MA 1H

Analog Multimeter

Nr. 3.348.322.02

M 1-1.1

BBC GOERZ METRAWATT

5: servicing / schematics

Contents

1. Use

The MA 1H is a multimeter for voltage, current and resistance measurements and for the rough measurement of capacitance. It is suitable for universal use in electronics, radio and television technology and digital technology and can be used for many measuring tasks in the field of general electrical technology. The meter is used chiefly by the handyman and in the fields of servicing, training and further training.

2. Specification

The MA 1H has 36 measuring ranges for direct and alternating voltage, direct and alternating current and resistance. Capacitance values can be ascertained by rough measurements.
All the measuring ranges are selected by means of the central measuring range switch. They are clearly arranged in the range of rotation of the switch.

A mirror is placed behind the scale for accurate reading of the measured values. The pivots of the measuring element and the measuring range switch are located in line one above the other, so that it is also possible to provide long scales for the Ω and dB measurements.
The robust plastics case and the core-magnet moving-coil measuring element with its sprung jewel bearings protect the meter against damage when subjected to rough mechanical stress.
2 instrument leads with firmly attached test points and attaching plugs protected so as to prevent accidental contact (cable set KS 17) or 2 instrument leads fitted with conventional banana plugs (cable set KS 19) can be supplied optionally as accessories.
The connection sockets are protected against accidental contact. Both the special instrument leads with shock protection (KS 17) and all measuring leads with conventional banana plugs (4 mm diameter) can be plugged in.
The unit is constructed for easy maintenance. Subject to safety regulations, defective components can be readily exchanged by qualified engineers.

3. Technical characteristics

Measurement ranges

Voltage	Output[1])	Internal resistance approximately —	Internal resistance approximately ~
0.15 V—	—	3.15 kΩ	—
0.5 V—	—	10 kΩ	—
1.5 V—	—15 . . . + 6 dB	31.5 kΩ	6.5 kΩ
5 V≂	— 5 . . . +16 dB	100 kΩ	20 kΩ
15 V≂	+ 5 . . . +26 dB	315 kΩ	65 kΩ
50 V≂	+15 . . . +36 dB	1 MΩ	200 kΩ
150 V≂	+25 . . . +46 dB	3.15 MΩ	650 kΩ
500 V≂	+35 . . . +56 dB	10 MΩ	2 MΩ
1000 V—	—	20 MΩ	—

Voltage-related input resistance with —: 20 kΩ/V
with ~: 4 kΩ/V

Current	Voltage drop approximately —	Voltage drop approximately ~
50 µA—	0.158 V	—
0.5 mA≂	1.15 V	1.0 V
5 mA≂	1.25 V	1.25 V
50 mA≂	1.25 V	1.25 V
500 mA≂	1.3 V	1.3 V
5000 mA≂	1.3 V	1.3 V

Resistance	Measuring range	Value in centre of scale (R_i)	Maximum measuring current I_{max}[2]) approx.
Ω x 1	1 Ω . . . 1 kΩ	18 Ω	83 mA
Ω x 10	10 Ω . . . 10 kΩ	180 Ω	8.3 mA
Ω x 100	100 Ω . . . 100 kΩ	1.8 kΩ	0.83 mA
Ω x 1000	1 kΩ . . . 1 MΩ	18 kΩ	0.083 mA

[1]) 0 dB ≙ 0.775 V in the range 1.5 V~; 0 dB ≙ 1 mW at 600 Ω
[2]) At battery voltage 1.5 V

Capacitance[3])	Measuring range
µF x 1000	2 000 . . . 200 000 µF
µF x 100	200 . . . 20 000 µF
µF x 10	20 . . . 2 000 µF
µF x 1	2 . . . 200 µF

Curve shape and its evaluation

Curve shape with ~: sine

The meter has half-wave rectification and is calibrated in effective values. It evaluates the arithmetical mean value of a half-wave and indicates differing values in the case of undulatory voltage or current depending on the terminal polarity.

Overload capacity

Range	Permanently loadable up to
0.15 V—	20 V≂
0.5 V	50 V≂
1.5 V	100 V≂
5 V—	150 V≂
15 V—	250 V≂
50 V—	250 V≂
150 V—	300 V≂
500 V—	600 V≂
1000 V—	1000 V—
50 µA—	5 mA≂
0.5 mA—	10 mA≂
5 mA—	30 mA≂
50 mA—	100 mA≂
500 mA—	800 mA≂
5000 mA—	3 A≂; 5 A≂ max. 2 min.

Range	Permanently loadable up to
—	—
—	—
—	—
1,5 V~	25 V≂
5 V~	50 V≂
50 V~	150 V≂
50 V~	250 V≂
150 V~	300 V≂
500 V~	600 V≂
—	—
—	—
0.5 mA~	10 mA≂
5 mA~	30 mA≂
50 mA~	100 mA≂
500 mA~	800 mA≂
5000 mA~	3 A≂; 5 A≂ max. 2 min.

Battery

for resistance measurement 1 miniature cell 1.5 V to IEC R 6[4]), leakproof

[3]) Rough measurement in the resistance measurement ranges; ascertaining the measured values by comparison scale (see Paragraph 4.7).
[4]) Obtainable at specialised dealers.

Case

Insulation group	A to VDE 0110	
Type of protection	Case IP 50, connections IP 20 to DIN 40 050	
Test voltage	3 kV to VDE 0410 or DIN 57 410	
Length of scales	A, V—	0 . . . 5 : approx. 83 mm
	A, V—	0 . . . 15.8: approx. 77 mm
	A, V~	0 . . . 5 : approx. 67 mm
	A, V~	0 . . . 15.8: approx. 59 mm
	Ω	∞ . . . 0 : approx. 52 mm
	dB	—15 . . . +6 : approx. 42 mm
Dimensions	92 x 126 x 45 mm	
Weight	Approximately 0.25 kg without battery	

4. Operation

4.1 Operating elements

Measuring range switch ⑥

The MA 1H has only one rotary switch ⑥ by which all the measuring ranges are selected.

The meter can be switched from the direct voltage ranges to the corresponding alternating voltage ranges, or from the direct current ranges to the corresponding alternating current ranges, without switching off the measured value. The measuring circuit is not interrupted upon switching over the current measuring ranges.

It must be ensured that the measuring range switch ⑥ is **first set to the highest measuring range** when measuring voltage and current. The switch then has to be switched to lower ranges until the optimum deflection is obtained.

Connection sockets ① . . . ④

The meter has 4 connection sockets with shockproof protection. Their functions are as follows:

Socket "⊥" ① = common connection for all measuring ranges (earth meter)

Socket "Ω" ② = connection for measuring resistance and capacitance (negative potential)

Socket "+1000 V ⎓" ③ = connection for measuring range 1000 V

Socket "+ V, A ⎓~" ④ = connection for all voltage and current measuring ranges (with the exception of range 1000 V-)

All measuring cables with shockproof protection (KS 17) available as accessories, and all measuring cables with banana plugs (diameter 4 mm) can be plugged into the sockets.

Potentiometer rotary knob ⑦

The rotary knob ⑦ is for setting the full deflection 0 Ω when measuring resistance in accordance with Section 4.6 and when measuring capacitance in accordance with Section 4.7.

4.2 Putting into operation

Inserting battery

The bottom portion ⑪ of the housing has to be removed from the unit for the purpose of inserting or changing the battery.

Caution: The measuring leads must be disconnected from the measuring circuit before opening the unit!

— Press lug ⑤ on the rear of the unit in the direction of the arrow with a test probe, banana plug or a similar object, and remove bottom part ⑪

— Insert 1.5 V miniature cell ⑨ into the battery compartment in accordance with the symbol given and the polarity signs.

Note: Use only a leakproof 1.5 V miniature cell to IEC R 6!

— Place unit ⑩ into the bottom part ⑪ of the housing and gently press the two parts together until they engage.

Mechanical zero-point check

— Place the MA 1H in a horizontal position at the edge of a table. The bottom third of the unit should project beyond the edge of the table.

— Check mechanical zero setting of the needle.

— If necessary, use a screwdriver to correct the position of the needle by turning the setscrew ⑧ on the rear of the unit.

Battery check

— Put measuring range switch ⑥ into position "Ω x 1"
— Short circuit connection sockets "⊥" ① and "Ω" ② with measuring cable
— Adjust needle to full deflection 0 Ω by potentiometer rotary knob ⑦.

The miniature battery is exhausted if full deflection is no longer obtainable, or the reading does not remain constant after adjustment. The battery then has to be exchanged for a new battery in the manner described above.

4.3 Safety precautions

The MA 1H is constructed in accordance with the safety regulations specified by DIN 57 410 (VDE 0410, IEC 414). It ensures the safety of the unit and the operator when used in accordance with the regulations. However, their safety is not guaranteed if the unit is used improperly or is handled carelessly.

The following general safety precautions must be observed:

— The unit must only be used by persons who are able to recognise the risk of electric shocks and to take safety precautions.
— The risk of electric shock exists whenever voltages can occur which are greater than 50 V relative to earth.
— The operator must not use the unit alone when making measurements involving the risk of electric shock. A second person must be informed.
— It must be borne in mind that unforeseen voltages can occur on units to be tested (such as defective units). Capacitors can, for example, be charged to a dangerous level!
— The measuring leads must not be damaged by, for example, cracks or fractures.
— No measurements must be made with the MA 1H in circuits with corona discharge (high voltage!).
— Special care must be taken when taking measurements in HF circuits in which dangerous undulatory voltages can exist.

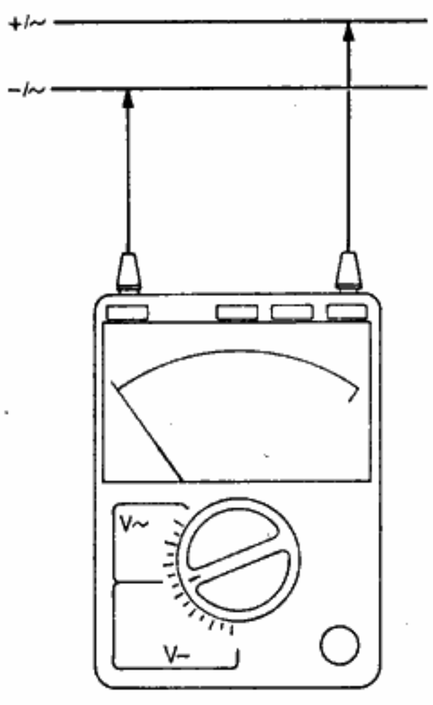
— Measurements must not be taken in wet environmental conditions. Hands, shoes, floor and work-place must be dry.
— It is essential to ensure that the measuring ranges are not overloaded to an inadmissible extent; see Table "Overload Capacity" in Section 3. The unit would be **immediately destroyed** if a current measuring range, a low voltage measuring range, or a resistance measuring range were, for example, to be connected to the 220 V mains. The **operator** would then be in **great danger!**

4.4 Voltage measurement

Caution: Irrespective of the value of the measuring voltage, the total of the measuring voltage and the voltage relative to earth must not exceed 1000 V for safety reasons when the MA 1H is directly connected.

With all voltage measurements, the left-hand connection socket ① marked "⊥" should, as far as possible, be connected direct to earth or to that point having the lowest potential relative to earth.

4.4.1 Direct voltages and alternating voltages up to 500 V

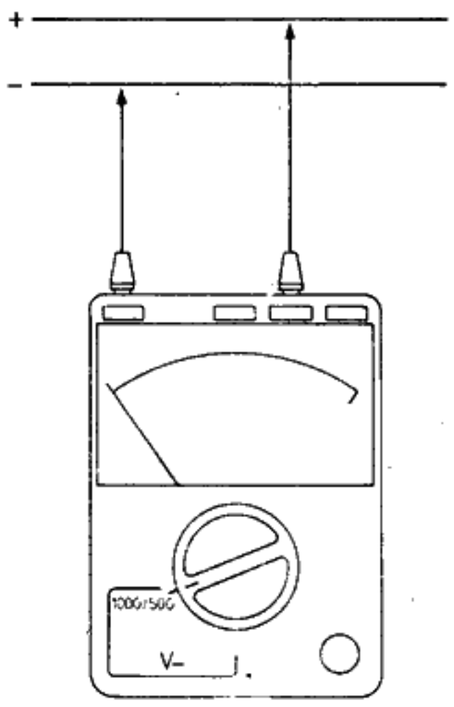


— Put measuring range switch ⑥ into the position 500 V⎓ or 500 V~
— Plug measuring leads into the unit; "black" measuring lead into socket ① "⊥" and (red) measuring lead into the socket ④ "+V, A ⎓".
— For safety, the test leads with anti-shock protected attaching plugs (KS 17) should be used
— Apply measuring voltage to the measuring leads. In the case of direct voltage, the socket ① "⊥" must be connected to the negative pole of the measuring voltage, and the socket ④ "+V, A ⎓" must be connected to the positive pole of the measuring voltage.

— When the measuring voltage is lower than 150 V, set the measuring range switch ⑥ to lower direct voltage ranges in the case of direct voltage, and to lower alternating voltage ranges in the case of alternating voltage, until the optimum deflection is attained.

— Read measurement value:
on the two upper scales 0 . . . 5 or 0 . . . 15 V, A ⎓ in the case of direct voltage,
on the scales 0 . . . 5 or 0 . . . 15 V, A~ below in the case of alternating voltage.

4.4.2 Direct voltages up to 1000 V



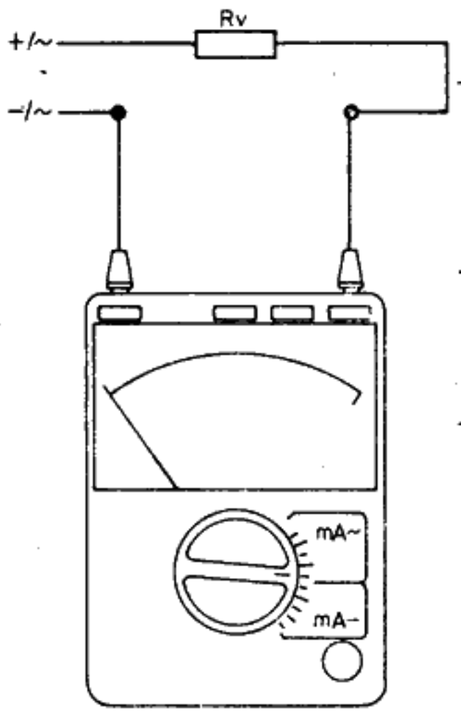
— Put measuring range switch ⑥ into the position 1000/500 V—

— Plug measuring leads into the unit; (black) measuring lead into the socket ① "⊥" and (red) measuring lead into the socket ③ "+1000 V ⎓".
For safety, the test leads with anti-shock protected attaching plugs (KS 17) should be used.

— Apply measuring voltage to the measuring leads. The socket ① "⊥" must be connected to the negative pole of the measuring voltage, and the socket ③ "+1000 V ⎓" must be connected to the positive pole of the measuring voltage.

— Read measured value on the upper scale 0 . . . 1000 V ⎓.

4.5 Measurement of direct and alternating currents up to 5 A



— Put measuring range switch ⑥ into the position 5000 mA— or 5000 mA~.

— Plug measuring leads into the unit; (black) measuring lead into the socket ① "⊥" and (red) measuring lead into the socket ④ "+V, A ⎓~"

— Switch off power supply to measuring circuit or load (R_v) and discharge all existing capacitors

— Open measuring circuit and securely connect measuring leads (without) transfer resistance!) in series with the load R_v. Note polarity sign when measuring direct current! Negative to socket ① "⊥" and positive to socket ④ "+V, A ⎓~"

Caution: The MA 1H must always be connected into the lead whose voltage is the lowest relative to earth. For safety reasons, the voltage relative to earth must not exceed 1000 V! The MA 1H must never be connected **in the current measuring ranges to a voltage source** which can supply a current higher than the maximum admissible current (see Section 3, Overload Capacity).
The unit would be **immediately destroyed** if a current measuring range were connected direct to, for example, a productive source of current with low voltage, or direct to the 220 V mains. **The operator would then be in great danger!**

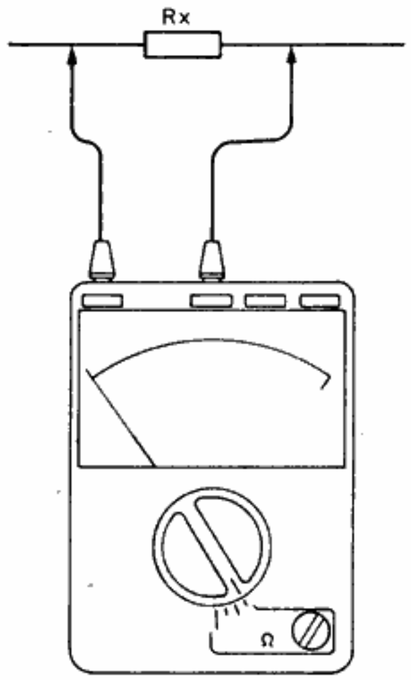
— Connect power supply to measuring circuit again

— If the measuring current is less than 500 mA, set the measuring range switch ⑥ to lower direct current ranges in the case of direct current, and to lower alternating

current ranges in the case of alternating current, until the optimum deflection is obtained.
The measuring circuit is not interrupted during switch-over!

— Read measured value:
On the upper scale 0 . . . 5 V, A ⎓ in the case of direct current, on the third scale from the top, 0 . . . 5 V, A~, in the case of alternating current.

4.6 Resistance measurement



Resistance is measured with direct voltage from the 1.5 V miniature cell used. The measuring range table in Section 3 shows the maximum measuring currents with full deflection and with a battery voltage of 1.5 V.
The polarity on the sockets is as follows:
Positive pole on the socket ① "⊥"
Negative pole on the socket ② "Ω"

— Set measuring range switch ⑥ to one of the measuring ranges Ω x 1 . . . Ω x 1000 according to the measured value to be anticipated.

— Plug measuring leads into the sockets ① "⊥" and ② "Ω"

— Short circuit measuring leads.

— Set measuring element needle to full deflection 0 Ω with potentiometer rotary knob ⑦.
The battery must be changed in accordance with Section 4.2 if the full deflection can no longer be obtained by adjustment or if the reading does not remain constant after adjustment.

— Connect the resistance R_x to be measured to the measuring leads.

Note: Only voltage-free objects must be measured.
External voltages would falsify the measurement result. They can also damage or destroy the unit and endanger the operator!

— Read the value indicated on the Ω scale and multiply by the factor corresponding to the measuring range set.

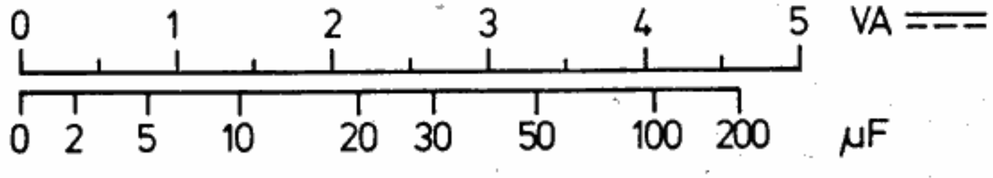
The measuring range should, as far as possible, be chosen such that a reading is obtained in the range 5 . . . 50. Measurement error, relative to the actual resistance value, is at a minimum in the centre of the range of deflection.

The full deflection 0 Ω must be occasionally checked during resistance measurements lasting over a long period of time and, as far as possible, should always be checked when switching from one resistance measuring range to another and, when necessary, it must be readjusted.

Note: Contact resistances on the battery connections can cause inaccurate setting of the full deflection 0 Ω, particularly in the low-resistance measuring ranges. Thus, satisfactory contact must be ensured by, for example, removing and replacing the battery (see Section 4.2).

4.7 Rough measurement of capacitance

Capacitance values can be ascertained in the resistance measuring ranges by rough measurements. The procedure is exactly the same as that described in the case of resistance measurement in Section 4.6. The capacitor to be measured, and which must be previously discharged, is connected in place of the resistor R_x. On connection of the capacitor, the needle of the instrument is deflected to a maximum value and then returns to its starting position (mechanical zero point). The point at which the deflection of the needle is reversed is indicative of the capacitance value. It can be read from the scale 0 . . . 5 V, A ⎓. The measured value can be ascertained from the following comparison scale and the capacitance measurement factor which corresponds to the measuring range set:



Measuring range	Factor for capacitance measurement	Scale range
Ω x 1000	µF x 1	2 . . . 200 µF
Ω x 100	µF x 10	20 . . . 2 000 µF
Ω x 10	µF x 100	200 . . . 20 000 µF
Ω x 1	µF x 1000	2 000 . . . 200 000 µF

The capacitor must be discharged again before repeating the measurement!

Example:
Selected measuring range: Ω x 100
Reversal point of needle: 3.3 on the upper scale
0 . . . 5 V, A ⎓
Capacitance value ascertained from the comparison scale: 50 µF
Multiplied by the factor for capacitance measurement: 50 µF x 10 = 500 µF

4.8 Measurement of amplitude and attenuation

In communications engineering, amplification and attenuation is almost exclusively given in dB as the logarithm of the ratio of measured voltage to a defined reference voltage. Thus, in fourpole networks, it is a simple matter to ascertain the total amplification or total attenuation by addition or subtraction of the individual values. The reference voltage is 0.775 V (1 mW in 600 Ω); the attenuation at this voltage is 0 dB.

The procedure for the measurement of amplification and attenuation is exactly the same as that given in Section 4.4.1 for the measurement of alternating voltage; however, the measured values are read from the dB scale. The range —15 . . . +6 dB given on the scale corresponds to the alternating voltage measuring range 1.5 V. In the higher voltage measuring ranges 5 V~, 15 V~, 50 V~ . . . , 10 dB, 20 dB, 30 dB . . . have to be added to the value read; see voltage measuring ranges given in the Table in Section 3.

If a direct voltage is superimposed on the alternating voltage to be measured, it can be cut out by means of a suitable capacitor which is to be connected in series with the measuring input.

The operating voltage of the series capacitor must be at least equal to the peak value of the voltage applied. With an additional error of 1% from the measured value, its value can be calculated from the following formula:

$$C_v \approx \frac{1}{0{,}89 \cdot \frac{f}{Hz} \cdot \frac{R_i}{M\Omega}} \cdot \mu F$$

in which R_i is the internal resistance of the MA 1H in the selected measuring range.

Example: With a superimposed alternating voltage of 1 kHz, a series capacitor of
$C_v = 0{,}0056\ \mu F = 5{,}6\ nF$
results for the measuring range 50 V~.

Caution: The capacitor is charged to the value of the direct voltage component. The charge can assume **dangerous** values and maintain them for a long period of time. The capacitor must therefore be discharged after the measurement!

4.9 Testing of diodes and transistors

The resistance measuring range Ω x 1000 is suitable for making rough tests of the function of diodes and transistors. A shortcircuit or an interruption of a diode or of a diode path between the base, collector and emitter of a transistor can be detected in a simple manner by a resistance measurement (see Section 4.6). The polarity of a diode and the base terminal of a transistor can be ascertained by means of this test.

Note: Positive pole is connected to the socket ① "⊥"
Negative pole is connected to the socket ② "Ω"

The component to be tested is not destroyed during this measurement, since the voltage does not exceed 1.75 V and the test current does not exceed 100 µA.

5. Servicing

5.1 Battery

The state of the battery should be checked from time to time. A discharged or decomposing battery should not be left in the battery compartment. The battery should be checked and changed in the manner described in Section 4.2.

6. Repairs and adjustment

The MA 1H is constructed for easy servicing. Defective parts can be changed without great difficulty.

However, repairs must only be undertaken by qualified engineers. The safety regulations must be observed!

The circuit diagram of the unit and the equipped circuit board are illustrated on the last pages of these operating instructions. The drawings show the characteristic values of the electrical components, and their positions on the circuit board. The testing points for adjustment are also shown.

6.1 Adjustment values and method of adjustment

Adusting the 5 A shunt ($R_1 + R_2$)

— Put measuring range switch ⑥ into position 5000 mA— or 5000 mA~.

— Connect current path to the sockets ① "⊥" and ④ "+V, A⎓"

— Read voltage drop at the testing points a and b

— Adjust by means of soldering bridge on shunt R_2
Resistance value of the 5 A shunt ($R_1 + R_2$): 251 mΩ ± 2%

Adjustment of direct voltage

— Adjustment is made on the complete unit without the bottom part ⑪ of the housing

— Put measuring range switch ⑥ into position 0.15 V—

— Apply constant voltage of 158.1 mV— to the sockets ① "⊥" and ④ "+V, A⎓"

— Adjust to full deflection 158.1 MV ± 0.5% (scale value 5 on the upper scale) with potentiometer R 33 (1 kΩ)

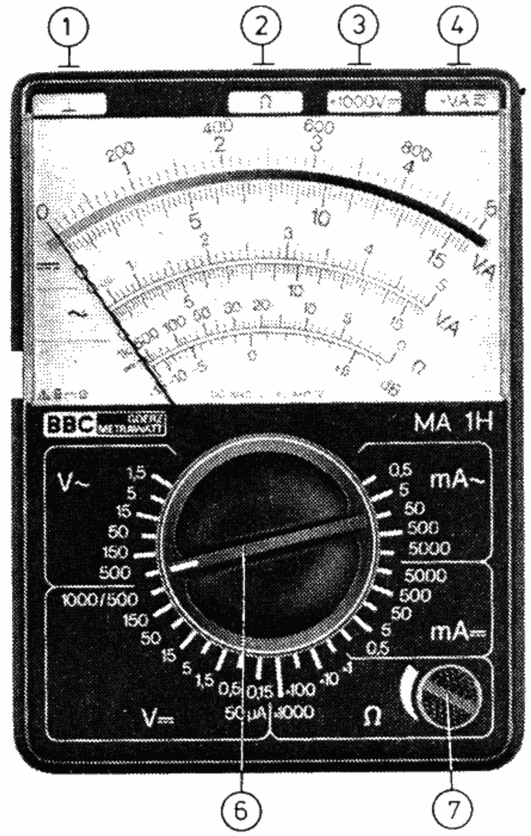
Adjustment of alternating current

— Adjustment is made on the complete unit without the bottom part ⑪ of the housing

— Put measuring range switch ⑥ into position 1.5 V~

— Feed in a purely sinusoidal constant current of 244.4 µA by way of the sockets ① "⊥" and ④ "+V, A⎓"

— Adjust to full deflection (scale value 5 on the upper scale) with potentiometer R 36 (2.2 kΩ)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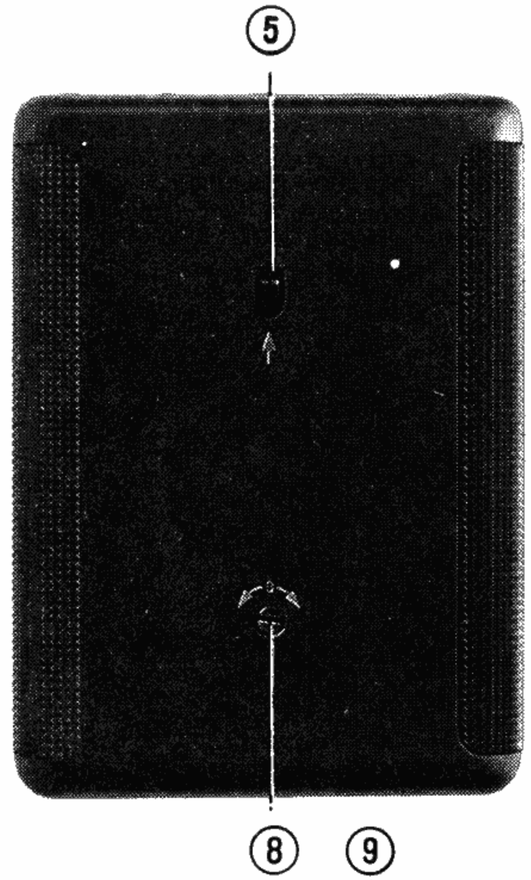
MA 1H
V~
mA~
mA⎓
V⎓
Ω
6
7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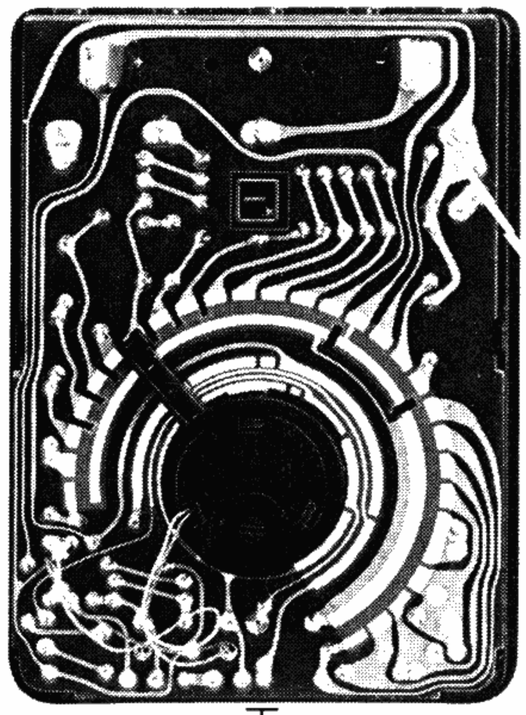
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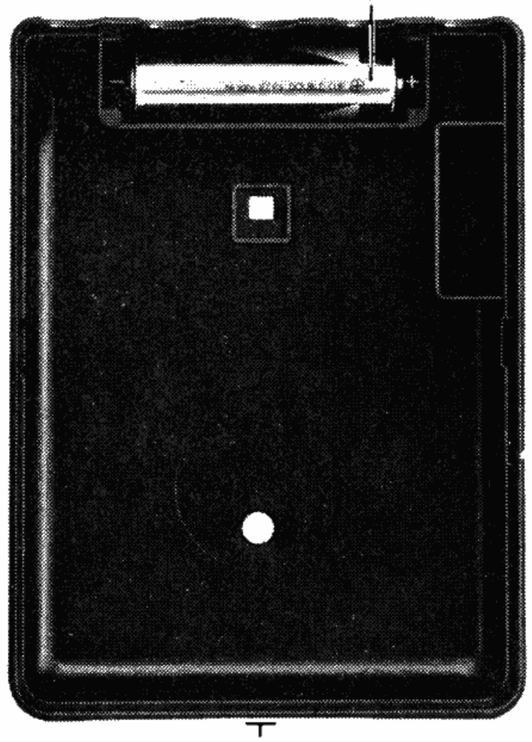
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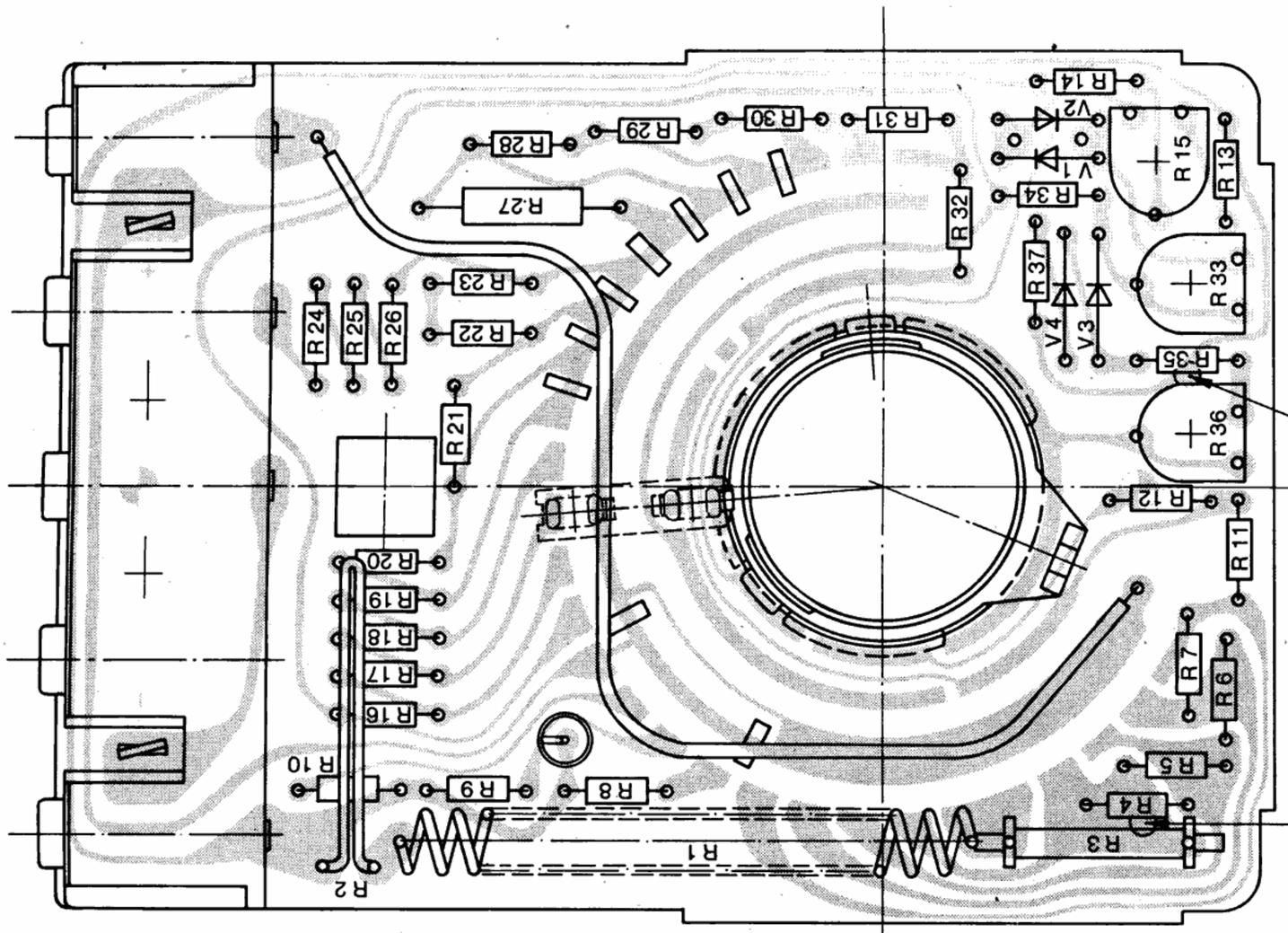

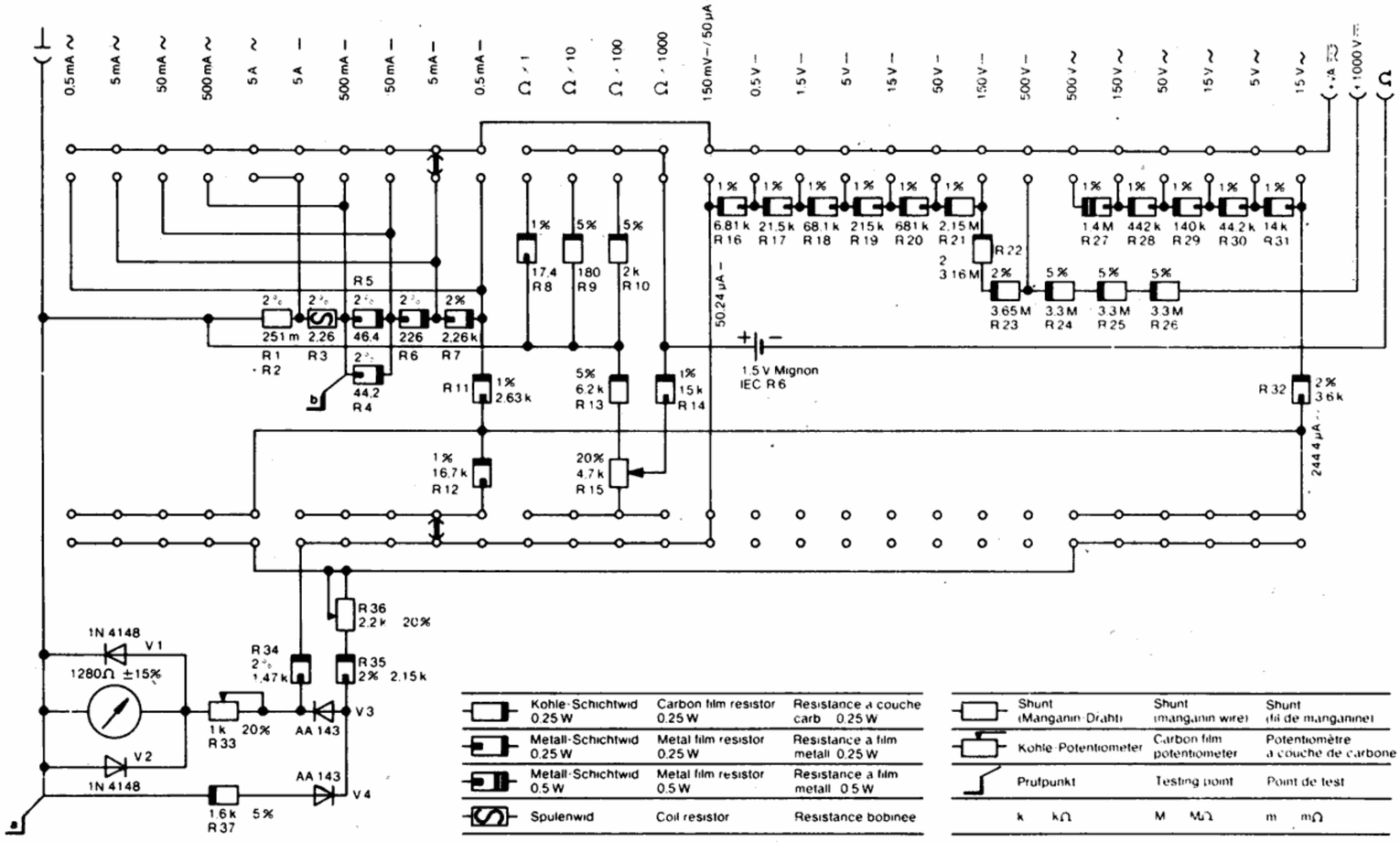

	Kohle-Schichtwid 0.25 W	Carbon film resistor 0.25 W	Resistance à couche carb 0.25 W
	Metall-Schichtwid 0.25 W	Metal film resistor 0.25 W	Resistance à film metall 0.25 W
	Metall-Schichtwid 0.5 W	Metal film resistor 0.5 W	Resistance à film metall 0.5 W
	Spulenwid	Coil resistor	Resistance bobinee

	Shunt (Manganin-Draht)	Shunt (manganin wire)	Shunt (fil de manganine)
	Kohle-Potentiometer	Carbon film potentiometer	Potentiomètre à couche de carbone
	Prüfpunkt	Testing point	Point de test
	k kΩ	M MΩ	m mΩ

Wirkschaltplan
Circuit board
Schéma de principe