

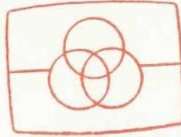
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digitest 500

TECHNICAL MANUAL

Sorry, no schematic.

Instrument Power Supplies

Power Supplies	Types			Current drain
	"S" without autonomous power pack	"S/P" with dry cells power pack	"S/B" with batteries power pack	
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	

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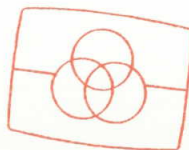
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I FUNCTIONAL DESIGNATION OF THE INSTRUMENT

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 μ V to 999 V
 - a.c. voltages 100 μ V to 420 V
 - d.c. currents 100 nA
 - a.c. currents 100 nA
- } up to 1A by means of shunts supplied
} on request.
- resistances 0.1 Ω to 999 k Ω

This instrument offers, for a small size, a great reliability and numerous possibilities which intend it as well for the equipment of control and adjustment 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 \pm 10 %;
 - supply by external d.c. voltage (12 V)*;
- With dry cells power pack ("S/P" type)
 - mains power supply 127-220 V \pm 10 %;
 - supply by external d.c. voltage (12 V)*;
 - supply by dry cells placed in the lower part of the instrument (12 \times 1.5 V).
- With batteries power pack ("S/B" type)
 - mains power supply 127-220 V \pm 10 %;
 - supply by Ni-Cad batteries incorporated with charger in the lower part of the instrument (10 \times 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 \pm 1 V.

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

- High voltage probe : 30 kV, accuracy $\pm 5 \%$,
- 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 (\pm) 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 (\pm) bulb, into account, which then remains lighted.
- polarity switching : by the function switch.
- temperature coefficient of the instrument : $\leq 4 \times 10^{-4}/^{\circ}\text{C}$.
- temperature coefficient of the internal reference source : $\leq 1.5 \times 10^{-4}/^{\circ}\text{C}$.
- overrange indication : indicated by lighting up of the bulb (\uparrow).
- overload indication : indicated by lighting up of the bulb Φ
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 uncertainty 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		Observations
									Overload Ω	Overrange† (4)	
d.c. Volts	1	50 mV	100 μ V	99.9 mV			2 M Ω	100 V	0.1 V < V < 40 V	99.9 mV	absolute error \pm 2 U at 500 pts \pm 4 U at 1000 pts (2)
	2	0.5 V	1 mV	999 mV	\pm 0.2% of the reading	\pm 0.4% of the reading	50 M Ω	500 V	200 V < V < 400 V	999 mV	
	3	5 V	10 mV	9.99 V	\pm 0.2% of the range		5 M Ω	1000 V		9.99 V	
	4	50 V	100 mV	99.9 V			5.5 M Ω	1000 V		99.9 V	
	5	500 V	1 V	999 V			10 M Ω	1000 V		999 V	
d.c. Amps (5)	6	50 μ A	100 nA	99.9 μ A	\pm 1% of the range	\pm 1% of the reading	Shunt R 1 k Ω	2.5 mA		99.9 μ A	voltage drop at 50 μ A: 50 mV
a.c. Volts	7	50 mV	100 μ V	99.9 mV			2 M Ω < 100 pF	100 Vac	40 Vac	99.9 mV	Pass band: 40 Hz - 10 kHz d.c. component \pm 500 V
	8	0.5 V	1 mV	999 mV	\pm 0.5% of the reading	\pm 1% of the reading	2 M Ω < 100 pF	100 Vac		999 mV	
	9	5 V	10 mV	9.99 V	\pm 0.5% of the range		2 M Ω < 100 pF	420 Vac		9.99 V	
	10	50 V	100 mV	99.9 V			2 M Ω < 100 pF	420 Vac		99.9 V	
	11	400 V	1 V	420 V			2 M Ω < 100 pF	420 Vac		99.9 V	
a.c. Amps (5)	12	50 μ A	100 nA	99.9 μ A	\pm 1.5% of the range	\pm 1.5% of the reading	Shunt R 1 k Ω	2.5 mA		99.9 μ A	
Ohms	13	50 Ω	100 m Ω	99.9 Ω	\pm 0.5% of the reading	\pm 1% of the reading	I: 1 mA	— 400 V	< — 40 Vdc	99.9 Ω	
	14	500 Ω	1 Ω	999 Ω			1 mA	to		999 Ω	
	15	5 k Ω	10 Ω	99.9 k Ω	\pm 0.5% of the range		100 μ A	+50 V d.c.		9.99 k Ω	
	16	50 k Ω	100 Ω	9.99 k Ω			10 μ A			99.9 k Ω	
	17	500 k Ω	1 k Ω	999 k Ω			1 μ A			999 k Ω	

(1) formula valid between 2% and 100% of the range (from 10 u to 500 u).

(2) re-injected 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 (V_x) 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 (V_x) a pulse appears at the output of the comparator T_1 .

— 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 V_x ; 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.

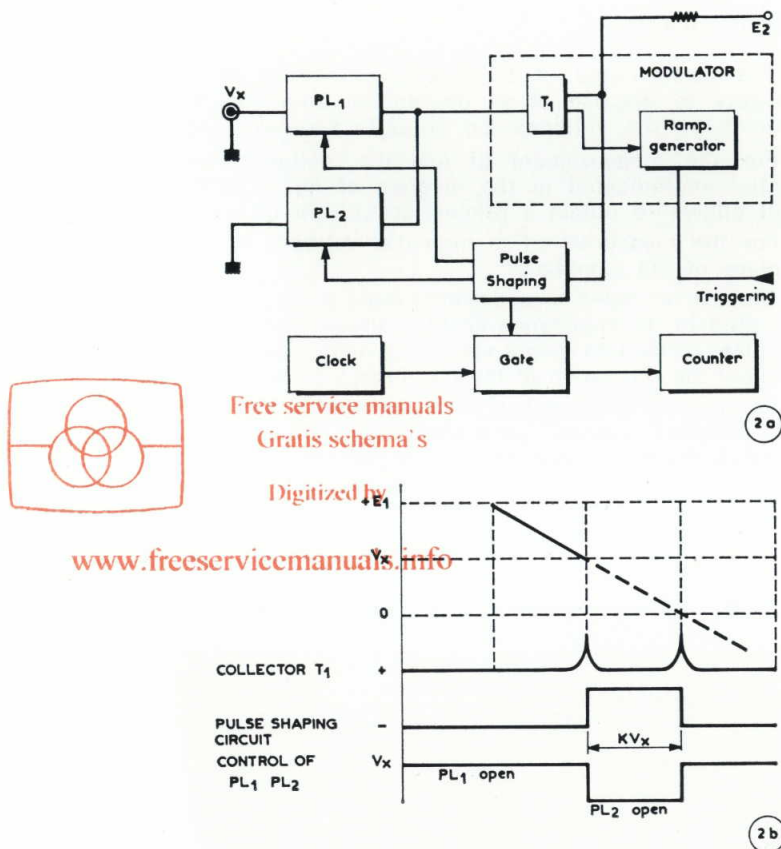


Figure 2 : Block diagram (a) and temporal diagram (b) of the converter.

- 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.

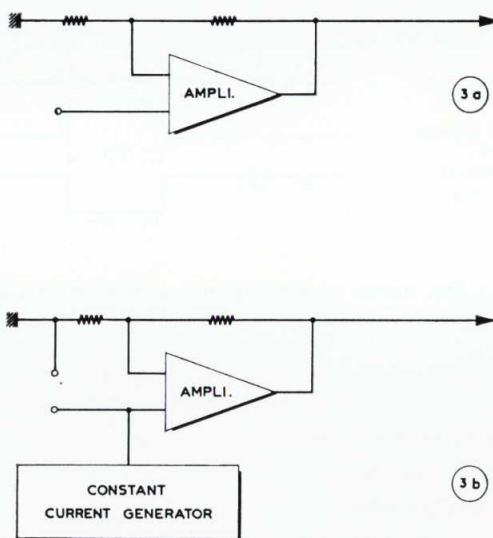


Figure 3 : Assembling principle of an operational amplifier (a) driven by a constant current generator (b).

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 :

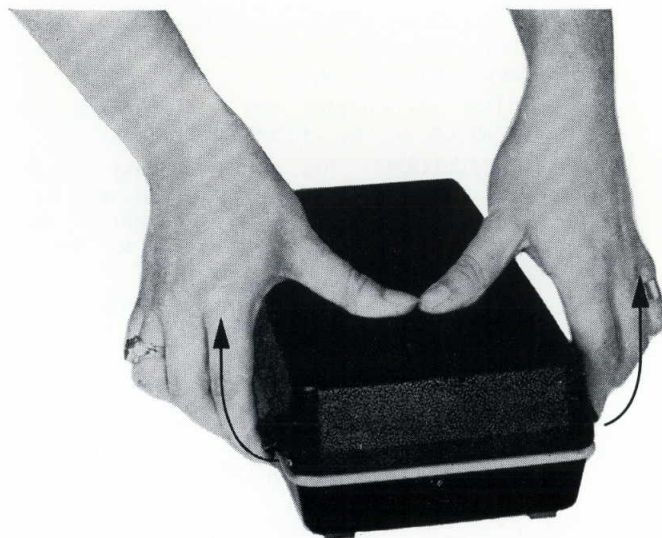


Figure 4

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 \uparrow)
- the overload (bulb marked Φ)

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 terminals "INPUT" and "O" by means of the measuring cords.

Two cases can then arise:

- a) The measurement result appears and the \pm bulb blinks or does not light up. The polarity chosen by SK1 switch is right.
- b) The instrument indicates 000 and the \pm 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_{\sim} 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_{\sim} (in a.c.) and SK2 switch on the 50 μ A 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 ($< 4 \times 10^{-4}/^{\circ}\text{C}$) or of the internal reference source ($< 1.5 \times 10^{-4}/^{\circ}\text{C}$).

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:

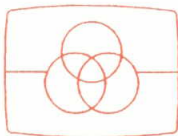
$\pm 2 \times 10^{-3}$ of the range $\pm 2 \times 10^{-3}$ of the reading, be in this case: $\pm 4 \times 10^{-3}$ of the reading.

In case of utilization of the instrument at $\pm 10^{\circ}\text{C}$ 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 ($< 1.5 \times 10^{-4}/^{\circ}\text{C}$), 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.



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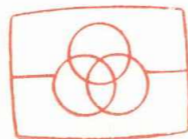
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