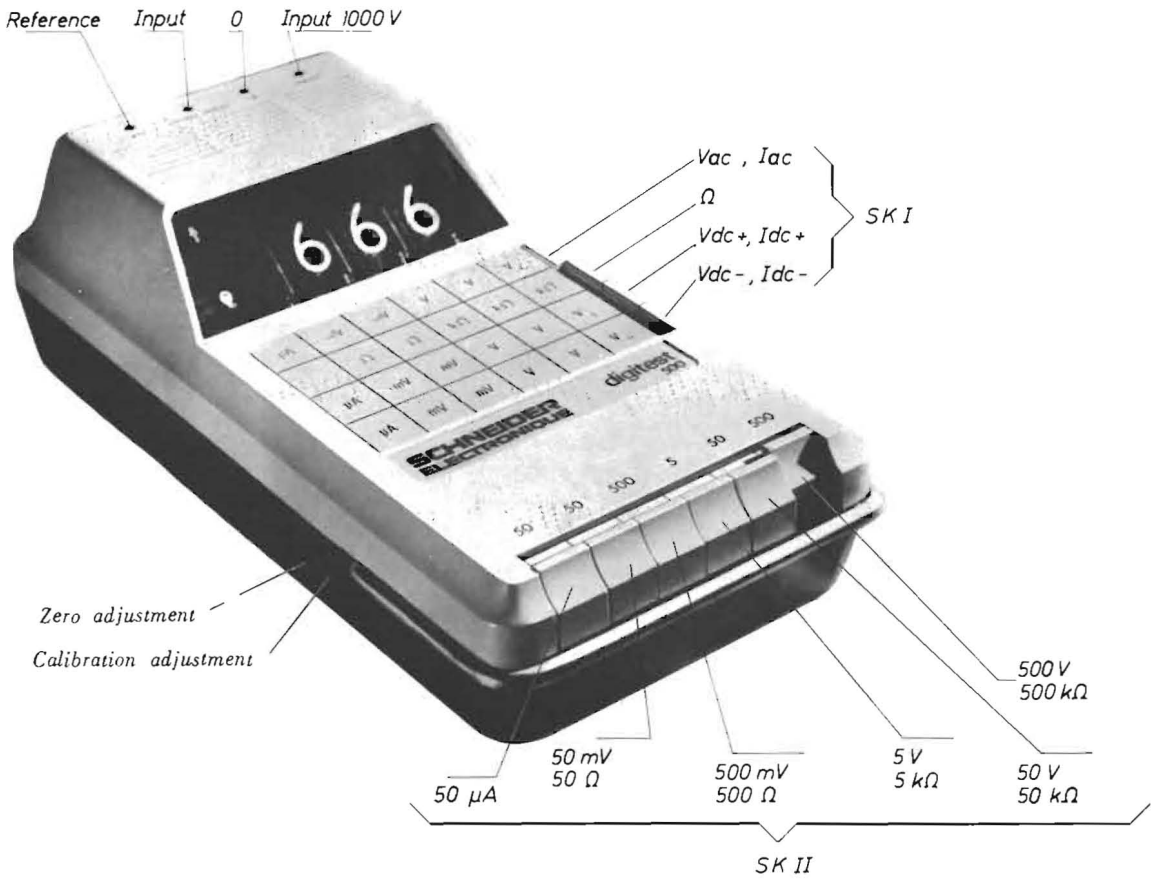
digitest 500

TECHNICAL MANUAL

Instrument Power Supplies

Types / Power Supplies	"S" without autonomous power pack	" S/P " with dry cells power pack	" S/B " with batteries power pack	Current drain
50/60 Hz Mains: 127-220 V without switching	yes	yes	yes	5 VA
12 V d.c. external	yes	yes	yes	180 mA
dry cells		yes		
batteries			yes	

TM/Digitest 500/2-1970/1st issue.
Code No. 544 250


Reference
Input
0
Input 1000 V
666
Vac , Iac
Ω
Vdc+, Idc+
Vdc-, Idc-
SK I
digitest
SCHNEIDER ELECTRONIQUE
Zero adjustment
Calibration adjustment
50 µA
50 mV
50 Ω
500 mV
500 Ω
5 V
5 kΩ
50 V
50 kΩ
500 V
500 kΩ
SK II

CONTENTS

I - FUNCTIONAL DESIGNATION OF THE INSTRUMENT

The Digitest 500 is a digital display multimeter designed for the measurement of d.c. and a.c. voltages, d.c. and a.c. currents and resistances.

Its 17 positions allow it to carry out measurements in following ranges :

— d.c. voltages 100 μV to 999 V
— a.c. voltages 100 μV to 420 V

— d.c. currents 100 nA } up to 1A by means of shunts supplied
— a.c. currents 100 nA } on request.

— resistances 0.1 Ω to 999 kΩ

This instrument offers, for a small size, a great reliability and numerous possibilities which intend it as well for the equipment of control and adjustement benches as for servicing and installation departments.

II - CONSTRUCTION OF THE INSTRUMENT UNIT

The Digitest 500, of very functional design, is equipped with two keyboard switches located orthogonally on two of its sides. One of these switches is intended for the function selection, the other for the measuring range selection.

The intersection of the straight lines extending the two pushed-in keys gives directly the function and the measuring unit on the engraved squaring on the instrument (the measuring range is marked above the pushed-in key of the front - switch).

Depending on the type (with or without autonomous power pack) the Digitest 500 has following power supply possibilities :

— Without autonomous power pack ("S" type)
  — mains power supply 127-220 V ± 10 %;
  — supply by external d.c. voltage (12 V)*;

— With dry cells power pack ("S/P" type)
  — mains power supply 127-220 V ± 10 %;
  — supply by external d.c. voltage (12 V)*;
  — supply by dry cells placed in the lower part of the instrument (12 × 1.5 V).

— With batteries power pack ("S/B" type)
  — mains power supply 127-220 V ± 10 %;
  — supply by Ni-Cad batteries incorporated with charger in the lower part of the instrument (10 × 1.2 V; 1.5 A/h).
  — supply by external d.c. voltage (12 V)*;

Note : The instrument being equipped with an automatic mains voltage switching system, no particular care has to be taken for its connection to the mains.

* **Remark: The allowable ripple, centred around 12 V, must be lower than ± 1 V.**

The additional accessories allowing to extend the measurement possibilities are given hereunder :

— High voltage probe : 30 kV, accuracy ± 5 %,

— External shunts : 1 mA - 10 mA - 0.1 A - 1 A
accuracy : 1 % in d.c.
1.5 % in a.c.

III - CHARACTERISTICS OF THE INSTRUMENT

The electrical characteristics of the Digitest 500 are following :

— display : by 3 gas tubes.

— number of measuring points : 999 (in overrange).

— polarity indication* : — the bulb marked (±) blinks or does not light up, the polarity is correct,
— it remains permanently lighted, the polarity is wrong and the polarity has to be switched by means of the V+, V— function switch,
— for ohms and a.c. volts, do not take the (±) bulb, into account, which then remains lighted.

— polarity switching : by the function switch.

— temperature coefficient of the instrument : $\leqslant 4 \times 10^{-4}/°C$.

— temperature coefficient of the internal reference source : $\leqslant 1.5 \times 10^{-4}/°C$.

— overrange indication : indicated by lighting up of the bulb (↑).

— overload indication : indicated by lighting up of the bulb ⚲ for input voltages above the values given in the characteristics table.

III.1 - Warranted values

The following table gives the complete characteristics of the instrument for operation at 25°C.

III.2 - Values given as information

The mechanical characteristics of the instrument are following :

— overall height : 70 mm
— overall width : 120 mm
— overall length : 230 mm
— weight : 1.2 kg

and its current drain :

5 VA on mains
0.18 A on 12 V d.c. external supply.

*A field of uncertainly remains for values below 10 units of the chosen range.

Function	Rep.	Range	Resolution	Allowable overrange	Measur.t accuracy (1)	Overrange field accuracy	Input	Protection	Bulb lighted for: Overload ⏚	Bulb lighted for: Overrange↑ (4)	Observations
d.c. Volts	1	50 mV	100 µV	99.9 mV	± 0.2% of the reading ± 0.2% of the range	± 0.4% of the reading	2 MΩ	100 V	0.1 V < V < 40 V 200 V < V < 400 V	99.9 mV	absolute error ± 2 U at 500 pts ± 4 U at 1000 pts (2)
	2	0.5 V	1 mV	999 mV			50 MΩ	500 V		999 mV	
	3	5 V	10 mV	9.99 V			5 MΩ	1000 V		9.99 V	
	4	50 V	100 mV	99.9 V			5.5 MΩ	1000 V		99.9 V	
	5	500 V	1 V	999 V			10 MΩ	1000 V		999 V	
d.c. Amps (5)	6	50 µA	100 nA	99.9 µA	± 1% of the range	± 1% of the reading	Shunt R 1 kΩ	2.5 mA		99.9 µA	voltage drop at 50 µA: 50 mV
a.c. Volts	7	50 mV	100 µV	99.9 mV	± 0.5% of the reading ± 0.5 % of the range	± 1% of the reading	2 MΩ<100 pF	100 Vac	40 Vac	99.9 mV	Pass band: 40 Hz - 10 kHz d.c. component ± 500 V
	8	0.5 V	1 mV	999 mV			2 MΩ<100 pF	100 Vac		999 mV	
	9	5 V	10 mV	9.99 V			2 MΩ<100 pF	420 Vac		9.99 V	
	10	50 V	100 mV	99.9 V			2 MΩ<100 pF	420 Vac		99.9 V	
	11	400 V	1 V	420 V			2 MΩ<100 pF	420 Vac			
a.c. Amps (5)	12	50 µA	100 nA	99.9 µA	± 1.5% et the range	± 1.5% of the reading	Shunt R 1 kΩ	2.5 mA		99.9 µA	
Ohms	13	50 Ω	100 mΩ	99.9 Ω	± 0.5 % of the reading ± 0.5 % of the range	± 1% of the reading	I: 1 mA	— 400 V to +50 V d.c.	< — 40 Vdc ≤ — 400 Vdc	99.9 Ω	
	14	500 Ω	1 Ω	999 Ω			1 mA			999 Ω	
	15	5 kΩ	10 Ω	99.9 kΩ			100 µA			9.99 kΩ	
	16	50 kΩ	100 Ω	9.99 kΩ			10 µA			99.9 kΩ	
	17	500 kΩ	1 kΩ	999 kΩ			1 µA			999 kΩ	

(1) formula valid between 2% and 100% of the range (from 10 u to 500 u).
(2) reinjected current < 50 nA to 25° C.
(3) on the other ranges the protection is carried out without overload indication.
(4) the overrange bulb is not operating on the 400 V a.c. range.
(5) the measuring range can be increased to 1 A in d.c. and in a.c. by use of external shunts supplied on request.

IV - PRINCIPLE OF OPERATION

The instrument is constituted by the following 4 main parts :

— an analog-to-digital converter,

— a counting and display unit,

— input circuits,

— a power supply.

The complete block diagram of the instrument is shown at the end of the manual.

IV.1 - The analog-to-digital converter

The method of conversion utilized is of the type with "single ramp and double comparison" allowing, by its principle, to obtain an "automatic zero".

The schematic of fig. 2 allows to follow the operation of this converter, composed essentially of:

— **a modulator,** constituted by a comparator (T_1) and a ramp generator (constant current generator charging a capacitor).

— **a set of two linear gates** (PL_1, PL_2) controlling, linearly, the passage of d.c. voltages.

The operation can be described as follows:

— The voltage to be measured (Vx) is applied to the input of the gate (PL_1) in the "open" state, the gate (PL_2) is then in the "closed" state.

— On the triggering of the modulator, the ramp voltage starts its progress (from +E to —E') and at its passage through the value (Vx) a pulse appears at the output of the comparator T.

— This pulse after passing through a shaping circuit changes the states of the gates PL_1 and PL_2. This state change carrying itself out in a very short time, the "zero" voltage is then applied through the gate (PL_2) to the comparator.

— The progress of the ramp going on, the coincidence "zero voltage" determines a new pulse at the output of the comparator T_1.

— The temporal diagram of fig. 2, shows that the time between these two pulses is proportional to Vx; and it is during this time that the pulses delivered by the clock are counted by the counter unit.

IV.2 - The counting and display unit

It is the principle of the "dynamic display" which is used in this part of the instrument constituted by following parts:

— **an LSI integrated circuit** (large scale integration) of MTOS technology, composed of:

— The counter composed of 3 decades,

— The display selector,

— The three position ring counter for the control of the display selector,

— The pulse shaping circuit,

— The linear gates control circuit.

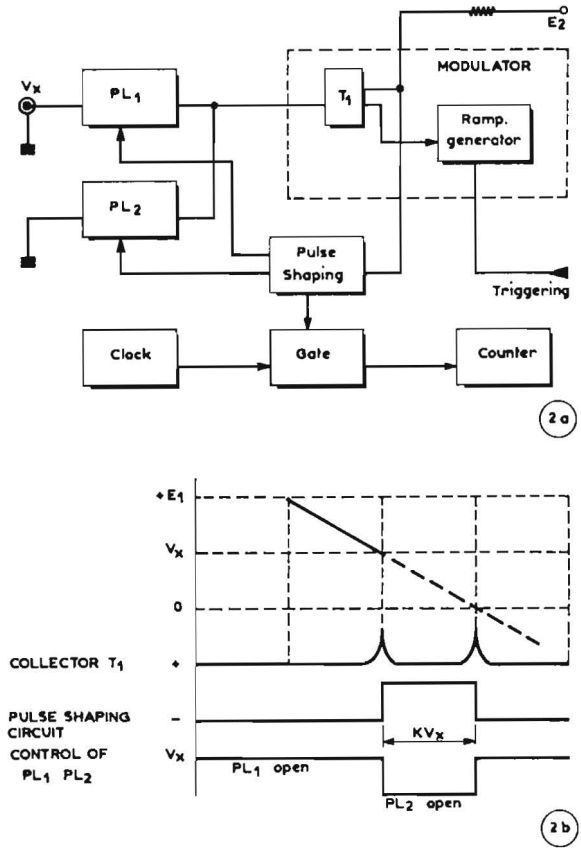


Figure 2 : Block diagram (a) and temporal diagram (b) of the converter.

— **a decoder matrix** transforming the 1-2-4-8 coded signals issued from the decimal code selector,

— **a display control circuit,**

— **an anode switch,**

— **the 3 display tubes.**

The operation of this counting and display unit can be described as follows :

The 1-2-4-8 outputs of each of the 3 decades are connected to a common selector which, controlled by the position ring counter, transforms the parallel information into serie information at the frequency of 2 kHz.

The three 1-2-4-8 signals corresponding to each one of the decades are applied to the decoder matrix which transforms them into decimal code and controls the display tube cathodes. Simultaneously the display tube anodes are switched in such a way that the lighting of the display tubes be in step with the sequential exploration of the 1-2-4-8 outputs of the counting decades.

IV.3 - **The input circuits**

The basic range of the instrument being 999 mV d.c. it is necessary to dispose of an operational amplifier for the measurement of low d.c. voltages, a.c. voltages and resistances.

For the measurement of low d.c. voltages, the amplifier is mounted as indicated in the diagram of fig. 3 a. A compensating circuit allows to obtain a reinjection current of less than 50 nA.

For the measurement of high d.c. voltages an attenuator takes the place of the amplifier.

The a.c. voltages measurement uses a discrete circuit amplifier associated to an impedance adapter circuit and to a linear rectifier. Particular precaution give a very good amplitude/frequency response and allow the utilization of the instrument beyond 10 kHz.

For the measurement of resistances, the amplifier is associated to a constant current generator. This generator flows into the measured resistance and delivers at the terminals of this a voltage proportional to its value; Fig. 3 b shows the utilized diagram.

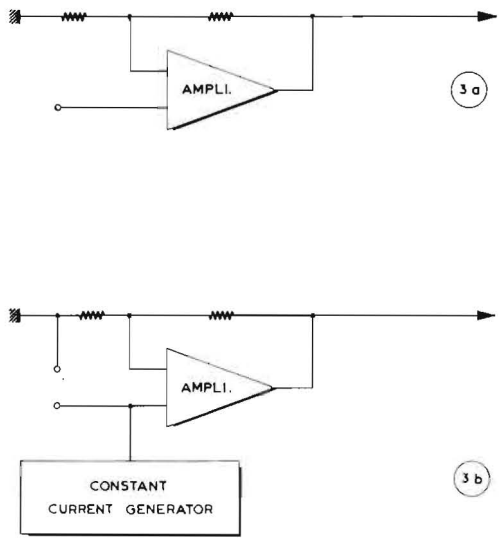


Figure 3 : Assembling principle of an operational amplifier (a) driven by a constant current generator (b).

IV.4 - **The power supply**

The power supply of the Digitest 500 type "S" is realized so as to allow the operation of the instrument either:

— without special care on mains from 115 to 240 V 50/60 Hz; the instrument being fitted with an automatic mains voltage switch.

— or on external 12 V d.c. voltage (from 11 to 18 V) by means of a static dc- converter incorporated in the instrument.

— A dry cells power pack can be easily screwed under the instrument to enable autonomous dry cells power supply.

— A batteries power pack can be easily screwed under the instrument to enable autonomous batteries power supply.

— A test point located at the rear of the lower box allows a checking of the "dry-cells" or "batteries" voltage.

V. - PRELIMINARY INSTRUCTIONS

The Digitest 500 is supplied ready for use provided with its protecting cover and with the accessories necessary for its operation (mains power cord and eventually, for the "S/P" and "S/B" models, the low voltage connection cord and the dry-cells or the batteries.

V.1- -Removing the protecting cover

The first operation to carry out is the removing of the protecting cover as shown in fig. 4 hereunder :

Figure 4

V.2 - Preparing for operation

V.2.1 - Digitest 500 "S"

— Connect the instrument to the mains supply by means of the cord supplied for this purpose and provided on one side with a three-pin plug to connect at the rear of the instrument and on the other with a standard socket.

— The instrument being equipped with an automatic supply voltage switching, it can be connected without special care to the mains having a voltage included between 115 V and 240 V - 50/60 Hz.

— Place the toggle switch A.M. located at the rear of the instrument on the "ON" position, the display tubes light up at once.

V.2.2 - **Digitest 500 "S/P"** (with dry cells power pack)

— Place in the box the 12 1.5 V dry-cells units of the type R 14 (baby) following the instructions shown on the bottom of said box. Fix the box to the instrument by means of the 2 screws of the box.

— Connect, by means of the small cord, the jack socket located at the rear of the instrument to the one located at the rear of the box.

— Put in operation as described in V.2.1.

V.2.3 - **Digitest 500 "S/B"** (with batteries power pack)

— Place in the box, the 10 accumulator units of 1.5 A/h capacity (for example: type RS 1.5 DEAC VARTA) following the instructions shown at the bottom of said box.

— The fixing of the lower box, connecting of the supply and placing in operation of the instrument are identical with these described in V.2.2.

— The accumulator box is equipped with a battery charger which will be utilized as follows:

VERY IMPORTANT: The charger being not equipped with automatic mains voltage switching, **it will be necessary to place the selector, located at the rear of the accumulator box, to the position corresponding to the utilized mains voltage.**

— Connect, by means of the mains power cord, the three pin plug located at the rear of the box to the mains supply.

— The batteries are then in charge and must stay it about ten hours.

NOTE: The Digitest 500 "S/P" and "S/B" models can, at any time, be utilized in "S" version, simply disconnect the cord connecting the instrument with the lower box and proceed as indicated in V.2.1.

VI - INSTRUCTIONS FOR USE

VI.1 - Security instructions

The mains power supply cord being a 3 wires cord (2 wires + 1 ground), one must take care when connecting the Digitest 500 or the battery charger to the mains to connect also to ground.

The lighting of the two bulbs located at the left of the display window allow to indicate:

— the overrange (bulb marked ↑)

— the overload (bulb marked ⚲)

NOTE: It is important to note that on the 400 V a.c. voltage the protection is 420 V, **WITHOUT OVERLOAD INDICATION.**

VI.2 - **Control means**

The fig. 1 gives the location and function of the different control means of the instrument.

VI.3 - **Preparing for measurements**

— Make sure that the measured values are within the operating limits and, in preference, within the nominal utilization ranges.

— The initial position of the controls SK1, SK2 can be any one.

— Connect the instrument to the supply source as described in V.2.

— Let the instrument warm up for 10 to 15 minutes and proceed to following checkings:

VI.3.1 - **"Zero" checking**

SK2 switch being positioned on 50 mV, strap both terminals "INPUT" and "O" and set alternately SK1 switch on V+ and V—, the instrument should in all cases display: 000 or 001. If this result is not obtained, retouch the adjustment marked "O" located on the left side of the instrument.

VI.3.2 - **"Full scale" calibration checking**

SK1 switch being positioned on V—, set SK2 switch on the 500 mV sensitivity.

Connect the terminal "INPUT" to the terminal "REF" located beside delivering a reference voltages of 900 mV.

The instrument must display 900. If this result is not obtained, retouch the adjustment marked "CAL", located on the left side of the instrument.

NOTE: The "REF" terminal is in fact a small diameter aperture at the bottom of which the reference voltage is sampled by means of a touch-needle.

The instrument is now ready for use.

VII - CARRYING OUT THE MEASUREMENTS

VII.1 - **Measurement of d.c. voltages below 99.9 V**

SK1 switch will be positioned on V+ or V— and SK2 switch on the range corresponding to the measurement to be carried out.

Connect the measured voltage between the therminals "INPUT" and "O" by means of the measuring cords.

Two cases can then arise:

a) The measurement result appears and the ± bulb blinks or does not light up. The polarity chosen by SK1 switch is right.

b) The instrument indicates 000 and the ± bulb remains lighted. The chosen polarity is incorrect. Change the polarity by means of SK1 switch to return to the conditions described at VII.1.a.

VII.2 - **Measurement of d.c. voltages above 99.9 V**

Proceed as in VII.1 in taking however care to connect the voltage to measure between the "500 V" and "O" terminals.

The 500 V terminal is intended only for the DC voltage higher than 100 V.

VII.3 - **Measurement of a.c. voltages**

Position SK1 switch on V~ and SK2 switch on the range corresponding to the measured voltage. Connect the measured voltage between the "INPUT" and "O" terminals by means of the measuring cords.

REMARK: The utilization of the instrument for a.c. voltages measurements of frequency higher than industrial frequencies (from 400 Hz to 10kHz) calls for following cares:

— check that the instrument is connected to ground (by means of its mains cord),

— connect the cold point of the measured source to the "O" terminal and the hot point to the "INPUT" terminal.

— connect, if there is one, the screening of the measured source to the ground.

VII.4 - **Measurement of d.c. and a.c. currents**

Position SK1 switch on V+ or V— (in d.c.) or on V~ (in a.c.) and SK2 switch on the 50 μA range. Connect the measuring cords between the "INPUT" and "O" terminals.

NOTE 1: The utilization of plug-in shunt boxes supplied on request allow to extend the range up to 1A d.c. or a.c.

NOTE 2: After having used the instrument in the micro-ammeter function, take care to position SK2 switch on a voltage range so as not to change the shunt of the instrument.

VII.5 - **Measurement of resistances**

Position SK1 switch on Ω and SK2 switch on the adequate range. Connect the measured resistance between "INPUT" and "O" terminals.

On the 50 Ω position, short-circuit the input and recheck the instrument zero before use.

For the measurement of high resistances (parasitic noise) or low resistances (contact and measuring cords resistance) take the same cares as with a classic multimeter.

VIII - ACCURACY CHECKING

VIII.1 - Correction in relation to temperature

— The measurement accuracy, given in table of chapter III, is valid when the measurement is carried out at a temperature identical to this existing at the time of calibration of the instrument.

— If the measurement is carried out at a different temperature, it is necessary to make a correction which will be function of the difference of temperature and of the temperature coefficient of the instrument ($< 4 \times 10^{-4}$/°C) or of the internal reference source ($< 1.5 \times 10^{-4}$/°C).

Example:

The instrument having been calibrated at a temperature of 25°C the measurement of a 50 V d.c. voltage at this same temperature will be made with an error of:

$\pm 2 \times 10^{-3}$ of the range $\pm 2 \times 10^{-3}$ of the reading, be in this case: $\pm 4 \times 10^{-3}$ of the reading.

In case of utilization of the instrument at $\pm$ 10°C around 25°C and without re-calibration, the additional error would be: $(\pm 4 \times 10^{-4})$ $10 = \pm 4 \times 10^{-3}$ be a total error of: $\pm 8 \times 10^{-3}$.

But, in taking care to recalibrate the instrument at this new temperature on its internal reference source and taking into account the temperature coefficient of the reference source ($< 1.5 \times 10^{-4}$/°C), the additional error would be: $(\pm 1.5 \times 10^{-4})$ $10 = \pm 1.5 \times 10^{-3}$ **which proves that the instrument maintains its class of accuracy.**

VIII.2 - Instrument accuracy checking

The accuracy checking of the Digitest 500 must be carried out with instruments or accessories of an accuracy about ten times higher.

IX - DETAILED DESCRIPTION OF THE CIRCUITS

IX.1 - dc voltage measuring circuit

A) General

Figure 5 is the block diagram of the dc voltage measuring circuit. The dc voltages are applied, either directly through a range selection switch, to an attenuator or amplifier circuit which standardizes the signals. These voltages are brought to a 1 V level (full scale) which is stored in integrator circuit (C 60 - R 72) or (C 61 - R 77). The integrating capacitor charge is applied to an analog-digital converter which transforms the 0 - 1 V level into a signal the duration of which is proportional to the voltage to be measured. This signal is obtained by comparing the voltage to be measured with a saw-tooth shaped voltage. The square signal, with a duration proportional to that of the signal to be measured, enables a gate which gives access to a counter summing up the pulses from a 200 kHz clock. The number

of pulses controlled by this gate is therefore proportional to the amplitude of the measured voltage. The resulting measurement is displayed by a dynamic device associated with the counter.

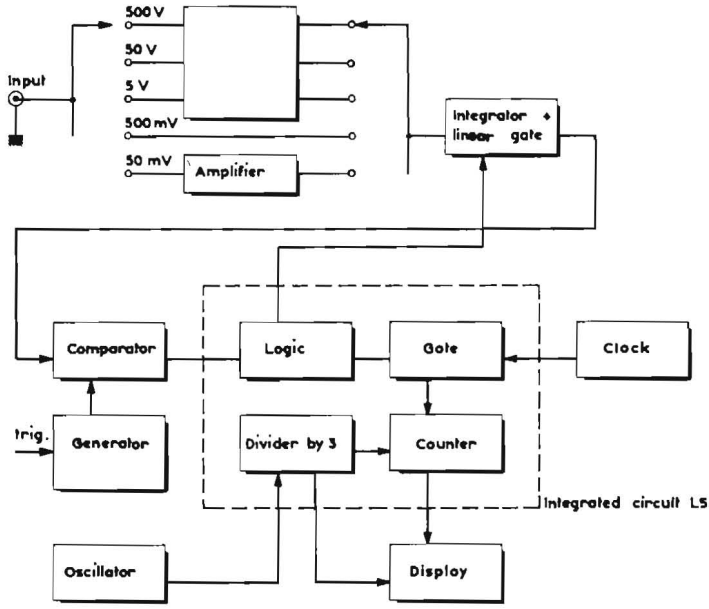


Fig. 5 : dc voltage measurement - block diagram.

B) **Attenuator - 5 V, 50 V, 500 V ranges.**

The attenuator is made up of a Vermet type, thick layer circuit (diagram 51.340) which divides the voltages by 10, 100, and 1000. Three potentiometers are used to calibrate the dividers (P 608, P 607, P 606).

Voltages comprised between 100 and 1000 V are applied to a separate measuring input designed to stand up to such high potentials.

C) **Amplifier - 50 mV range.**

An operational amplifier A (Fig. 6) is used for the 50 mV range (diagram 51.147). The loop gain is adjusted by means of potentiometer (P. 502).

This amplifier is of the μA 709 type.

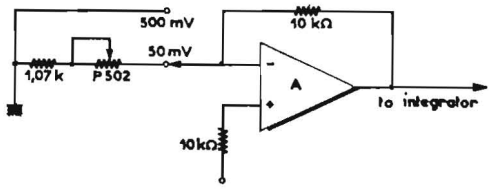


Fig. 6 : Operational amplifier.

A transistor (Q 500), associated with resistors R 502 and R 503, is located between the amplifier + and — inputs and is used to compensate the amplifier offset current, by means of potentiometer P 502.

IX.2 - **Analog-digital converter**

A) **Principle**

This is a single ramp conversion, double comparison (through a single comparator) type converter, providing automatic zero adjustment.

The voltage to be measured Vx is applied either to gate PL_1 (positive Vx) or to gate PL_2 (negative Vx). Switching is carried out manually (key V+ or V—) (Fig. 7).

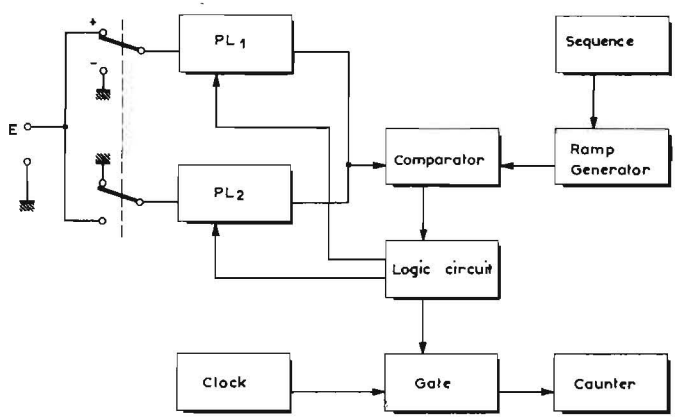


Fig. 7 : Block diagram of the converter.

At time t = 0 (Fig. 8) the ramp voltage begins to progress from +E to —E'. When it crosses value Vx, a pulse appears at the comparator output. This pulse triggers a logic circuit which switches the linear gates and enables the counter gate. At the second comparison phase, the comparator delivers a second pulse which closes the counter gate and correctly repositions gates PL_1 and PL_2 in readiness for the next measurement.

B) **Operation of sub-assemblies**

1 - **Linear gates** (diagram 51.347)

These are constituted by field effect transistors Q 54 and Q 52 (channel N).

Their control voltage, ranging between — 10 V and 0 V, is provided through transistors Q 55 and Q 66.

The input transistors are protected by diodes D 50 to D 53. The control signals for the two gates are provided by the MTOS integrated circuit.

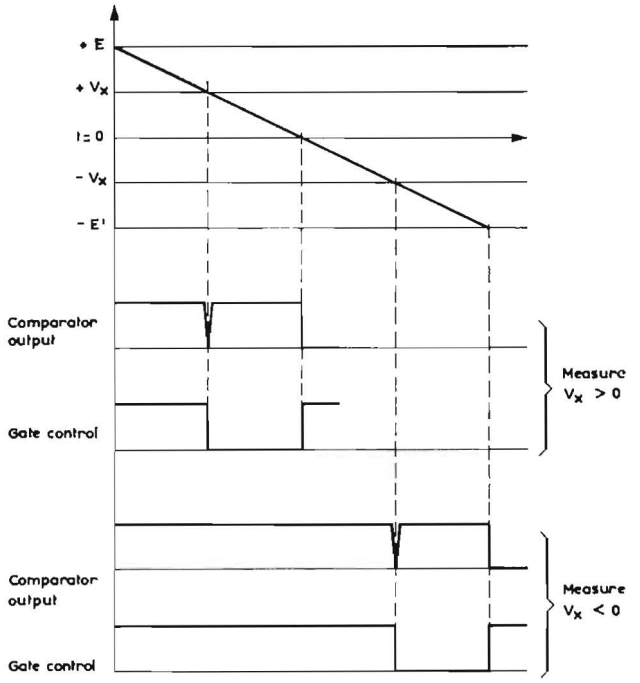


Fig. 8 : Converter timing diagram.

2 - **Ramp generator** (diagram 51.347)

Comprises two main parts:

2.1 - a supply circuit (Q 59, Q 61, Q 62, and TZ 6.2) with a temperature coefficient equal to 1×10^{-4}/°C. To prevent the circuit Q 61, TZ 6.2 to be affected by temperature variations, the voltage value of Zener diode TZ 6.2 has a tolerance comprised between 0 and + 5 %.

2.2 - a constant current generator (Q 60 PNP, Q 87 NPN, C 58). Transistor Q 59 is used as a switch (Fig. 9).

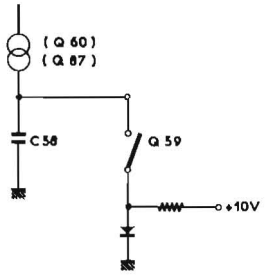


Fig. 9 : Ramp generator.

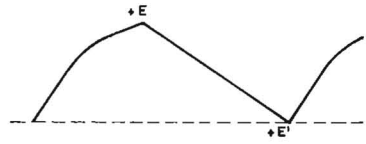


Fig. 10

While the counter is reset to zero, transistor Q 59 is saturated and allows the charge of capacitor C 58 to reach +E (5 V AC/DC).

At the end of the resetting operation, Q 59 is blocked and capacitor C 58 provides a constant current discharge (Fig. 10). The linearly decreasing voltage is applied to the comparator.

Voltage —E' is defined by diode D 55 and resistance bridge R 68 - R 69.

The 10 μs/mV conversion time can be adjusted by means of potentiometers P 51 (on front panel) and P 52.

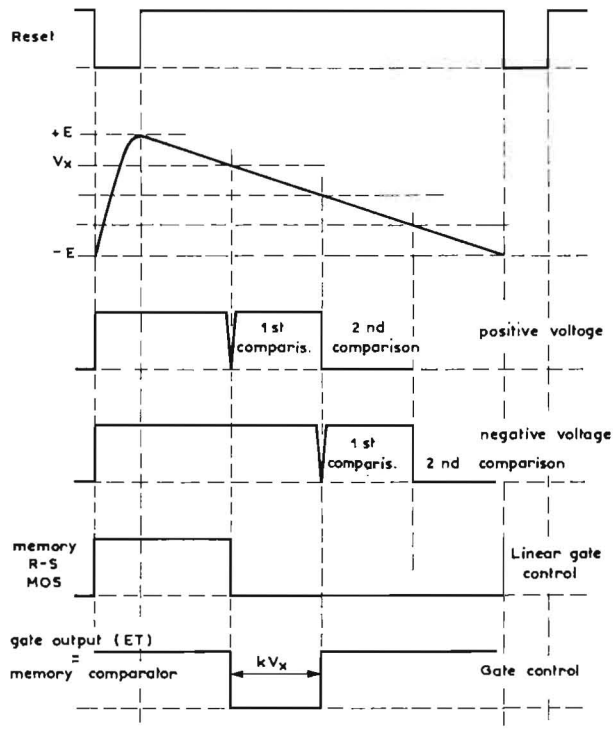


Fig. 11

3 - **Comparator**

This element is composed of two field effect transitors Q 50 and Q 51. The voltage to be measured Vx is applied to the gate of Q 50 while the sawtooth signal is applied to the gate of Q 51. The

voltage variation, between the drains of both transistors, is amplified by transistors Q 56, 57 and 58 (Q 86 becomes conductor when comparison takes place) and is then applied to the MTOS logic circuit.

IX.3 - **Sequence circuit** (diagram 51.347)

The purpose of this circuit is to deliver a zero resetting signal allowing a new measuring operation to take place. It includes an astable (Q 69, Q 70) and a shaping circuit (Q 68, Q 67).

IX.4 - **Clock** (diagram 51.347)

The clock signal is supplied by an L-C oscillator (Q 75, C 51 and transformer T 50). T 50 is adjusted so as to supply a 200 kHz signal. C 51 and T 50 have opposed temperature coefficients to provide the oscillator with a frequency stability better than $50 \times 10^{-6}/°C$. Transistor Q 76 is used for signal shaping.

IX.5 - **Counter and display**

Since a dynamic type display has been selected, the counter/display unit interface is carried out through a selector. The counter unit, selector, dynamic display control and counter gate control, are integrated in an IC3D type MTOS circuit.

MTOS circuit - Function

The MTOS circuit is divided into several separate parts (see block diagram). It includes :

1) - a counter composed of a bistable (B_1) and three decades the coded outputs of which (BCD 1-2-4-8) are applied to a selector. The latter converts the parallel data into series data.

The 200 kHz clock signal is applied to output 8 of the MTOS circuit.

Selector scanning is initiated by a counter which divides by three the frequency of the DC-AC converter oscillator (supply). A decoding operation provides 3 moments which control the selector, each moment corresponding to the unit, ten or hundred decade (Fig. 12).

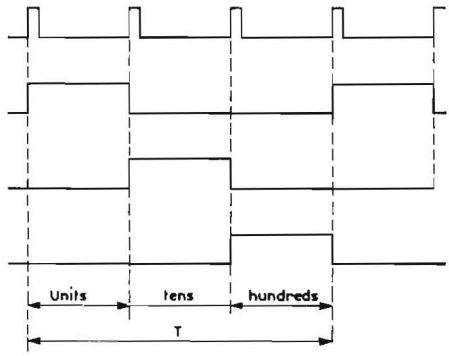


Fig. 12 : Decoding.

— during the "unit" period, outputs $\overline{A_1}$, $\overline{B_1}$, $\overline{C_1}$, $\overline{D_1}$, are transferred in $\overline{A}$, $\overline{B}$, $\overline{C}$, $\overline{D}$.

— during the "ten" period, outputs $\overline{A_2}$, $\overline{B_2}$, $\overline{C_2}$, $\overline{D_2}$, are transferred in $\overline{A}$, $\overline{B}$, $\overline{C}$, $\overline{D}$.

— during the "hundred" period, outputs $\overline{A_3}$, $\overline{B_3}$, $\overline{C_3}$, $\overline{D_3}$, are transferred in $\overline{A}$, $\overline{B}$, $\overline{C}$, $\overline{D}$,

The "unit", "ten" and "hundred" periods will be used within ,the display unit, to respectively control the "unit" "ten", and "hundred" anodes of the display tubes (MTOS outputs 4, 5, and 6).

2) The counter gate is also integrated within the MTOS circuit. It is composed of a three input NAND circuit (H), an inverter-amplifier (A1) and of gate P1.

Gate H differentiates between the comparator output signals and memory R_1 output (see Fig. 11).

The comparator output signal is applied to terminal 3 controlling, on the one hand, memory R1 and, the other hand, gate H. The latter then controls gate P which gives access to the counter.

IX.6 - **Display unit** (diagram 51.347)

MTOS outputs $\overline{A}$, $\overline{B}$, $\overline{C}$, and $\overline{D}$ (7, 8, 9, 10) are applied to a series of inverters (Q 77 to Q 84), in order to obtain the 1.2.4.8. outputs of each decades and their complement, on the collectors of the said transistors.

Decoding and display are carried out by means of a decoder (diagrams 51.347 and 51.209 and of the transistors controlling the display tube cathodes (Q 200 to Q 209). The cathodes for each digit of the three tubes are parallel-controlled (dynamic display).

The anode of each tube is controlled by the MTOS output signals (outputs 4, 5, and 6). The anode switches are constituted by transistors Q 94 - Q 95 ("unit"), Q 93 - Q 92 ("ten") and Q 90 - Q 91 ("hundred") (diagram 51.347).

The anode potential is set to +90 V (outside the anode control signals). Transistors Q 1 is saturated during the two periods when the display tube is not conducting. Capacitor C 1 is therefore charged to +90 V, through D 1 and D 2.

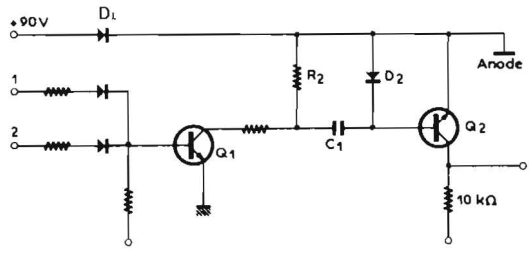


Fig. 13 : three identical circuits - one for each anode.

At the third period, Q_1 is blocked and a variation of + 90 V is detected on the terminals of C 1. Transistor Q 2 begins to conduct (current I_B is injected in Q 2, through cell R_2-C_1), and the display tube is then crossed by a current I_a (3 mA AC/DC). At the moment when Q 1 is again saturated, Q 2 is blocked and current I_a becomes nil again. The three circuits are sequentially controlled by the anode control signals.

IX.7 - **Overrange circuit** (diagram 51.347)

A signal corresponding to a "1000" information is avalaible on output 16 of the MTOS circuit (3rd decade counter output). After shaping through Q 74, this signal is stored by means of bistable Q 73 - Q 72. When overrange occurs, Q 73 is blocked, Q 89 then becomes conductor and allows the overrange indicator to light up

IX.8 - **Incorrect polarity circuit** (diagram 51.347)

This circuit operates when the three display tubes are positioned on zero. This takes place when an inverse voltage is applied on the "INPUT" and "O" terminals.

Transistor Q 200 is saturated thus blocking transistors Q 71 and saturating Q 88. The "incorrect polarity" warning indicator is then lighted.

Capacitor C 62 is necessary to create a hysteresis effect so that the indicator does not light up when the instrument displays "O" and "1" (short-circuited inputs).

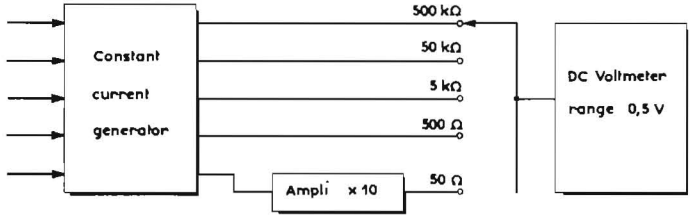


Fig. 14 : Resistance measurement - Block diagram.

IX.9 - **Resistance measuring circuit** (diagrams 51.148 and 51.348)

This circuit is that of the 0.5 V dc range. It allows voltage measurement across the terminals of the resistor to be measured.

The constant current generator comprises a Δ Vb/ΔT matched double transistor (type TD 401). Four potentiometers (P 400, P 600, P 601, P 602) are provided to adjust the value of the current in the resistors to be measured.

The constant current generator is protected by means of diodes D 400 and D 401.

For the 50 Ω range the maximum current crossing the measured resistance is 1 mA. This resistance is connected to the terminals of the amplifier (50 mV dc range).

IX.10 - **ac voltage measuring circuit**

A) General

The ac voltage to be measured may be applied either directly on to the linear rectifier (0.5 V range) or through the attenuator (500 V, 50 V, 5 V ranges) or amplifier (50 mV range) (see Fig. 15).

The output signal (5 V for the 500 V range - 0.5 V on other ranges) is applied to the linear rectifier through an impedance adaptor.

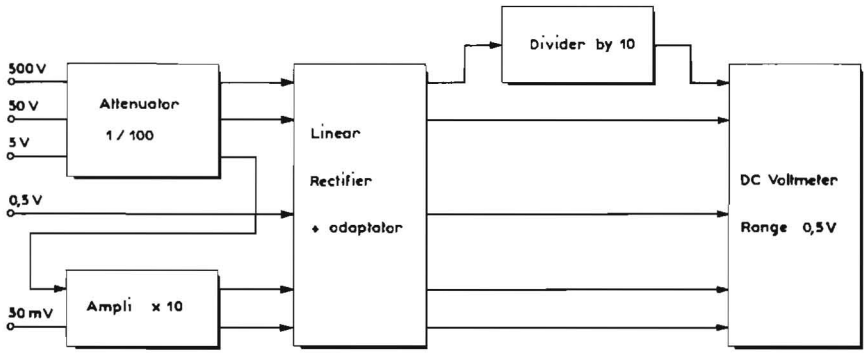


Fig. 15 . ac voltage measurement - Block diagram.

The impedance adaptor circuit allows to obtain a high input impedance and a low output impedance. The linear rectifier converts the ac signal into dc voltage.

B) **ac attenuator** (diagram 51.348)

This attenuator comprises resistors R 608, R 609 and potentiometer P 605. The latter is used to adjust the attenuation coefficient to 1/100 while variable capacitors C 603 and C 607 adjust the attenuator pass band.

C) **10 × Gain amplifier**

This amplifier is the same as for the 50 mV dc range.

D) **Adaptor** (diagram 51.348)

Comprising transistors Q 600 and Q 601, this circuit allows to adapt the high impedance attenuator output to the low impedance linear rectifier input circuit.

This circuit is protected against possible overloads, by means of diodes D 600 and D 601.

E) **ac rectifier** (diagrams 51.348 and 51.149)

The rectifier circuit incorporates a very high gain amplifier A associated with two diodes (D 300 and D 301) which allows to obtain at E 1 and E 2, the rectified input signal. This signal is then smoothed by networks R 304, C 304 and R 303, C 302, to obtain at e1 and e2 a voltage which is negative and positive with respect to earth. Both voltages are applied simultaneously to the two converter inputs.

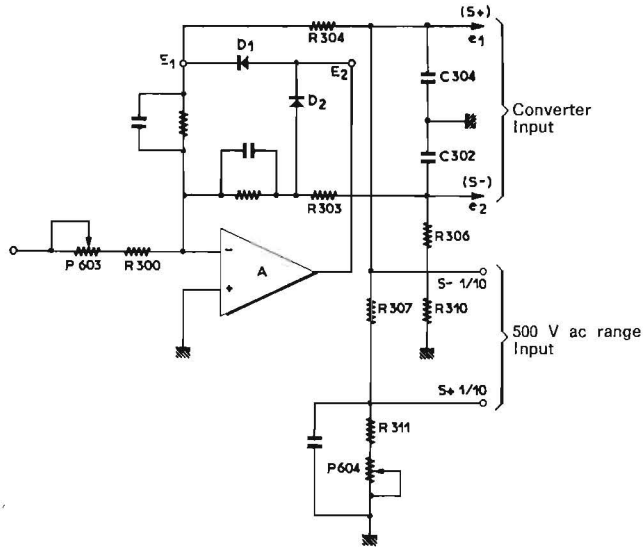


Fig. 16 : Linear rectifier - Block diagram.

Potentiometer P 603 is used to adjust the amplifier gain to 1 while P 604 is used to adjust the ratio to 1/10 for the 500 V range.

Amplifier A, comprising transistors Q 300, Q 301 and Q 302, is of the d.c total reaction differential type (R 314, R 315).

IX.11 - **dc current measuring circuit** (diagram 51.348)

The principle is similar to the one for 50 mV dc voltage measurement with addition of a shunt (R 607) at the input.

The value of the shunt resistor is such that it gives rise to a 0.1 full-scale measurement voltage.

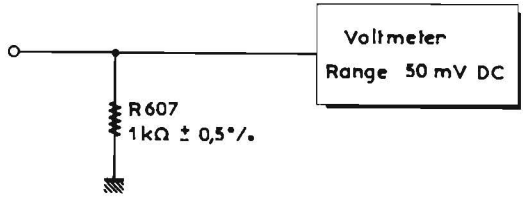


Fig. 17 : Shunt for dc current measurement.

IX.12 - **ac current measuring circuit** (diagram 51.348)

The above process is used, but the shunt is associated to the 50 mV AC range.

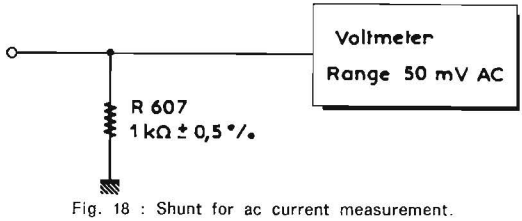


Fig. 18 : Shunt for ac current measurement.

IX.13 - Overload protection circuits

IX.13.1 - 50 mV, 500 mV dc voltages.

Two diodes, D 500 and D 501, are used to limit the voltage applied to the amplifier input.

IX.13.2 - Analog-digital converter protection.

Four opposed diodes, D 50 to D 53, connected across the storage capacitor, are used to limit the voltage to +3 V.

IX.13.3 - Impedance adaptor protection.

Two diodes, D 600 and D 601, are used to limit the voltage applied to the terminals of transistor Q 601, the overload being absorbed by resistor R 602.

IX.13.4 - Constant current generator protection (ohmmeter)

Two diodes, D 400 and D 401, are used to limit the collector voltage to +0 and —14 V, the overload being absorbed by a 3.6 kΩ resistor. If the overload is too great, it blows a quick-acting 31 mA fuse.

IX.14 - Overload indicating circuit

This circuit comprises transistors Q 54, Q 65, Q 64, divider bridge R 46 - R 43 which fixes the —V protection potential in negative voltage, and divider bridge R 45, R 42, R 40 which fixes the protection potential in positive voltage. When the voltage to be measured exceeds values —V or +V, transistor Q 64, provided for positive voltage overloads, tends to be saturated. The same applies for transistor Q 65, provided for negative voltage overloads. When the voltage to be measured reaches the critical level, indicator Ⓟ lights up.

IX.15 - Power supply

IX.15.1 - Digitest « S ».

a) **ac-dc converter.**

The ac-dc static converter (diagram 51.209 A) is supplied either with an external dc voltage, or with a rectified and smoothed voltage from the mains automatic switching circuit (diagram 51.209).

A regulating circuit, comprising transistors Q 100, Q 101, Q 102, is used to supply the ac-dc converter with a constant — 10 V supply, adjusted by means of potentiometer P 100.

Transistors Q 101 and Q 102 are supplied from a pair of diodes (located in assembly GA 409) while capacitors C 104 and C 105 are used to increase the regulating rate. The voltage upstream of the regulation circuit may then vary from 11 to 18 V.

The ac-dc converter comprises transistors Q 103 - Q 104 and transformer T-100, the oscillation frequency being approximately equal to 7 kHz.

b) **dc voltages** (diagram 51.209/2)

+ 10 V

The +10 V supply is obtained from the above described regulated supply (IX.15.1-a) and is used to feed certain logic circuits of the converter.

— 17 V

This voltage is required to feed the MTOS circuit, the converter and the constant current generator (— 12 V ohmmeter range). It is obtained after a brief rectifying and smoothing process.

— 10 V ; — 3 V

These voltages, required to feed the MTOS circuit, are obtained after a brief rectifying and smoothing process.

+ 180 ; + 90 V

These voltages, required to feed the display tube anode control circuits, are obtained through a doubling circuit (+ 180 V) and after brief rectifying and smoothing process (+ 90 V).

c) **Automatic mains switching** (diagram 51.209).

This circuit, comprising transistor Q 85 and thyristor Q 95, allows automatic switching from half-wave rectification for 180 to 240 V mains voltages, to full-wave rectification for mains voltages of lesser values. The triggering threshold is adjusted by means of potentiometer P 53.

IX.15.2-**Digitest "S/P"**

The ac-dc static converter is supplied by the dry cells located in the power pack screwed under the instrument.

IX.15.3-**Digitest "S/B"**

The ac-dc static converter is supplied by the batteries housed in the power pack underneath the instrument. This power pack also houses a battery charging circuit, the whole unit behaving as an external power supply for the ac-dc static converter.

The battery charging circuit is constituted by two thyristors allowing to regulate the charge. Potentiometer P 700 allows to adjust the charging current. When the batteries are charged, the thyristor (2 N 4146) cuts out and the said batteries are directly brought into operation.

X. - **CALIBRATION**

X.1 - **General**

Provisions have been made for the calibration of the Digitest 500 at all cardinal points. Convenient calibration adjustments are provided to expedite calibration. The calibration should be performed in the sequence given.

If only a portion of the Digitest 500 is to be calibrated, all preceding checks should be made first. For location of the adjustment controls, refer to figure 20 and 21. Adjustment controls should be resealed with a drop of varnish after adjustment.

X.2 - **Equipment required**

Calibration standards with the characteristics shown below must be employed :

A - dc voltage standard	: 100 mV - 1000 V $^{1} \times 10^{-4}$ accuracy
B - ac voltage standard	: 300 mV - 500 V 40 Hz to 10 kHz 0.1 % accuracy.
C - Resistor decade	: 100 Ω to 1 MΩ 0.1 % accuracy.
D - Shunt resistor	: 1000 Ω (non reactive) 0.1 % accuracy.

E - Suitable dc and ac current sources.

NOTE : A standard ammeter may be used, if available.

X.3 - **Preliminary checkings**

Before proceeding to any adjustment, following preliminary checkings have to be carried out :

A - Connect the Digitest 500 to a 115 V ac mains supply and allow it to warm up approximately 10 to 15 minutes.

B - Checking of the automatic mains supply switching.

Check that the voltage at the C.54 terminals is 10.5 V. By means of a variable transformer, increase the supply voltage up to 160 V ac. Voltage at C.54 terminals should raise from 10.5 V to about 18.5 V. Around this figure of the supply voltage, the full-wave rectification of the converter supply (dc - ac - dc) switches suddenly to a half-wave rectification and the voltage at the C.54 terminals must drop from 18.5 V to 10.5 V. Adjust P.53 potentiometer so that this switching takes place for a 160 V ac mains supply.

After this checking, the instrument can be supplied either from 127 V ac or 220 V ac mains.

C - Checking of the + 10 V dc voltage.

Connect a voltmeter between test point + 10 V (fig. 21) and " O " terminal, and adjust the voltage to + 10 V ± 0.1 V by means of P 100 potentiometer. SK1 and SK2 switches being set at any given range, check that within the limits of ± 10 % of the nominal value of the mains supply (127 V ac or 220 V ac) the + 10 V voltage remains equal to + 10 V ± 0.1 V.

D - Checking of the reference voltage.

Make sure that the reference voltage is 900 mV dc, by means of a measuring instrument with an input impedance equal or greater than 1000 MΩ connected between the " REF " and " O " terminals on the top of the instrument.

Adjust P 50 if necessary.

E - Adjustment of the batteries charging voltage (Digitest 500 S/B).

Check that the open-circuit batteries charging voltage does not exceed 14.2 V.

If necessary, adjust with P 700.

X.4 - **dc voltage calibration**

A - 500 mV range calibration.

1. - Set SK1 and SK2 switches respectively on V + and 500 mV.
2 - Apply a voltage of + 999 mV dc to the input from the dc voltage standard and adjust " CAL " potentiometer (P 51) on the side of the instrument to obtain a reading of 999.
3. - If the above adjustment cannot be accomplished, set P 51 potentiometer to mid-range, and with + 999 mV dc at the input, adjust the display to 999 by means of P 52.
4. - Set SK1 switch on V —.
Apply — 999 mV dc from the dc voltage standard to verify symmetry.

B - 500 mV range linearity check.

Step the dc voltage standard through 111, 222, 333..., 999 mV to check linearity.

C - 50 mV range calibration.

1. - Set SK2 switch on 50 mV.

Shorten the input of the Digitest 500.

Adjust " O " potentiometer (P 501) on the side of the instrument to obtain a reading of 000 or 001 whilst switching SK1 alternatively on V + and V —.

2. - If the display cannot be adjusted at zero by means of P. 501, connect the " INPUT " and " O " terminals with a 5.6 kΩ resistor and adjust display to zero by means of P.502 whilst switching SK1 alternatively to V + and V —.

3. - Leave SK2 switch on 50 mV and set SK1 on V +. Apply 99.9 mV dc to the input from the dc voltage standard.

If necessary, adjust display to 999 by means of P 500.

D - 50 mV range linearity check.

Step the dc voltage standard through + 11.1, + 22.2, + 33.3..., + 99.9 mV to check linearity.

Repeat with negative voltages.

E - 5 V range calibration.

Set SK2 switch on 5 V and apply 9.99 V from the dc voltage standard.

Adjust P 608 if necessary.

F - 50 V range calibration.

Set SK2 switch on 50 V and apply 99.9 V from the dc voltage standard.

Adjust P 607 if necessary.

G - 500 V range calibration.

Set SK2 switch on 500 V and from dc voltage standard apply 999 V between terminals " O " and " 500 V ".

Adjust P 606 if necessary.

X.5 - **ac voltage calibration**

The Digitest 500 ac calibration must be done with a pure sine wave.

Ground the third wire of the mains cord.

A - 500 mV rms range calibration.

Set SK1 and SK2 switches respectively on V ~ and 500 V.

Apply 999 mV rms — 1 kHz to the input from the ac voltage standard. If display 999 is not obtained adjust P 603.

Check frequency linearity.

B - 50 mV rms range calibration.

Press 50 mV push-button switch in.

Apply 99.9 mV rms — 1kHz from the ac voltage standard. Check for correct display.

If necessary, return to 500 mV range and adjust P 603 again.

C - 50 V rms range calibration.

1. - Set SK2 switch on 50 V and apply 99.9 V — 50-60 Hz from the ac voltage standard. Adjust P 605 if necessary.
2. - Apply 99.9 V — 8-10 kHz to the input and adjust the display by means of C 603 if necessary.

607

D - 5 V rms range calibration.

Set SK2 switch on 5 V and apply 9.99 V — 8 kHz to the input Adjust C ~~607~~ if necessary.

603

E - 500 V rms range calibration.

Set SK2 switch on 500 V and apply 300 V — 50-60 Hz from the ac voltage standard. Adjust by means of P 609 if necessary.

Check the accuracy at 300 V — 10 kHz and 400 V — 50-60 Hz.

X.6 - **Ohmmeter calibration**

Press the Ω push-button in.

Set SK2 on the different ranges indicated in table below, connect the appropriate resistance standard for full scale indication on the Digitest 500 and make the necessary adjustments.

Range	Adjustment	Ohmmeter current
500 Ω	P 400 centering of all ranges	1 mA
50 Ω		1 mA
5 kΩ	P 600	100 µA
50 kΩ	P 601	10 µA
500 kΩ	P 602	1 µA

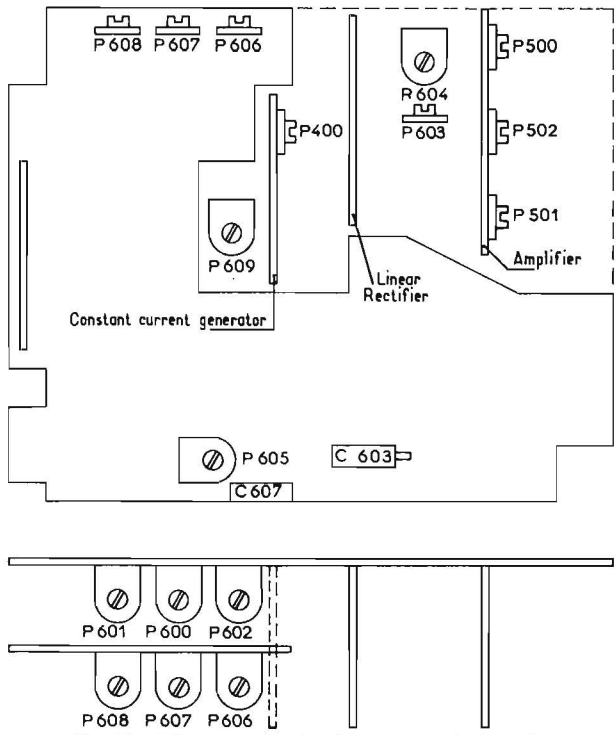


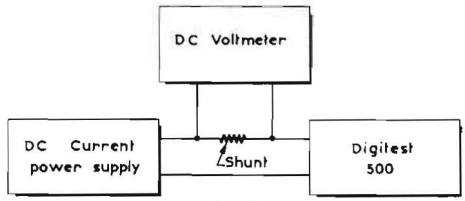
Fig. 20 : Adjustments location (attenuator and adaptor).

X.7 - **dc current calibration**

The dc current section of the Digitest 500 may be calibrated by using a one ampere dc power supply, a 1000 Ω standard current shunt and a suitably accurate dc voltmeter.

Figure below is a diagram of the test hookup.

If necessary, change the R ~~604~~ 1 kΩ ± 0.5 % shunt.



Fi. 19

X.8 - **ac current calibration**

No calibration is necessary. The shunt is the same as that used in the dc current measuring section, and the applicable ac portion was calibrated as a part of the ac voltmeter section.

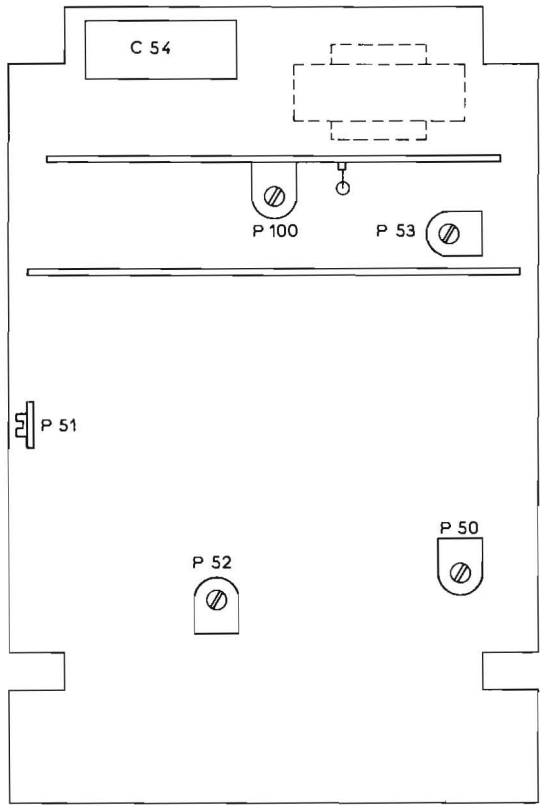


Fig. 21 : Adjustments location (main circuit).

XI. - **MAINTENANCE**

If the Digitest 500 should malfunction, refer to table hereunder for the troubleshooting chart. This information, with the schematics at the end of the manual should be sufficient to troubleshoot and repair the Digitest 500.

Trouble	Possible cause	Corrective action
Digitest 500 completely inoperative (mains supply).	1. Power fuse (F1).	1. Check fuse F1.
	2. M-ON-A-OFF switch.	2. Check and replace.
	3. Display tubes supply.	3a. Check the dc-dc converter frequency (7 kHz).
		3b. If necessary, replace transistors Q 103 and Q 104.
	4. No regulation of + 10 V dc supply.	4a. Replace transistors Q 100, Q 101, Q 102.
		4b. Replace diode bridge P 1.
Digitest 500 completely inoperative (batteries supply).	1. Accumulators discharged.	1. Replace accumulators.
	2. Charger inoperative.	2a. Check fuse.
		2b. Check charger supply; if necessary replace thyristors T 700 and T 701.
		2c. Check the connection of the AMP lugs.
(dry cells supply)	3. Dry cells discharged.	3. Replace dry cells.

Trouble	Possible cause	Corrective action
500 mV dc range inoperative.	1. 12 V dc power supply.	1a. Check — 12 V dc.
		1b. Replace transistors Q 62, Q 39 and Q 61.
	2. 200 kHz clock.	2a. Check clock frequency (200 kHz).
		2b. Replace transistors Q 75, Q 76 or oscillator can T 50.
	3. Constant current generator.	3. Check and eventually replace transistors Q 60 and Q 87.
	4. Comparator.	4. Check and eventually replace FET Q 50 and Q 51 and transistor Q 86.
	5. Linear gates.	5. Check and eventually replace FET Q 53 and Q 52.
	6. LSI-MTOS.	6. Check and eventually replace the CI 3 D MTOS.
	7. Open wiring.	7. Check and repair.
All ranges other than 500 mV dc are inoperative.	1. Fuse F2.	1. Replace fuse F 2.
	2. Open wiring.	2. Check and repair.
	3. Adaptor unit.	3. Replace adaptor unit.
	4. Range and function switches.	4. Check and repair.
Overrange indicator always on or off.	1. Transistor drivers.	1. Check and eventually replace transistors Q 72, Q 73, Q 74 and Q 89.
	2. Neon lamp.	2. Replace neon lamp.
Polarity indicator malfunction.	1. Transistor drivers.	1. Check and eventually replace transistors Q 71 and Q 88.
	2. Neon lamp.	2. Replace neon lamp.
Overload indicator malfunction.	1. Transistor drivers.	1. Check and replace transistors Q 54, Q 64 and Q 65 if necessary.
	2. Neon lamp.	2. Replace neon lamp.

X - PARTS LIST

Circuit diagram designation	Value	Part number	
Mains power supply		295 401	Drwg 51.209
Resistors			
R 1	3.3 K	173 068	Carbon, 5%, 1/4 W
R 2	4.3 K	173 076	»
R 3	4.7 K	173 072	»
R 4	10 K	173 080	»
R 5	10 K	173 080	»
Diodes			
D 1	TV 4	138 001	
D 2	34 P 4	136 995	
D 3	TZ 3.6 V	138 096	
printed circuit board		453 592	
Anode control n° 2		295 404	Drwg 51.347
Resistors			
R 10 thru R 12	220 K	173 263	Carbon, 5%, 1/4 W
R 13 thru R 18	47 K	173 096	»
Diodes			
D 10 thru D 15	34 P 4	136 995	
printed circuit board		453 595	
Anode control n° 1		295 403	Drwg 51.347
Resistors			
R 20 thru R 22	510 K	173 272	Carbon, 5%, 1/4 W
R 23 thru R 25	39 K	173 094	Carbon, 5%, 1/4 W

Circuit diagram designation	Value	Part number	
Capacitors			
C 20 thru C 22	0.01 pF/250 V	166 054	Polyester ± 20 %
Diodes			
D 20 thru D 22	34 P 4	136 995	
D 23 thru D 25	P 200	138 047	
printed circuit board		453 594	
Decoding		295 402	Drwg 51.347
Diodes			
D 30 thru D 39	34 P 3	136 995	
printed circuit board		453 593	
Overload		295 412	Drwg 51.347
Resistors			
R 40	200 Ω	173 039	Carbon, 5%, 1/4 W
R 41	200 Ω		
R 42	820 Ω	173 054	»
R 43	820 Ω		
R 44	5.6 K	173 074	»
R 45	5.6 K		
R 46	5.6 K		
R 47	240 Ω	173 041	»
R 48	3.9 K	173 070	»
R 49	100 Ω	173 032	»
printed circuit board		453 603	

Circuit diagram designation	Value	Part number	
Main circuit		295 477	Drwg 51.347
Resistors			
R 50	5.6 K	173 074	Carbon, 5%, 1/4 W
R 51	10 K	173 080	»
R 52	10 K		
R 53	10 K		
R 54	1.5 K	173 060	»
R 55	560 Ω	173 050	»
R 56	39 K	173 094	»
R 57	820 Ω	173 054	»
R 58	200 K	173 262	»
R 59	200 K		
R 60	27 K	173 090	»
R 61	47 K	173 096	»
R 62	47 K	173 096	»
R 63	3.9 K	173 070	»
R 64	9.1 K	173 079	»
R 65	15 K	173 084	»
R 66	1 K	173 056	»
R 67	13 K	173 083	»
R 68	6.8 K	173 076	»
R 69	4.7 K	173 072	»
R 70	4.7 K	173 072	»
R 71	107 K	174 036	Metal film, 1%, 1/2 W
R 72	9.1 K	173 037	»
R 73	12.1 K	174 017	Metal film, 1%, 1/2 W
R 74	12.1 K	174 017	»
R 75	51 K	174 018	»
R 76	1 M	174 030	»
R 77	100 K	171 447	»
R 78	100 K	171 447	
R 79	910 Ω	173 055	Carbon, 5%, 1/4 W
R 80	20 K	173 087	»
Potentiometers			
P 50	5 K	191 127	0.75 W, 20% H
P 51	2.2 K	191 130	» V
P 52	4.7 K	191 126	» H
P 53	4.7 K	191 126	» H

Circuit diagram designation	Value	Part number	
Capacitors			
C 50	4700 pF	162 095	Ceramic + 100 — 20%
C 51	1500 pF	167 041	Styroflex 33 V ± 2,5%
C 52	56 pF	162 204	Ceramic ± 10%
C 53	100 pF	162 186	— ± 10% 500 V
C 54	1000 uF/25 V	168 274	Tantalum
C 55	10 uF/25 V	168 289	Tantalum
C 56	2 uF/25 V	168 188	+ 50, — 20%
C 57	2 uF/25 V		
C 58	1 uf/160 V	166 139	Polyester
C 59	1.0 uF/30 V	168 194	+ 50, — 20%
C 60	0.1 uF/250 V	166 056	Polyester ± 20%
C 61	0.1 uF/250 V	168 056	»
C 62	20 uF/16 V	168 207	Tantalum
C 63	3 uF/16 V	168 270	»
C 64	3 uF/16 V	168 270	»
C 65	4 uF/16 V	168 272	»
Transistors			
Q 50	SPF 137	134 260	
Q 51	SPF 137	134 260	
Q 52	2 N 5459	134 261	
Q 53	2 N 5459	134 261	
Q 54 thru Q 63	B C 153	134 220	
Q 64 thru Q 85	2 N 2713	134 103	
Q 86	2 N 3605	134 966	
Q 87	125 DT 2	134 226	
Q 88	BSW 32	134 115	
Q 89	BSW 32	134 115	
Q 90 thru Q 95	BSW 69	134 263	
Q 96	2 N 4145	134 259	

Circuit diagram designation	Value	Part number	
Diodes			
D 50 thru D 55	BA 129	138 024	
D 56	TZ 5.2-5 %	138 096	
D 57	TZ 6.2-5 %	138 091	
D 58	W01 100 V-1 A	295 206	
D 59	TV 4	138 001	
Integrated Circuit LSI MTOS		133 012	
Module			
cathode control n° 1		174 047	
cathode control n° 2		174 048	
comparator		174 052	
overload		295 412	
decoder		174 049	
mains power supply		295 401	
decoding		295 402	
linear gate		174 046	
multivibrator		174 044	
anode control n° 1		295 403	
anode control n° 2		295 404	
overrange		174 050	
printed circuit board		453 574	
connector TM 9		146 219	
connector TM 19		146 170	
connector TMF CIDA		146 224	
power supply transformer		225 108	
holder for mains plug and "on-off" switch"		468 798	
oscillator inductance		231 315	
fuse holder		153 058	
"on-off" switch		203 010	
mains plug		159 124	
jack		159 123	

Circuit diagram designation	Value	Part number	
Power supply		295 377	Drwg 51.209/2
Resistors			
R 100	1.2 K	173 058	Carbon, 5%, 1/4W
R 101	2.7 K	173 066	»
R 102	100 Ω	174 072	Carbon, 5%, 0.8 W
R 103	2.7 K	173 066	Carbon, 5%, 1/4 W
R 104	820 Ω	173 054	»
R 105	1.5 K	173 060	»
R 106	6.8 K	173 076	»
R 107	220 Ω	173 040	»
R 108	4.7 K	173 072	»
R 109	220 Ω	173 040	»
R 110	680 Ω	173 052	»
R 111	390 Ω	173 046	»
Potentiometer			
P 100	2.2 K	191 130	± 20%, 0.75 W, V
Capacitors			
C 100	10 uF/16 V	168 271	Tantalum
C 101	1 uF/40 V	168 248	»
C 102	10 uF/16 V	168 271	»
C 103	1 uF/40 V	168 248	»
C 104	2 uF/25 V	168 188	»
C 105	2 uF/25 V	»	»
C 106	4 uF/25 V	168 276	Tantalum
C 107	2 uF/40 V	168 273	»
C 108	10 uF/16 V	168 271	»
C 109	10 uF/16 V	168 271	»
C 110	10 uF/16 V	168 271	»
C 111	0.22 uF/300 V	166 088	Polyester ± 20 %
C 112	0.22 uF/300 V	166 088	»
C 113	0.22 uF/300 V	166 088	»

Circuit diagram designation	Value	Part number	
Diodes			
D 100	TZ 6 V 2	138 092	
D 101	TV 4	138 001	
D 102	GA 409	138 097	
Transistors			
Q 100	2 N 2195 A	134 961	
Q 101	2 N 2713	134 103	
Q 102	2 N 2713	134 103	
Q 103	AC 181	134 153	
Q 104	AC 181	134 153	
connector	TM 19 MC 1	146 218	
transformer		224 171	
heat sink		468 093	
printed circuit board		453 582	
Display		295 380	Drwg 51.347
Resistors			
R 200	180 K	173 261	Carbon, 5%, 1/4 W
R 201	180 K	173 261	»
R 202	360 K	173 268	»
R 203	360 K	173 268	»
Capacitor			
C 200	0.1 uF/250 V	166 056	Polyester ± 20%
Transistors			
Q 200 thru Q 209	BSW 69	134 263	
Tubes			
L 200 thru L 202	1093 A	131 094	
Lamp			
T 200	2 306	252 017	
Neon			
N 200	76 521	252 023	
N 201	76 521	252 023	
Lamp and neon holder		151 070	
display resistors module		174 045	
printed circuit board		453 575	
connector		146 171	

Circuit diagram designation	Value	Part number	
Linear rectifier		295 373	Drwg 51.149
Resistors			
R 300	8.2 K	174 021	Metal film, 2%, 1/2 W
R 301	10 K	174 022	»
R 302	10 K	174 022	»
R 303	47 K	173 096	Carbon, 5%, 1/4 W
R 304	47 K	173 096	»
R 305	24 K	173 089	»
R 306	1 M	174 030	Metal film, 2%, 1/2 W
R 307	1 M	174 030	»
R 308	24 K	173 089	Metal oxyde, 1%, 1/2 W
R 309	39 K	173 094	»
R 310	100 K	174 043	Metal film, 2%, 1/2 W
R 311	110 K	174 042	»
R 312	10 K	173 080	Carbon, 5%, 1/4 W
R 313	10 K	173 080	»
R 314	20 K	173 087	»
R 315	20 K	173 087	»
R 316	30 K	173 091	»
Capacitors			
C 300	10 uF/4 V	168 247	Tantalum
C 301	10 uF/4 V	168 247	Tantalum
C 302	2 uF/40 V	168 273	»
C 303	0.1 uF/250 V	166 056	Polyester, 20%
C 304	2 uF/40 V	168 273	Tantalum
C 305	0.1 uF/250 V	166 056	Polyester, 20%
C 306	10 uF/4 V	168 247	Tantalum

Circuit diagram designation	Value	Part number	
Diodes			
D 300	34 P 4	136 995	
D 301	34 P 4	136 995	
D 302	TZ 3.3 V	138 093	
Transistors			
Q 300	BC 183	134 194	
Q 301	BC 183	134 194	
Q 302	BC 153	134 220	
printed circuit board		453 581	
Constant current generator		295 372	Drwg 51.148
Resistors			
R 400	121 K	174 017	Metal film, 2%, 1/2 W
R 401	121 K	174 017	»
R 402	62 K	174 024	»
R 403	62 K	174 024	»
R 404	5.36 K	174 025	»
R 405	3.6 K	174 073	3 W
R 406	56.2 K	174 026	Metal film, 1%, 1/2 W
R 407	590 K	174 031	»
R 408	5.9 M	174 034	Metal film, 2%, 1/2 W
Potentiometer			
P 400	4.7 K	191 126	0.75 W, 20%, V
Diodes			
D 400	BA 129	138 024	
D 401	P 200	138 047	
Transistor			
Q 400	TD 401	134 258	
printed circuit board		453 580	

Circuit diagram designation	Value	Part number	
DC amplifier		295 371	Drwg 51.147
Resistors			
R 500	10 K	174 071	Metal oxyde, 3 W, 5%
R 501	2 M	174 040	Carbon, 5%, 1/4 W
R 502	1.8 M	174 041	»
R 503	1.8 M	»	»
R 504	470 K	173 271	»
R 505	500 K	173 273	»
R 506	1.5 K	173 060	»
R 507	10 K	174 070	Metal oxyde, 1/4 W, 5%
R 508	10 K	173 080	Carbon 0.8 W, 5%
R 509	1,07 K	174 078	Metal film, 1%, 1/2 W
Potentiometers			
P 500	100 K	191 140	0.75 W, 20%, H
P 501	100 Ω	191 146	0.75 W, 20%, V
P 502	470 K	191 142	0.75 W, 20%, H
Capacitors			
C 500	2 uF/25 V	168 188	Tantalum
C 501	2 uF/25 V	168 188	»
C 502	500 pF/63 V	167 034	
C 503	22 pF/160 V	167 057	
Transistor			
Q 500	B C 153	134 220	
Diodes			
D 500	B A 129	138 024	
D 501	B A 129	138 024	
D 502	34 P 4	136 995	
D 503	34 P 4	»	
D 504	34 P 4	»	
operational amplifier	uA 709 C	295 397	
screw driver slider		468 856	
printed circuit board		453 579	

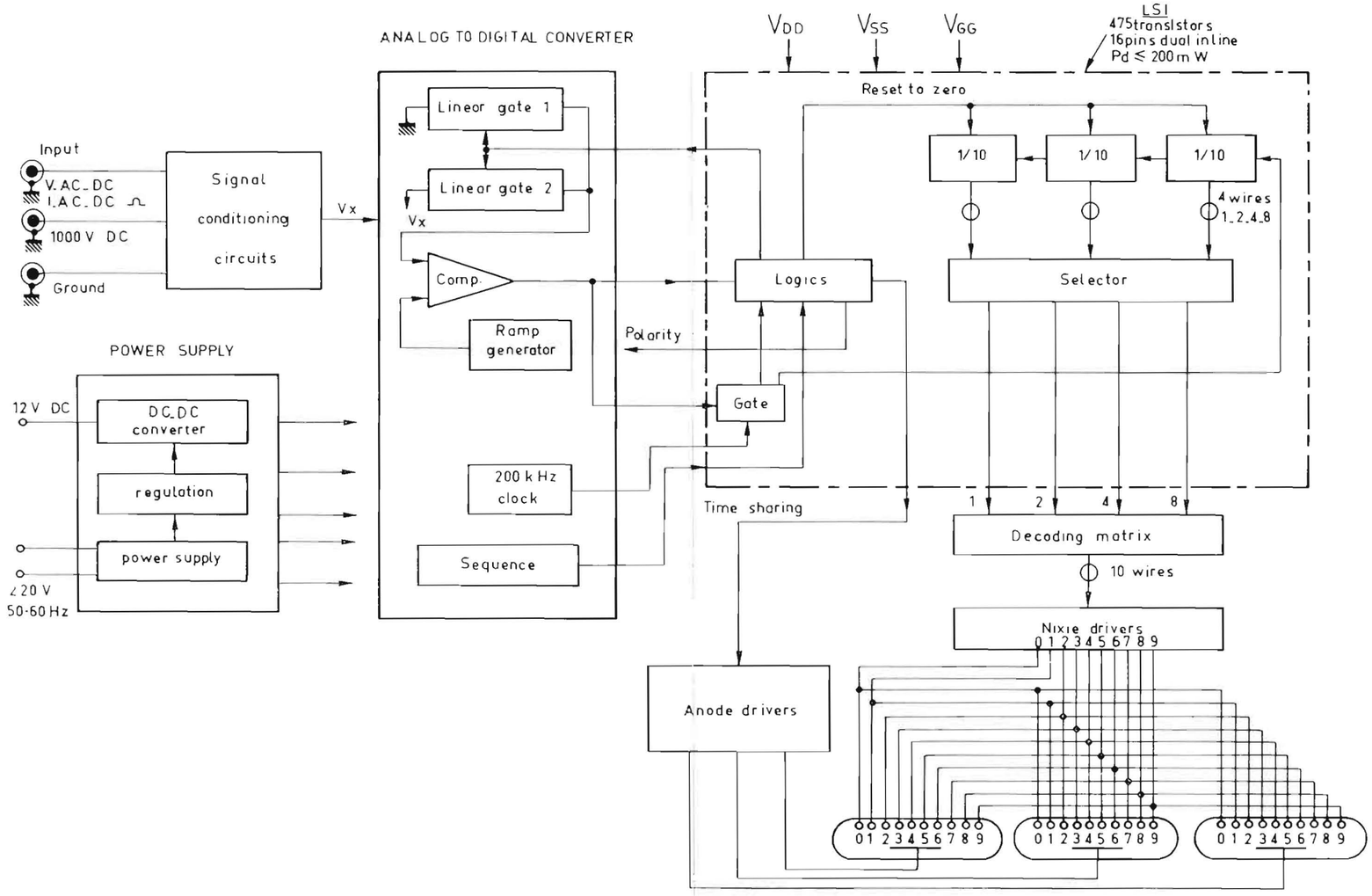
Circuit diagram designation	Value	Part number	
Adaptor		295 374	Drwg 51.348
Resistors			
R 600	5.1 K	173 073	Carbon, 1/4 W, 5%
R 601	2.2 M	174 049	»
R 602	100 K	173 255	»
R 603	100 K	173 255	»
R 604	360 Ω	173 045	»
R 605	82 Ω	173 030	»
R 606	510 K	173 272	»
R 607	1 K	174 040	1/3 W, 5%
Capacitors			
C 600	33 nF/1000 V	168 221	Polyester 20%
C 601	160 uF/16 V	166 140	Tantalum
C 602	20 uF/16 V	168 207	»
Potentiometers			
P 600	4.7 K	191 131	0.75 W, 20%, V
P 601	47 K	191 134	0.75 W, 20%, V
P 602	470 K	191 137	0.75 W, 20%, V
P 603	470 Ω	191 148	0.75 W, 20%, V
P 604	22 K	191 128	0.75 W, 20%, H
Transistors			
Q 600	2N 2926	134 962	
Q 601	2N 3819	134 181	
Diodes			
D 600	BA 129	138 024	
D 601	BA 129	138 024	
printed circuit board		453 573	
fuse	31 mA D	143 920	
fuse holder		468 415	

Circuit diagram designation	Value	Part number	
Attenuator		295 388	Drwg 51.348
Resistors			
R 608	2 M	174 039	Metal oxyde, 1/2 W, 1%
R 609	19.1 K	174 038	Metal oxyde, 1/2 W, 2%
Capacitors			
C 603	1-6 pF	188 023	Linear, 400 V PP
C 604	1000 pF	167 005	2.5% 160 V
C 605	47 pF	161 063	Ceramic ± 10%
C 606	0.1 uF	166 056	± 20% 250 V
C 607	10-40 pF	188 026	adjust.
C 608	150 pF	162 188	
Potentiometers			
P 605	2.2 K	191 125	0.75 W, 20%, H
P 606	470 K	191 148	0.75 W, 20%, V
P 607	2.2 K	191 130	0.75 W, 20%, V
P 608	22 K	191 133	0.75 W, 20%, V
resistive attenuator		178 002	
printed circuit board		453 572	

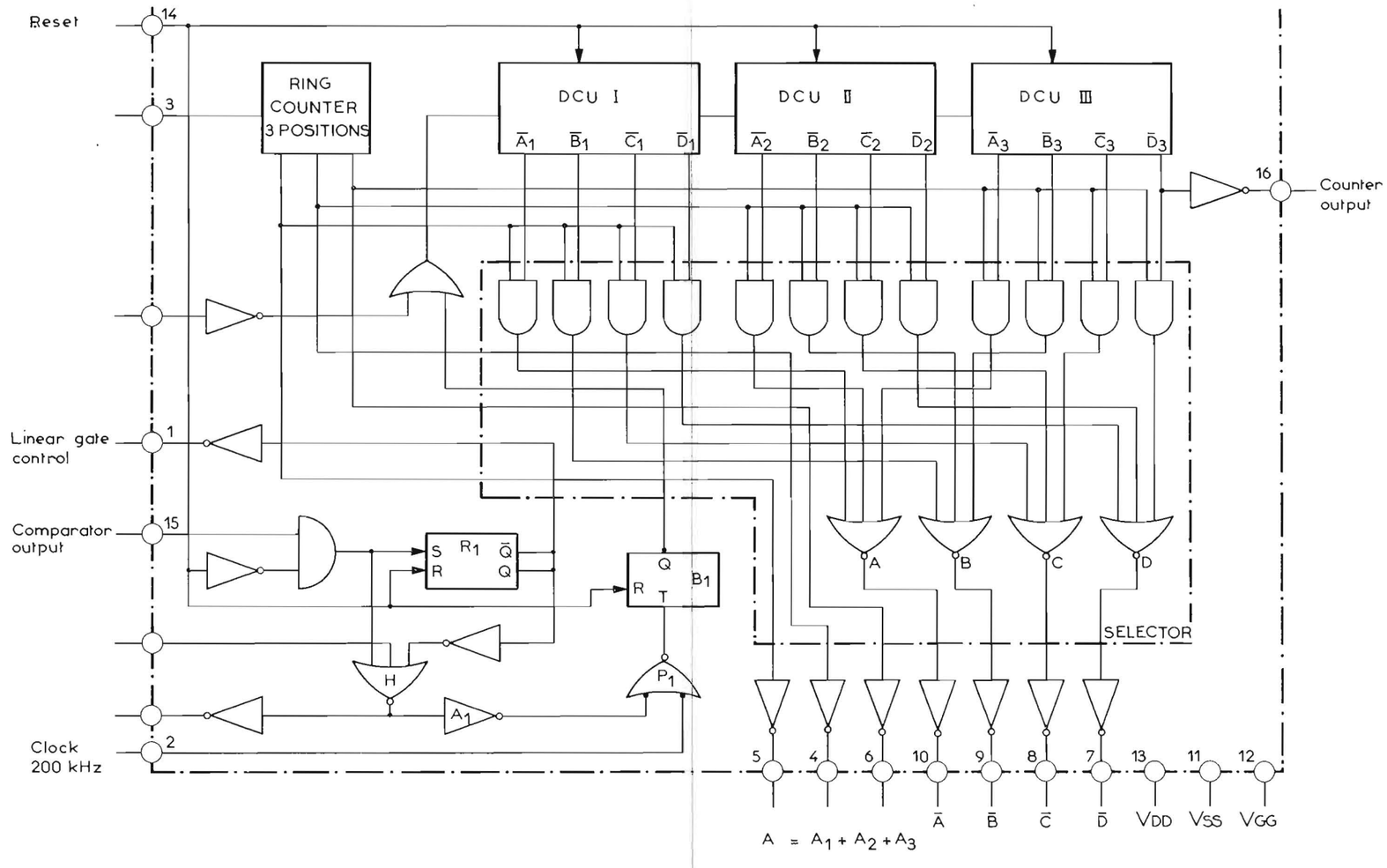
Circuit diagram designation	Value	Part number	
Batteries power supply		295 461	Drwg 51.273
Resistors			
R 700	1 K	173 056	
R 702	33 Ω	176 903	3 W
R 703	39 Ω	176 904	3 W
Potentiometer			
P 700	1 K	191 124	VA 05 H
Capacitor			
C 700	200 uF	168 945	25/30 V
Thyristors			
T 700	2 N 4146	134 281	
T 701	2 N 4146	123 281	
Diodes			
D 700	BY 158	130 001	
D 701	ZG 10	138 117	
D 702	P 200	138 047	
Fuse holder		468 415	
Delayed fuse	31 mA	143 938	
3 pins socket		159 122	
On-off swith	500 V/1A	203 012	
Transformer		225 126	

Circuit diagram designation	Part number	
Miscellaneous		
Monogram	523 192	
Identification plate	487 133	
Plastic case (upper part)	442 258	
Plastic case (lower part)	442 257	
Plastic top cover	442 256	
Handle	439 089	
Front fastening screws	463 162	
Rear fastening screws	463 163	
Display tubes holder	468 803	
Protection glass	431 331	
Push-button switch holder (6)	468 801	
Push-button switch holder (4)	468 802	
Dry cells case	295 459	
Batteries case	295 460	
Anti-slide feet	435 133	
Push-button	471 249	
Function label	527 576	

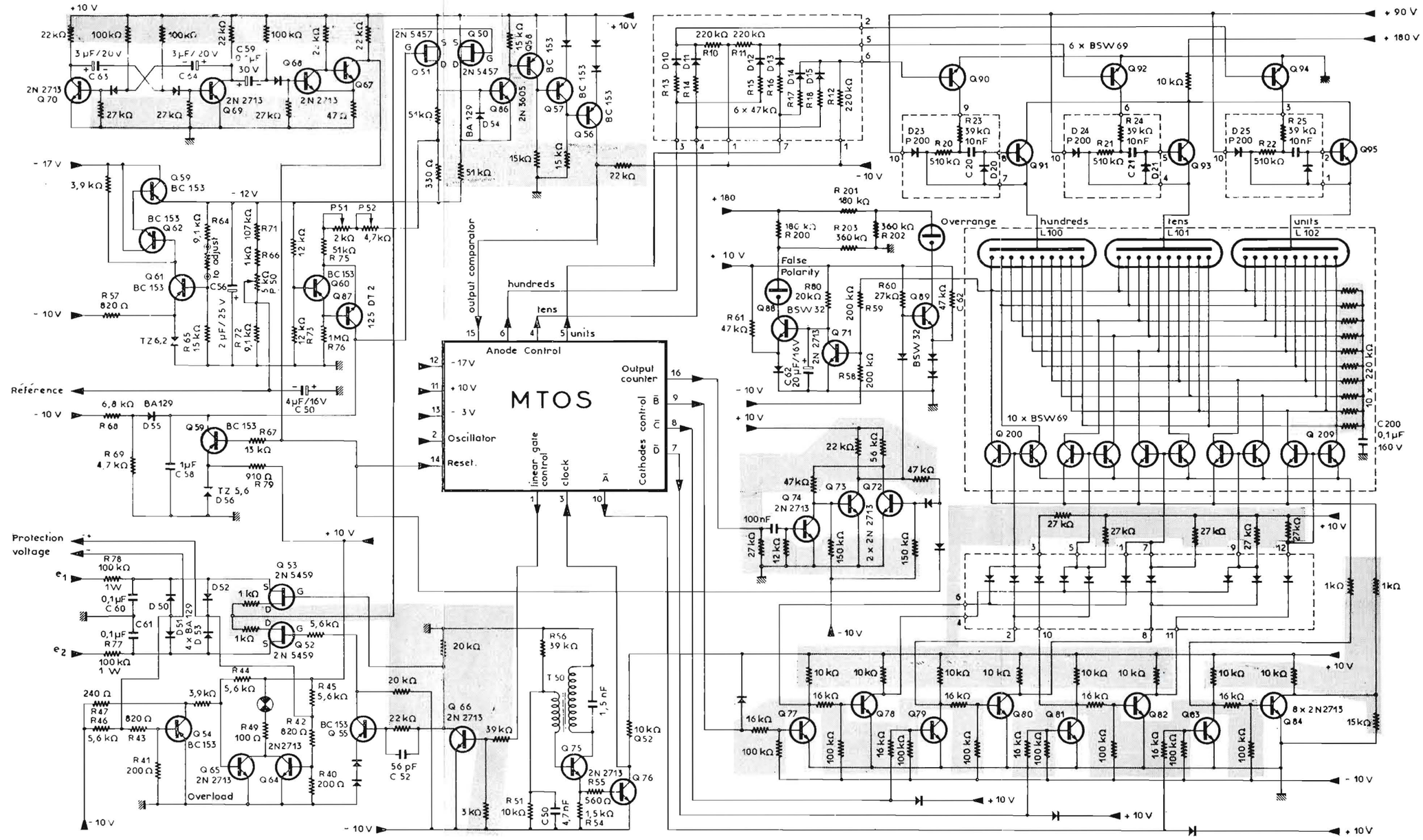
BLOCK DIAGRAM



BLOCK DIAGRAM OF THE INTEGRATED CIRCUIT LSI MTOS



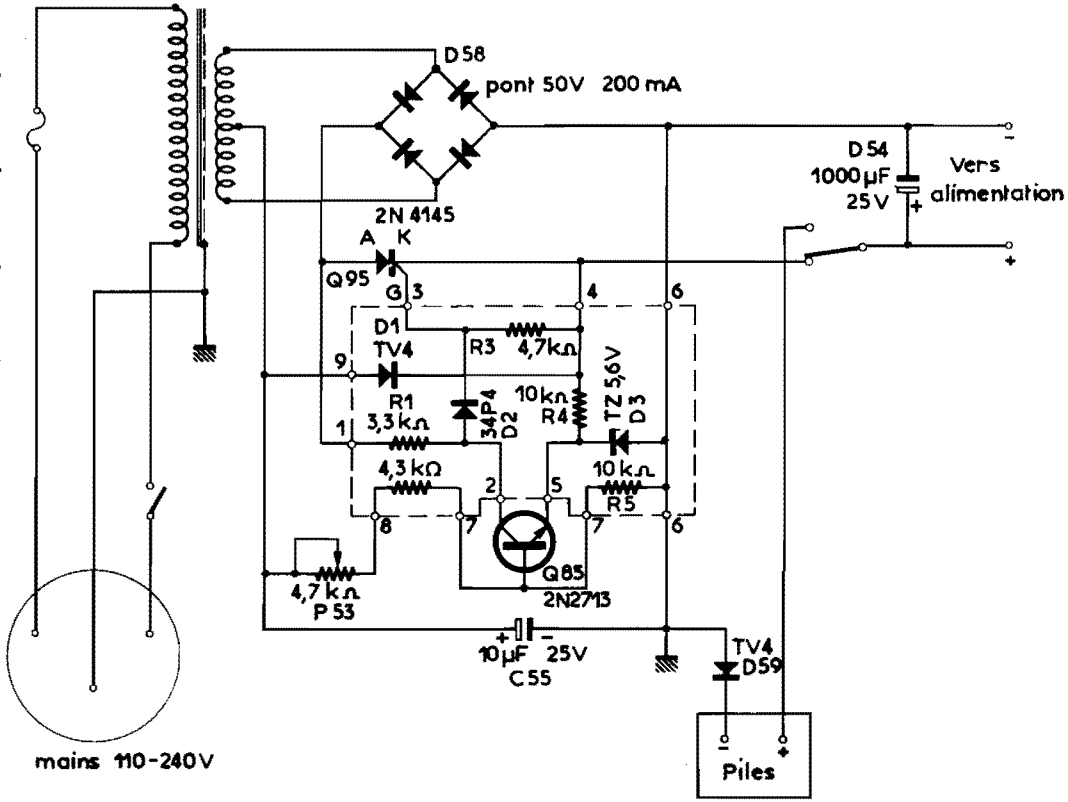
LAY



Diodes without mark = 34 P 4

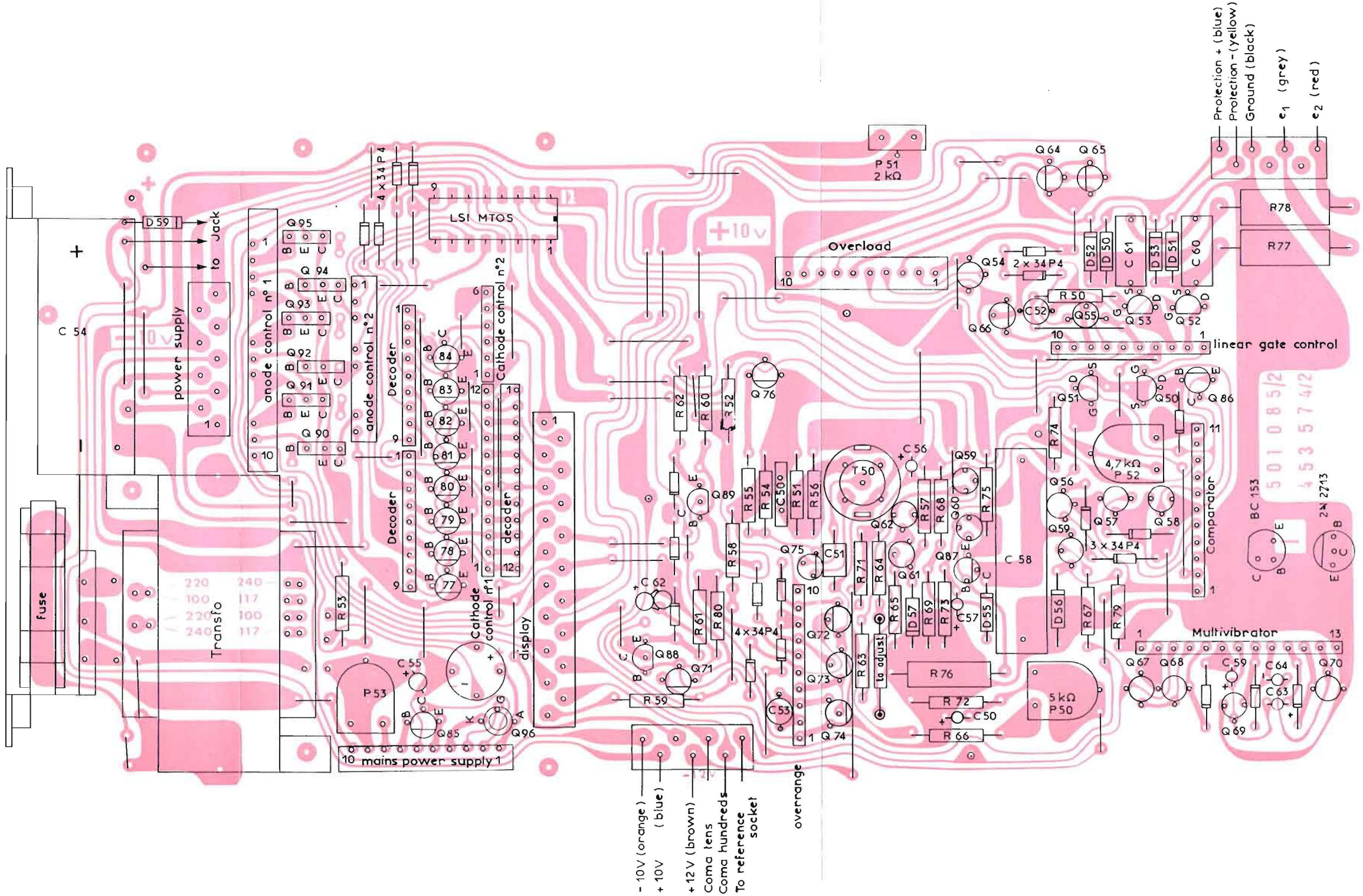
DRAWING 51.347

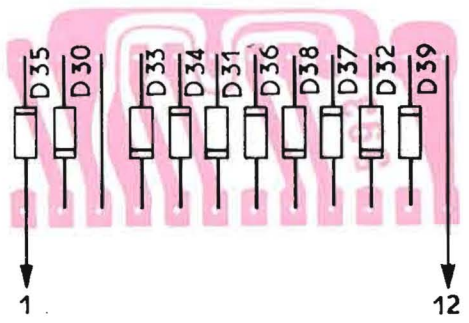
MAINS POWER SUPPLY



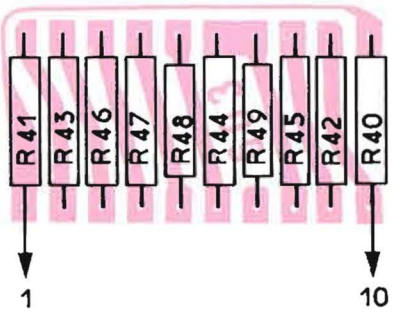
DRAWING 51.209/A

MAIN CIRCUIT LAY-OUT

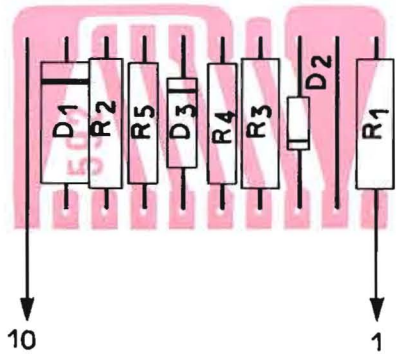




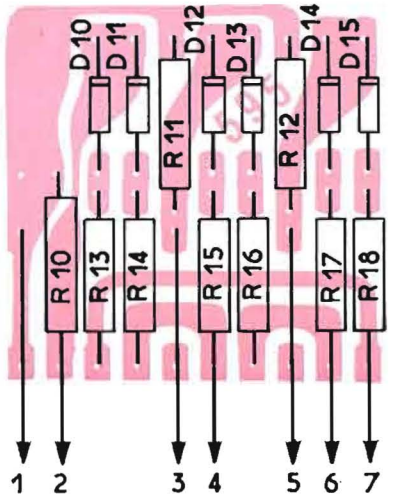
DECODER MODULE



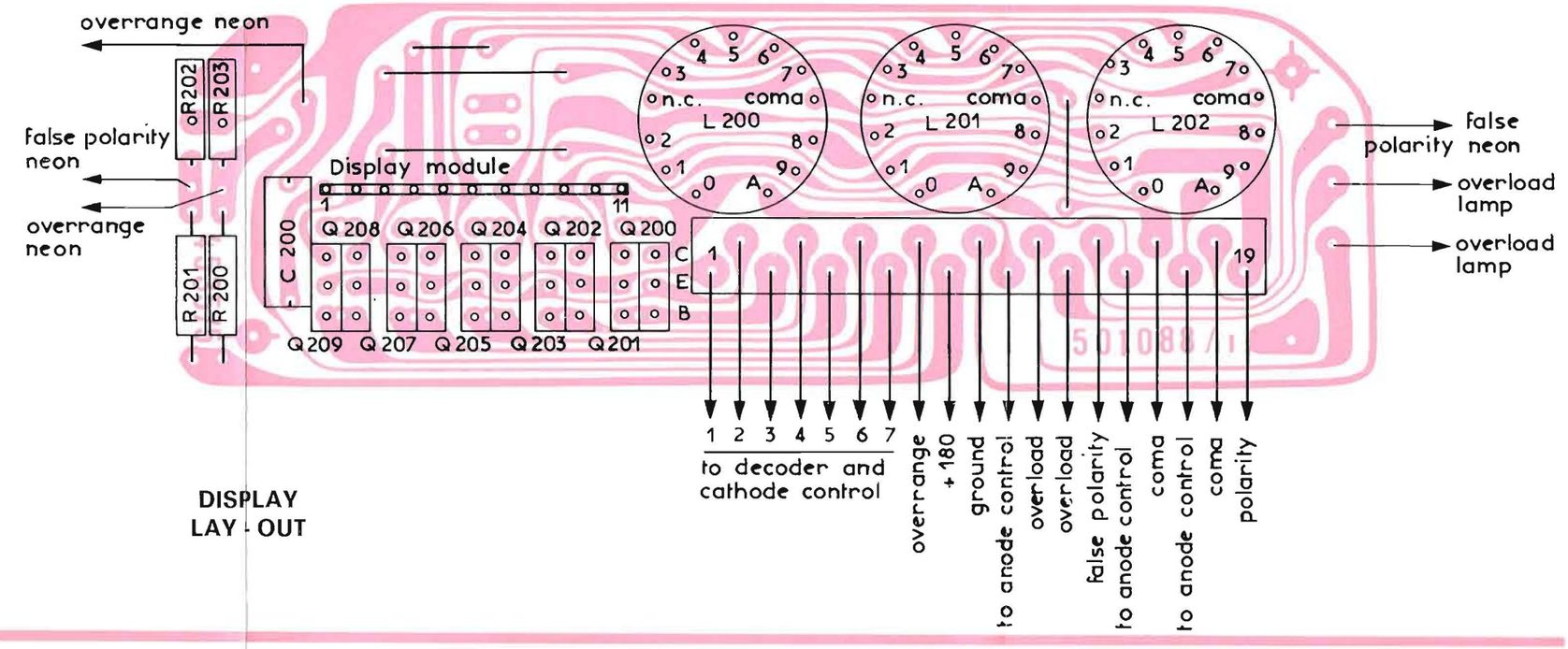
OVERLOAD MODULE



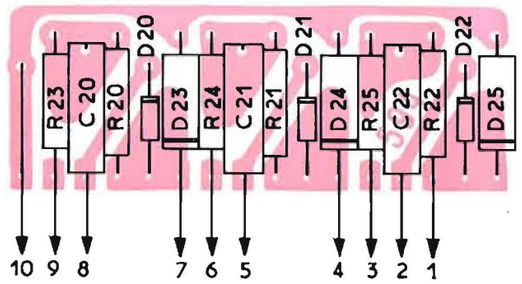
MAINS POWER SUPPLY MODULE



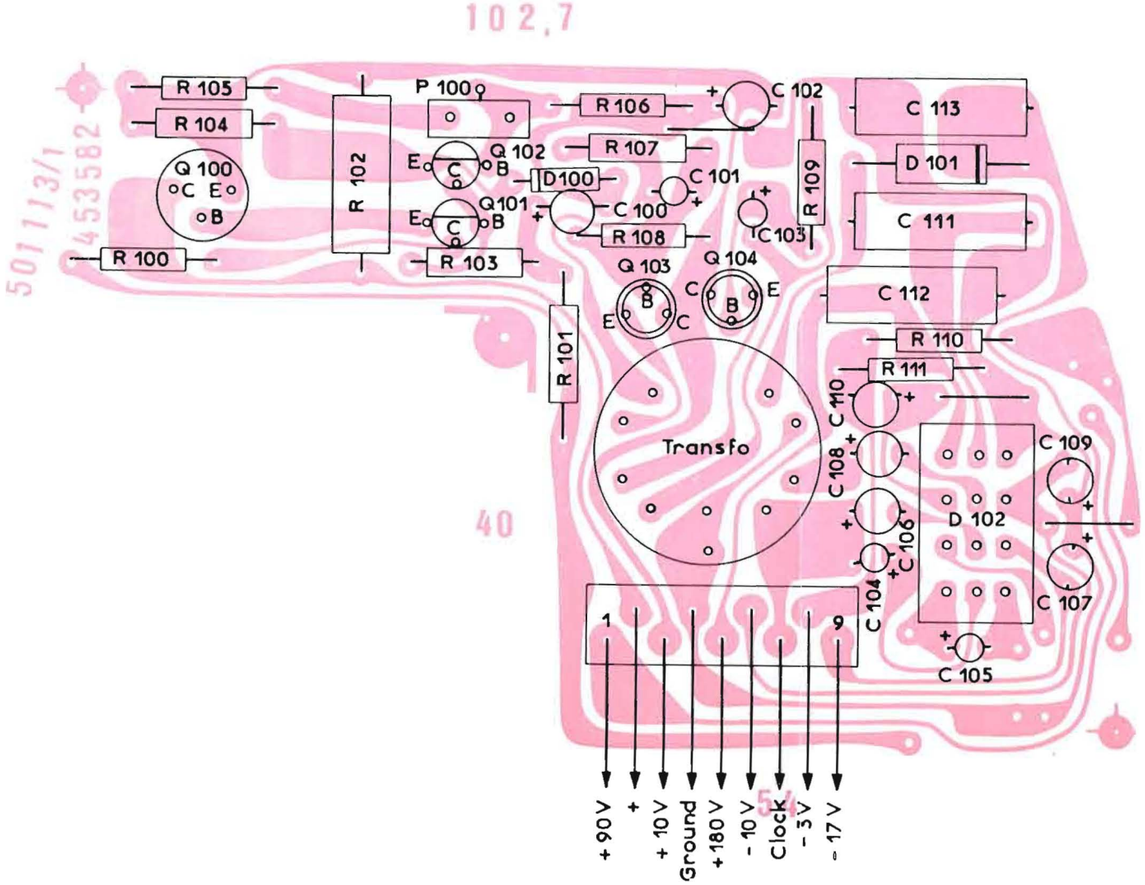
ANODE CONTROLE NEZ MODULE



DISPLAY
LAY - OUT

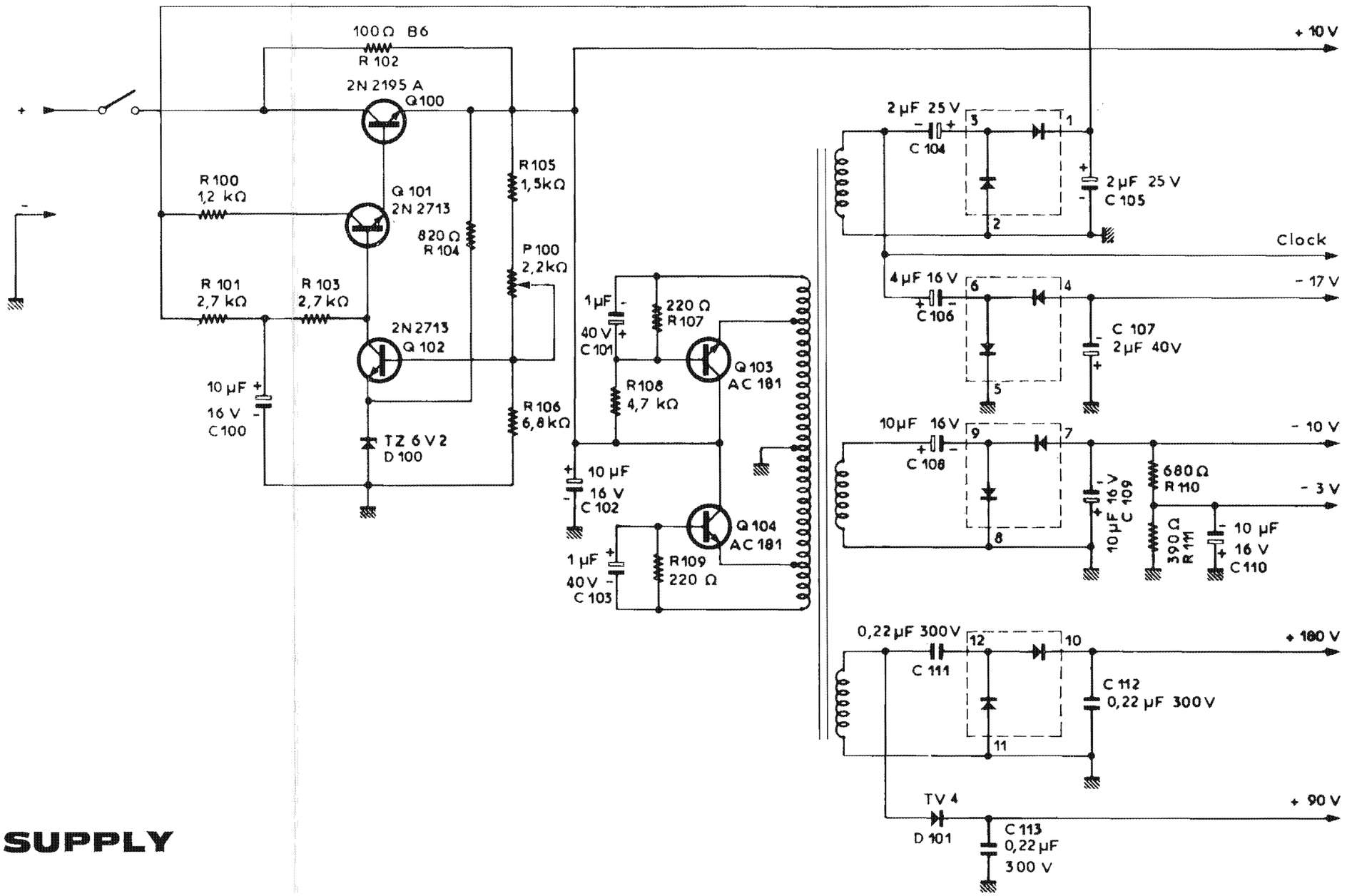


ANODE
CONTROLE N° 1 MODULE


102,7
5011131/1
453582
R 105
R 104
Q 100
C E
B
R 100
R 102
P 100
Q 102
E C B
D100
Q101
E C B
R 103
R 106
R 107
C 100
R 108
C 102
C 101
C 103
R 109
C 113
D 101
C 111
C 112
R 110
R 111
Q 103
B E C
Q 104
C B E
R 101
Transfo
C 110
C 108
C 106
C 104
C 109
D 102
C 107
C 105
1
9
+ 90 V
+
+ 10 V
Ground
+ 180 V
- 10 V
Clock
- 5 V
- 17 V
40
54

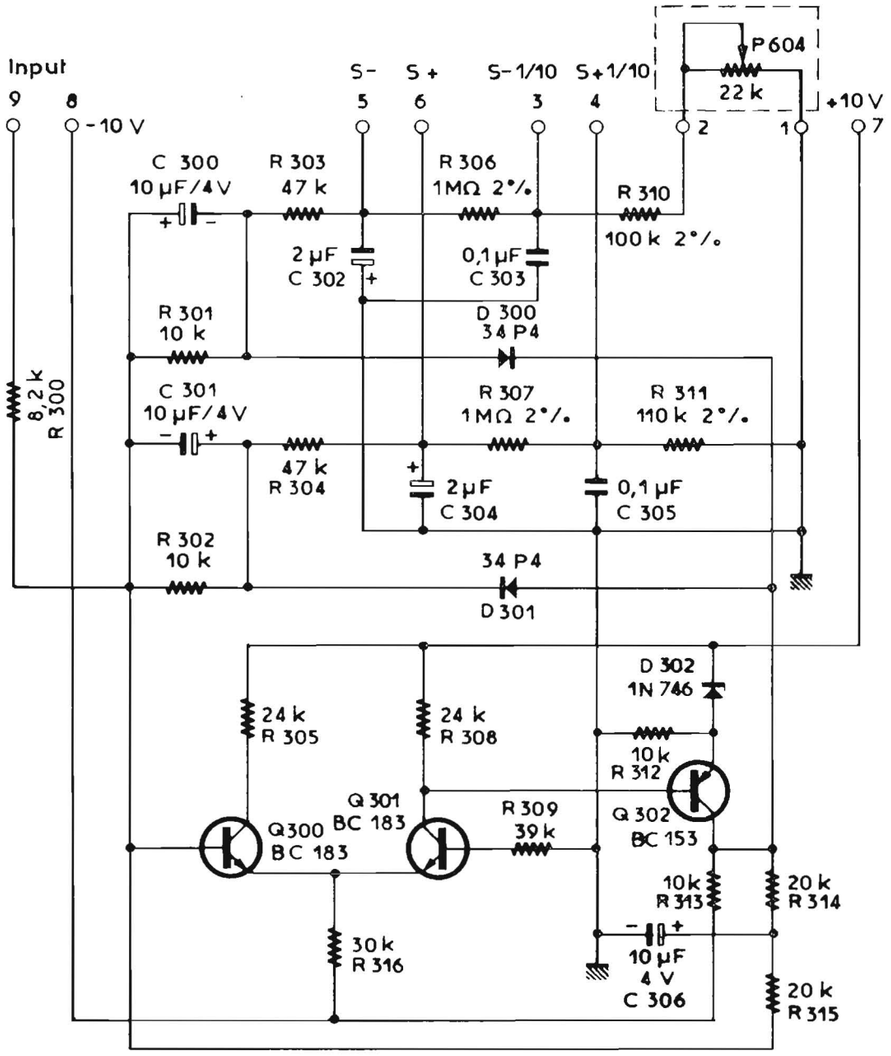
POWE

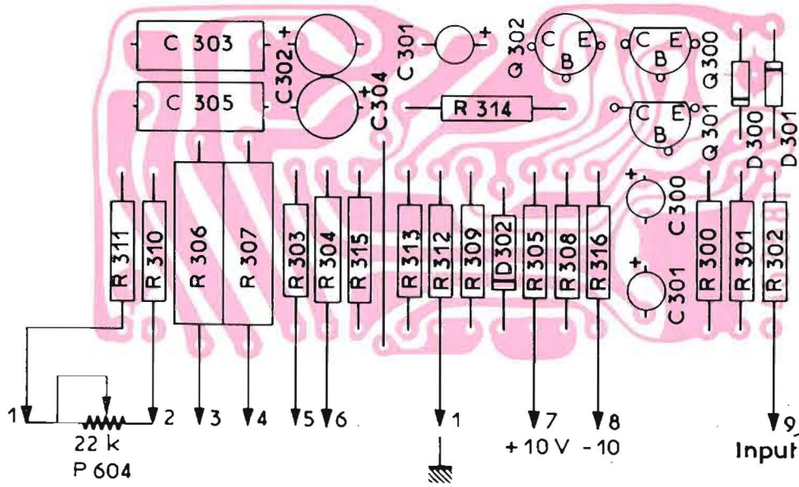
SUPPLY



DRAWING 51.209

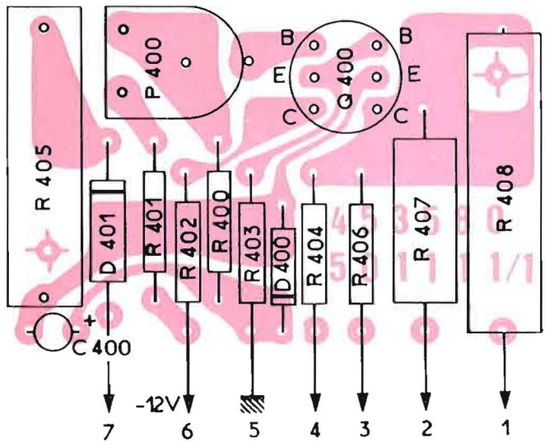
LINEAR RECTIFIER

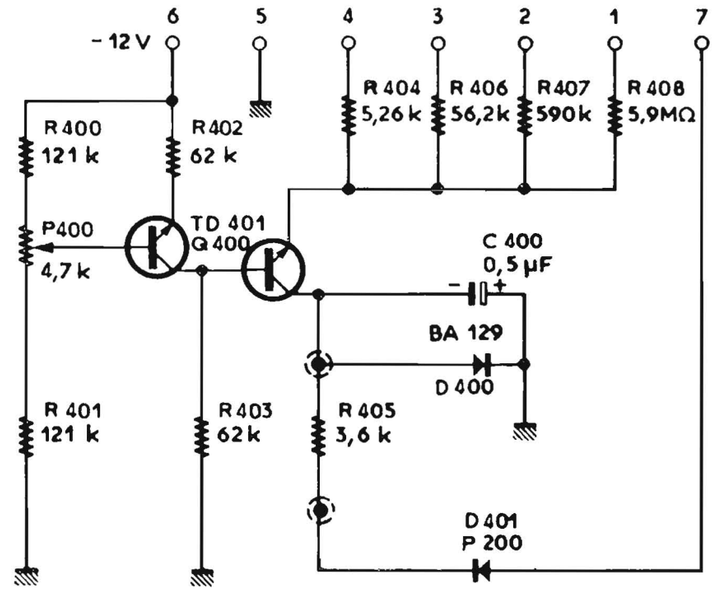




DRAWING 51.149

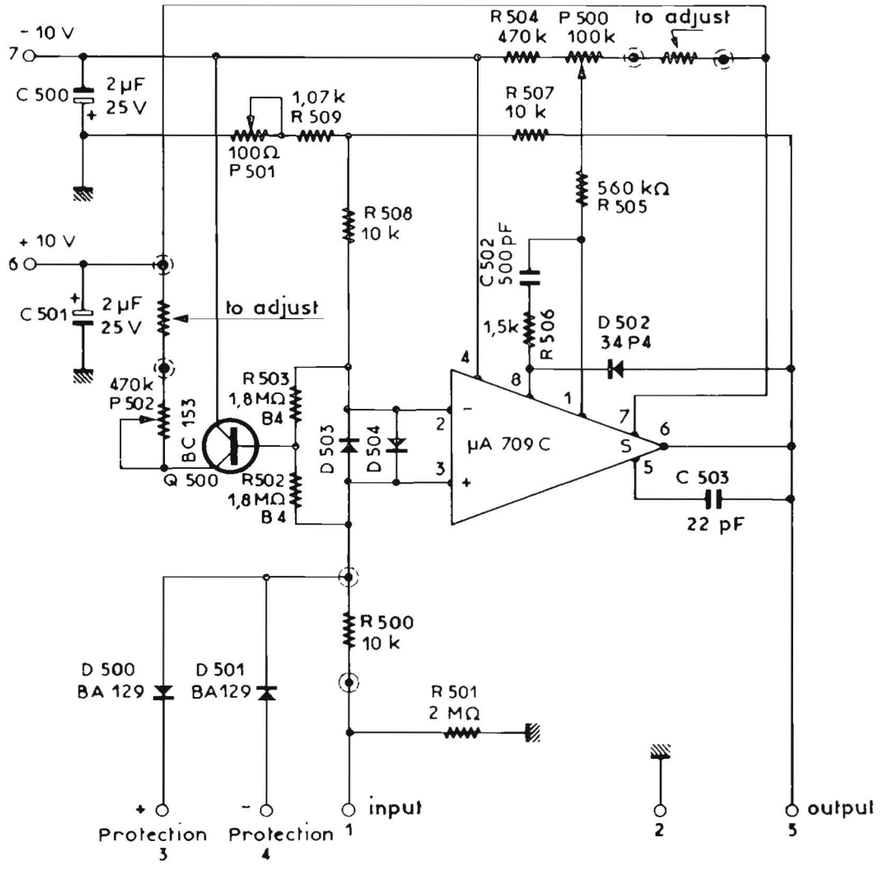
CONSTANT CURRENT GENERATOR

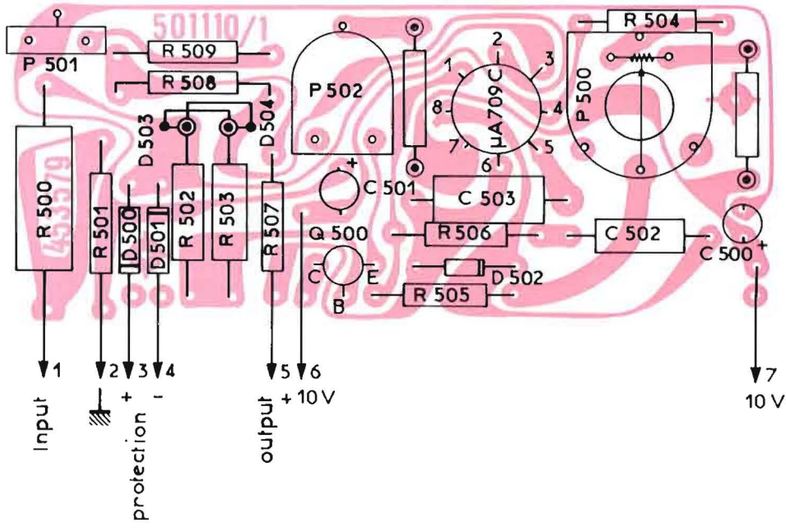




DRAWING 51.148

AMPLIFIER

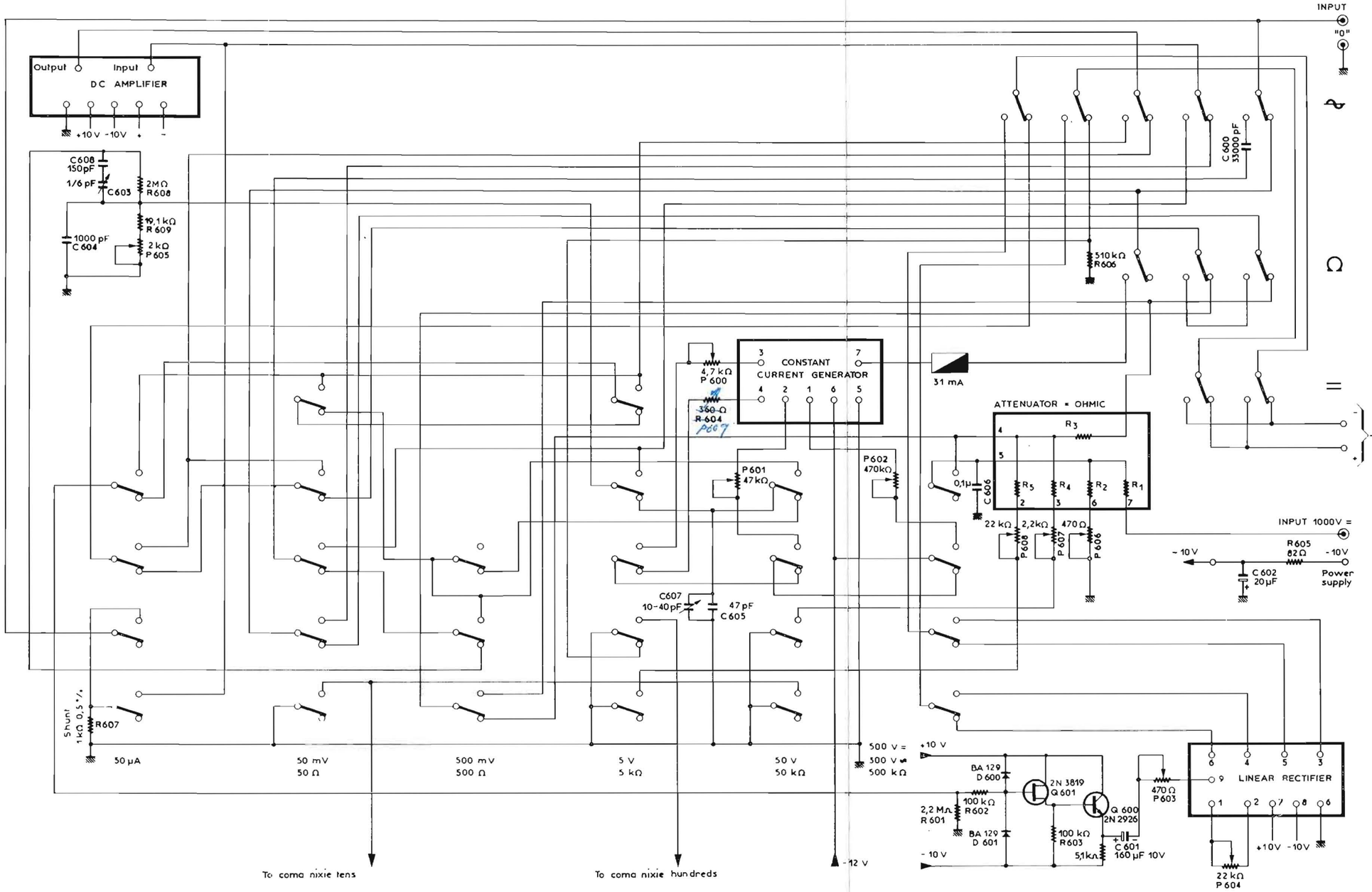




DRAWING 51.147

ADAPTOR

ATTENUATOR

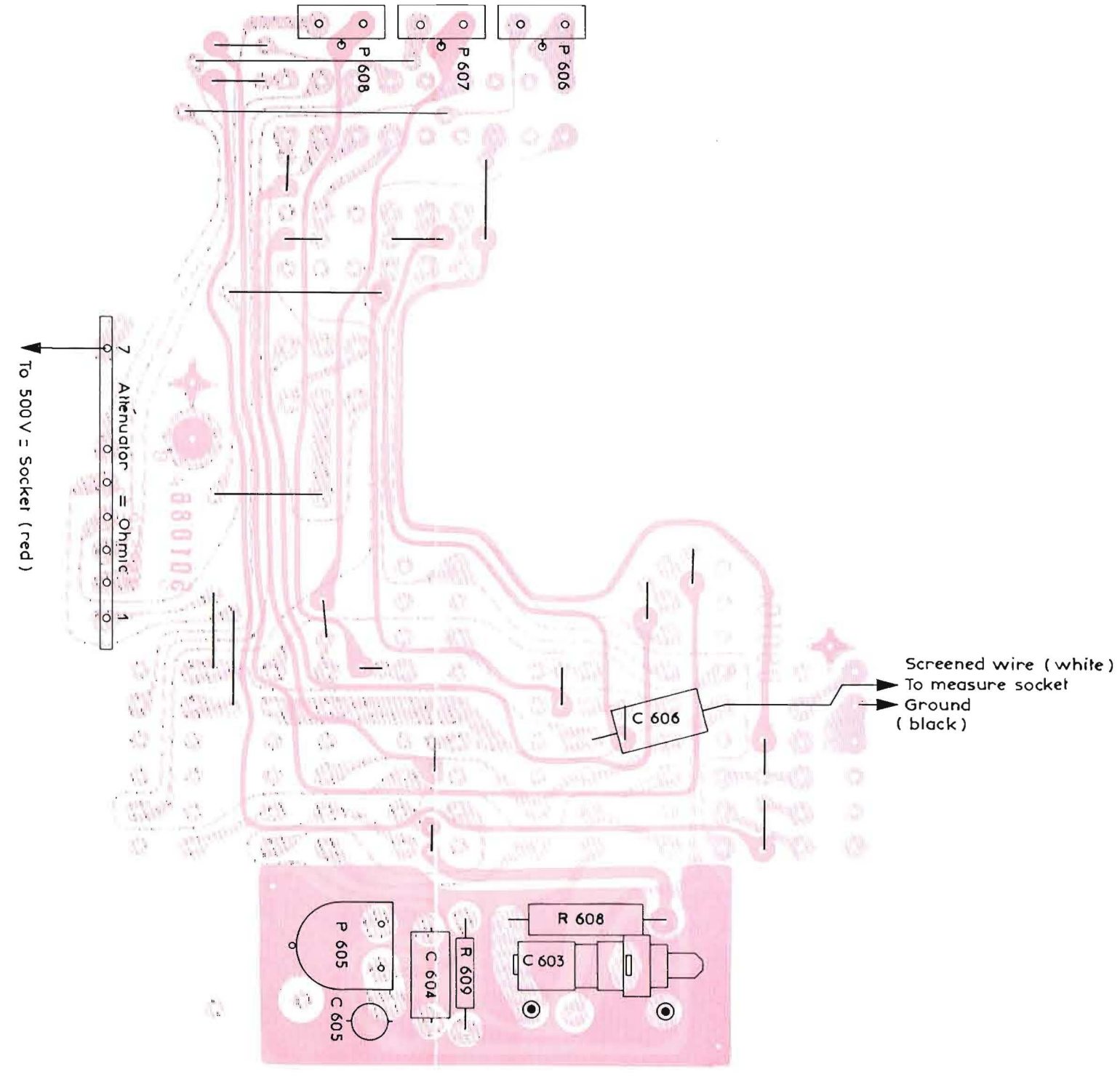


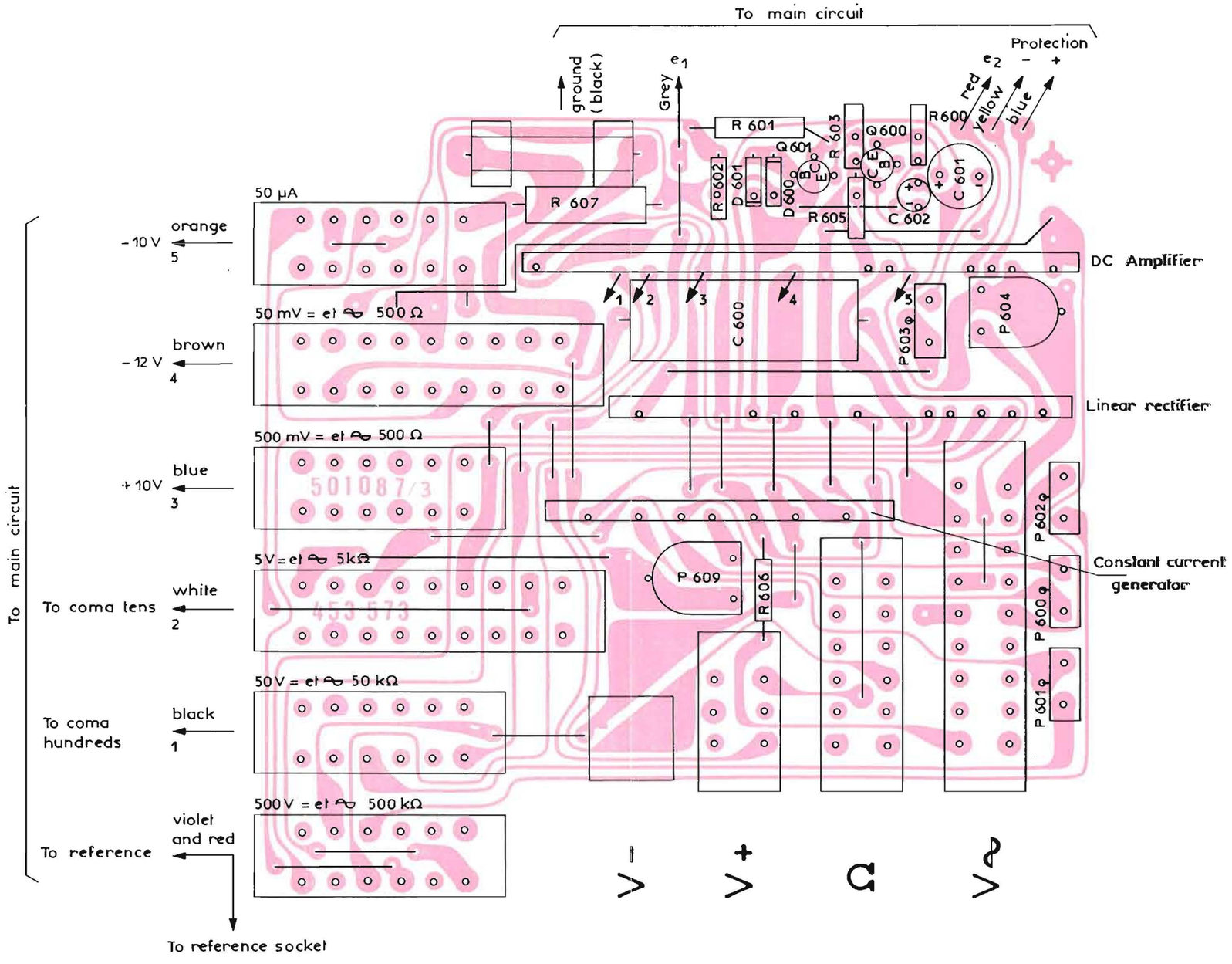
DRAWING 51.348

ADAPTOR

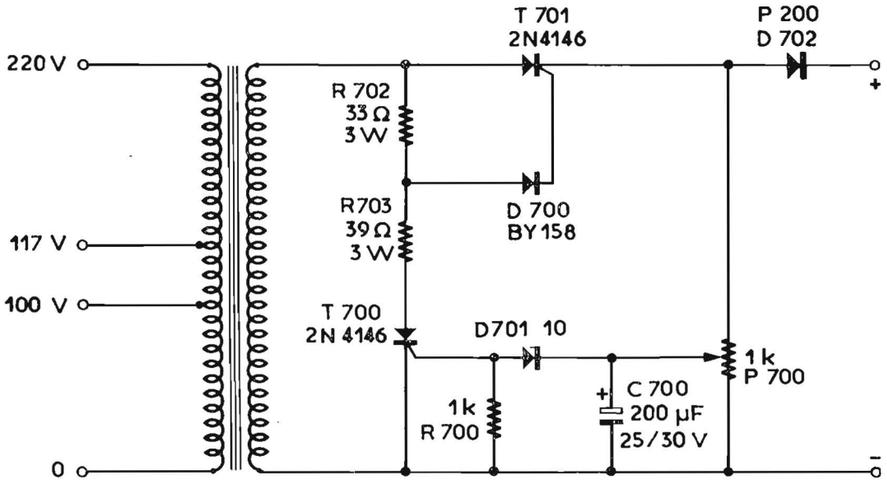
ATTENUATOR

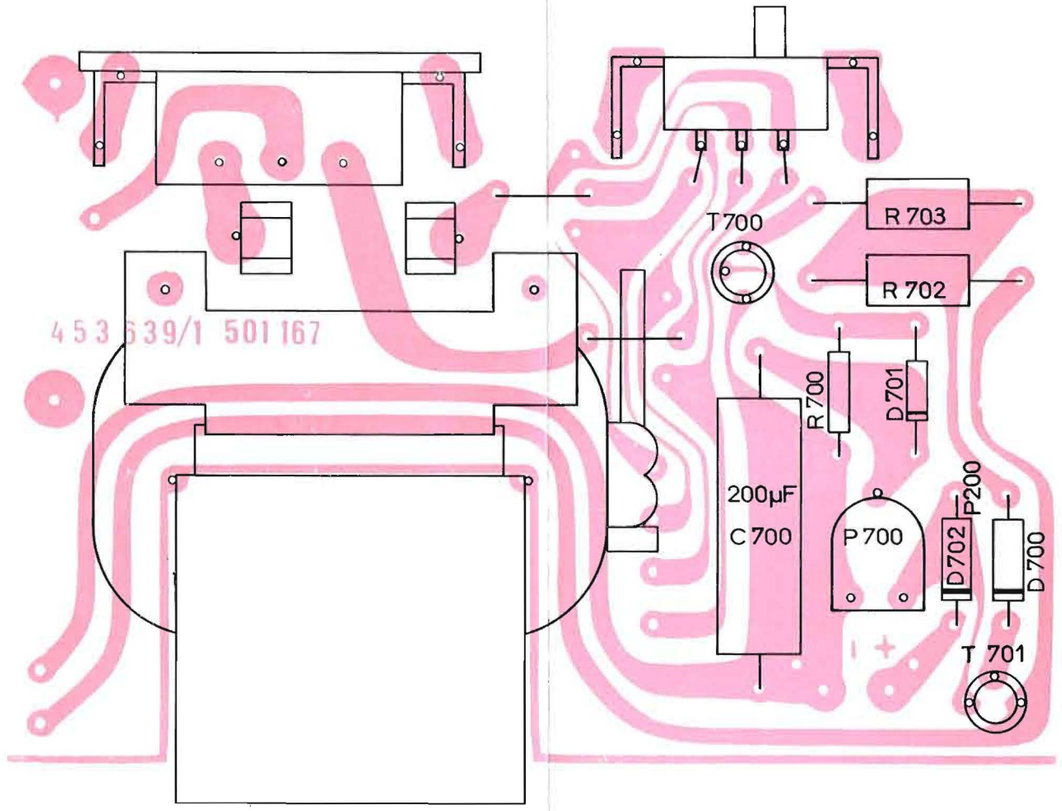
LAY-OUT




To main circuit
Protection
ground (black)
Grey
e1
e2 – +
red
yellow
blue
R 601
R 607
R 603
R 602
D 601
D 600
Q 601
Q 600
R 600
R 605
C 602
C 601
50 µA
orange
– 10 V
5
DC Amplifier
50 mV = et ≂ 500 Ω
brown
– 12 V
4
C 600
P 603
P 604
Linear rectifier
500 mV = et ≂ 500 Ω
blue
+ 10V
3
P 602
Constant current generator
5V = et ≂ 5kΩ
To coma tens
white
2
P 609
R 606
P 600
50 V = et ≂ 50 kΩ
To coma hundreds
black
1
P 601
500 V = et ≂ 500 kΩ
violet and red
To reference
V⎓
V+
Ω
V≂
To main circuit
To reference socket

BATTERIES POWER SUPPLY





DRAWING 51.273