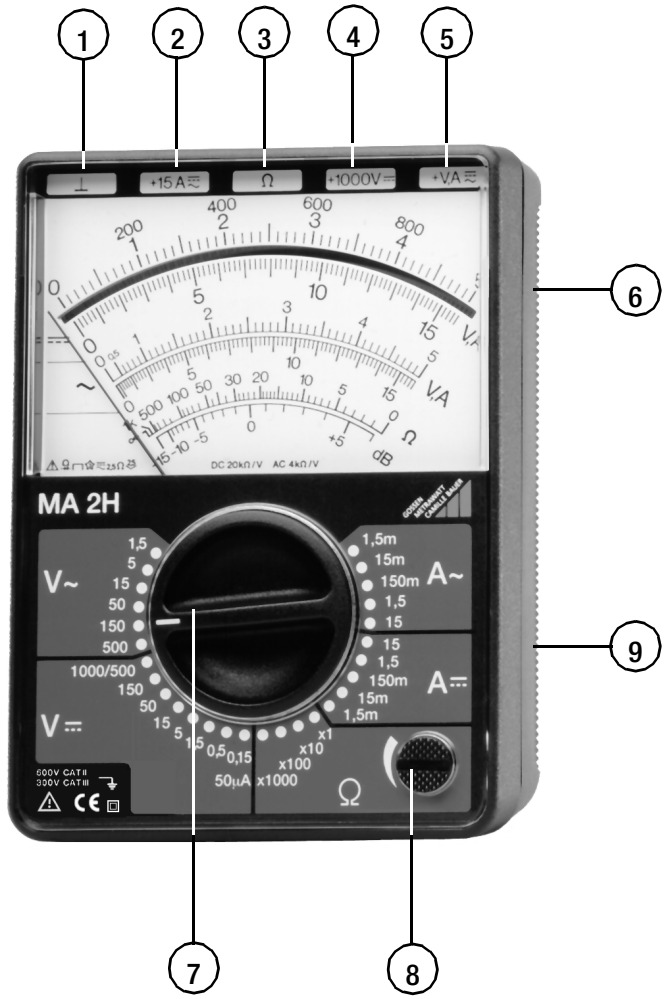
Operating Instructions

GOSSEN METRAWATT CAMILLE BAUER

MA 2H

Analog Multimeter

3-348-323-02
5/3.00



1 Common connection for all measuring ranges (Instrument earth)

2 Connection for highest current range 15 A≂

3 Connection for resistance measurement and capacitance measurement (negative potential)

4 Connection for highest DC voltage range 1000 V⎓

5 Connection for all voltage and current ranges (apart from the 15 A≂ and 1000 V⎓ ranges)

6 Catch for locking the rear of the apparatus

7 Range switch

8 Potentiometer knob

9 Set screw for mechanical zero setting of the pointer

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1 Safety precautions

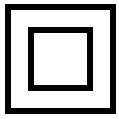
The multimeter has been built in accordance with the safety requirements of IEC 61010-1/EN 61010-1/VDE 0411-1. When used as prescribed, the safety of the operator and of the apparatus are guaranteed. They are not guaranteed if the apparatus is used incorrectly or carelessly. **It is therefore essential to read the present Operating Instructions carefully and in full, and to observe all the points therein before using the multimeter**.

The following general safety precautions are to be observed:

- The apparatus must only be used by persons who are in a position to appreciate the danger of accidental contact and to take safety precautions.
- There is a danger of shock in every case when there is a likelihood of voltages in excess of 50 V against earth.
- When measurements are being taken during which there is a risk of shock, no work must be effected alone. A second person is to be informed.
- Allowances must be made for the possibility that equipment being measured (e.g. defective appliances) can give rise to the presence of unexpected voltages; capacitors, for example, may be dangerously charged!
- The test leads must not be damaged, e.g. tears or broken areas.
- No measurements are to be taken using the multimeter in circuits with corona discharge (high voltage!).
- Particular caution is recommended when measuring HF circuits. Dangerous undulating voltages rnay be present.
- Measurements should not be effected in damp ambient conditions. Hands, shoes, floor and working area must be dry.
- It is absolutely essential to ensure that the measuring ranges are not excessively overloaded; cf. table entitled "Overload Capacity" in Kapitel 5. Connection of a current, low voltage or resistance measurement range to the 230 V mains, for example, would result in the **immediate destruction** of the apparatus. The **operator** would be in the **greatest danger**!

Meaning of symbols on the device

Warning concerning a point of danger
(Attention: observe documentation)



Continuous, doubled or reinforced insulation

Indicates EU conformity

Earth

2 Application

The measuring instrument is used for measuring voltage, current, resistance and estimated capacitance. It is sultable for universal application in the fields of electronics, radio and television engineering and digital technology, and can also be used in a large number of measuring applications in the field of general electrical engineering.

3 Description

The measuring instrument has 36 measuring ranges for DC and AC voltage, DC and AC current and resistance. Capacitance values can also be determined by estimated measurements
All the measuring ranges are selected by means of the central range switch. They are clearly arranged in the turning circle of the switch.
A mirror is placed behind the scale to facilitate precise reading of the measured values. The axes of rotation of the measuring mechanism and the range switch are in superposed alignment, which enables the use of long scales even in the case of Ω and dB measurement. The strong plastic housing and the shock-mounted bearings of the core magnet moving coil system protect the instrument from rough handling. 2 instrument leads with firmly attached test points and attaching plugs protected so as to prevent accidental contact. 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 instrument is built for easy servicing. Defective components can be exchanged without any great difficulty by technicians, observing the safety precautions laid down.

4 Operation

4.1 Controls

Range Switch

The multimeter has only one rotary switch. This is used to select all measuring ranges. The apparatus can be switched over from the DC voltage ranges to the corresponding AC voltage ranges, or from the DC ranges to the corresponding AC ranges without any need to disconnect the measured variable. The measuring circuit is not interrupted when switching over current ranges.
For voltage and current measurement, care must be taken to ensure that the range switch is **first of all** set to the **highest range**. It is then to be switched down to lower ranges until the optimum deflection is obtained.

Connection sockets

The instrument has 5 connecting sockets which are protected from accidental contact. Their functions are as follows:

Socket „⊥“ = common connection for all measuring ranges (instrument earth)

Socket „+ 15 A ⎓⎓“ = connection for highest current range 15 A ⎓⎓

Socket „Ω“ = connection for resistance measurement and capacitance measurement (negative potential)

Socket „+1000 V ⎓“ = connection for highest DC voltage range 1000 V ⎓

Socket „+V, A ⎓⎓“ = connection for all voltage and current ranges (apart from the ranges 15 A ⎓⎓ and 1000 V ⎓)

The sockets can accommodate the instrument leads with shock protected attaching plugs that can be supplied as well as all measuring cables with banana plugs (diameter 4 mm).

Potentiometer knob

The rotary knob is used to set the full deflection 0 Ω when measuring resistance as per Kapitel 4.5 and capacitance according to Kapitel 4.6.

4.2 Starting the Instrument

Battery

Bottom half must be removed from the instrument in order to install or exchange the battery.

Attention!
Before opening the apparatus, the instrument leads must be disconnected from the test circuit!

- ➪ Press the catch on the rear of the apparatus, using a test point, banana plug or similar object, in the direction of the arrow and remove the lower portion
- ➪ Place the 1.5 V miniature battery in the battery compartment in accordance with the symbol and pole sign.

Attention!
Only use a leak-proof 1.5 V miniature battery according to IEC R 6!

- ➪ Place the apparatus in the lower portion of the housing and gently press the two halves together until they lock into place

Mechanical zero point check

- ➪ Place the multimeter flat on the edge of a table. The lower third of the apparatus should project over the edge.
- ➪ Check the mechanical zero setting of the pointer.
- ➪ If necessary, adjust the set screw on the rear of the apparatus with a screwdriver to correct the setting.

Battery check

- ➪ Set the range switch to the „Ω x 1“ position.
- ➪ Short-circuit connecting sockets „⊥“ and „Ω“ using an instrument lead.
- ➪ Set the pointer to full deflection position 0 Ω using potentiometer knob.

If it is no longer possible to set the full deflection or if the reading does not remain constant after setting, the miniature battery is spent. Replace as described above.

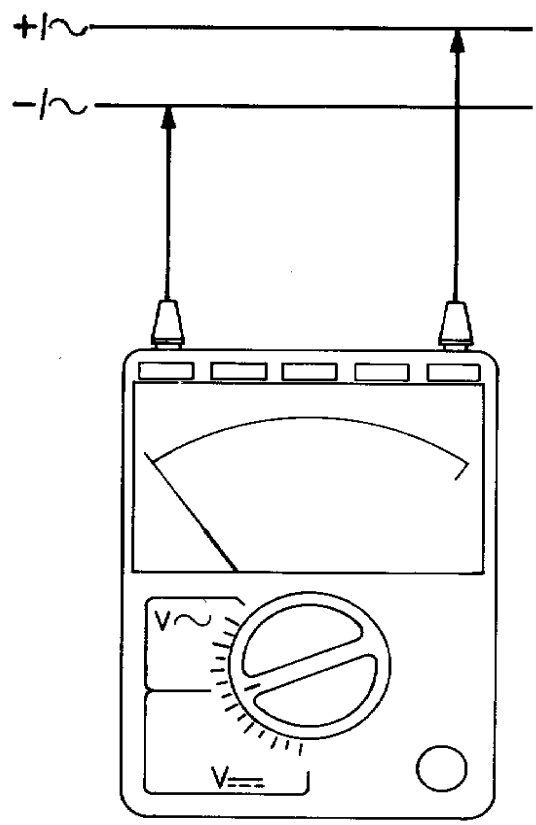
4.3 Voltage Measurement

Attention!
Whatever the value of the measured voltage, as a safety precaution, do not exceed the sum of 1000 V CAT I; 600 V CAT II; 300 V CAT III for measured voltage plus voltage against earth when directly connecting up the multimeter!

The left-hand connection socket marked „⊥“ should be connected whenever possible and for all voltage measurements to the point with the lowest potential against earth.

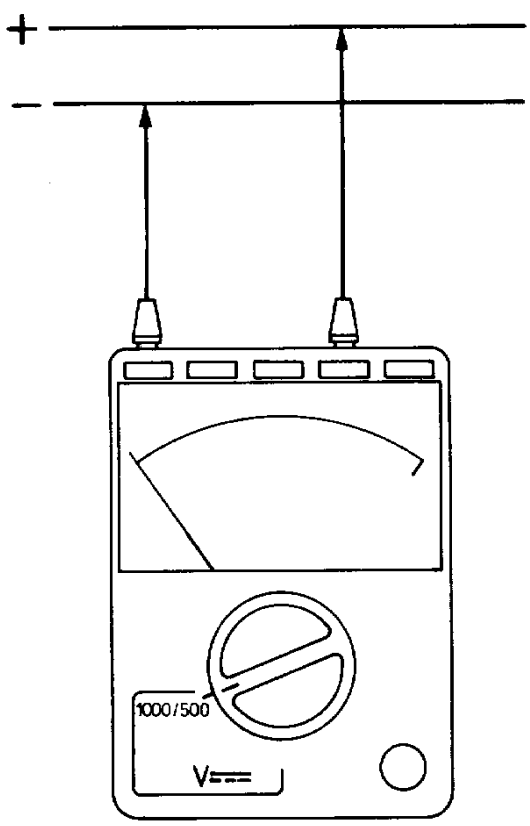
4.3.1 DC and AC Voltage up to 500

- Set the range switch to the position 500 V ⎓ or 500 V ∼.
- Plug the test leads into the apparatus (black) test lead to socket „⊥“ and (red) lead to socket „+ V, ⎓∼ “.
- For safety, the test leads with anti-shock protected attaching plugs should be used.
- Apply the measured voltage to the test leads. For DC voltage, the socket „⊥“ must be connected to the negative pole of the measured voltage and socket „+ V, A ⎓∼“ to its positive pole.
- If the measured voltage is less than 150 V, set range switch, in the case of DC voltage, to the lower Dc voltage ranges and, in the case of AC voltage, to the lower AC voltage ranges, proceeding until optimum deflection is obtained.



➪ Read off the measured value: in the case of DC voltage, on the two upper scales 0 ... 5 or 0 ... 15 V, A ⎓ , in that of AC voltage, on the scales beneath 0 ... 5 or 0 ... 15 V, A ∼ .

4.3.2 DC Voltages up to 1000 V



➪ Set range switch to the position 1000/500 V ⎓.

➪ Plug test leads into the apparatus; (black) test lead to socket „⊥“ and (red) lead to socket „+ 1000 V ⎓ “.

➪ For safety, the test leads with anti-shock protected attaching plugs should be used.

➪ Apply the voltage measured to the test leads. Socket „⊥“ should be connected to the negative pole of the measured voltage and socket „+ 1000 V ⎓“ to the positive pole.

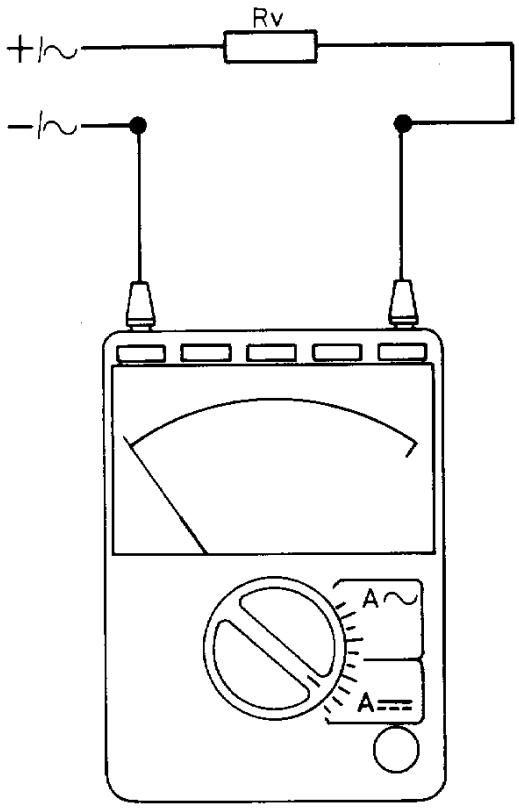
➪ Read the measured value off the upper scale 0 ... 1000 V ⎓.

4.4 Current Measurement

Attention!

The multimeter must always be connected to the lead whose voltage against earth is smallest. For reasons of safety, the voltage against earth must not exceed 1 000 V CAT I; 600 V CAT II; 300 V CAT III! The measuring instrument must **never** be connected in the **current ranges to a voltage source** that can supply a higher current than the allowable maximum (cf. Kapitel 5: "Overload capacity"). If a current range is connected, for example, directly to the 230 V mains, the apparatus will be **immediately destroyed**. The **operator** would be in **extreme danger!**

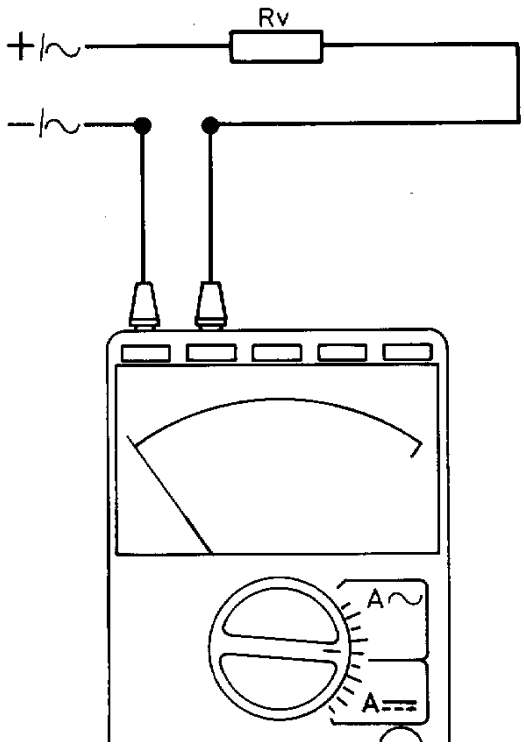
4.4.1 Direct and Alternating Currents up to 1.5 A



- Set the range switch to the position 1.5 A ⎓ or 1.5 A ~.
- Plug the test leads into the apparatus; (black) test lead to the socket „⊥“ and (red) test lead to the socket „+ V, A ⎓~ “.
- Disconnect the supply to the test circuit or consumer (R_V) and discharge all capacitors, if any.
- Disconnect the test circuit and connect the test leads safely (no contact resistance) in series to the consumer R_V. When measuring direct current, observe the correct pole signs. Negative to socket „⊥“ and positive to socket „+V, A ⎓~ “.
- Re-connect supply to the test circuit.
- If the current for measurement is less than 150 mA, adjust the range switch, in the case of direct current, to the lower DC ranges and, in that of alternating current, to the lower AC ranges until optimum deflection is obtained. The test circuit is not interrupted during switch-over!

- Read off the measured value: in the case of Dc on the second scale from the top 0 ... 15 V, A ⎓, in that of AC on the fourth scale from the top 0 ... 15 V, A ∼.

4.4.2 Direct and Alternating Currents up to 15 A

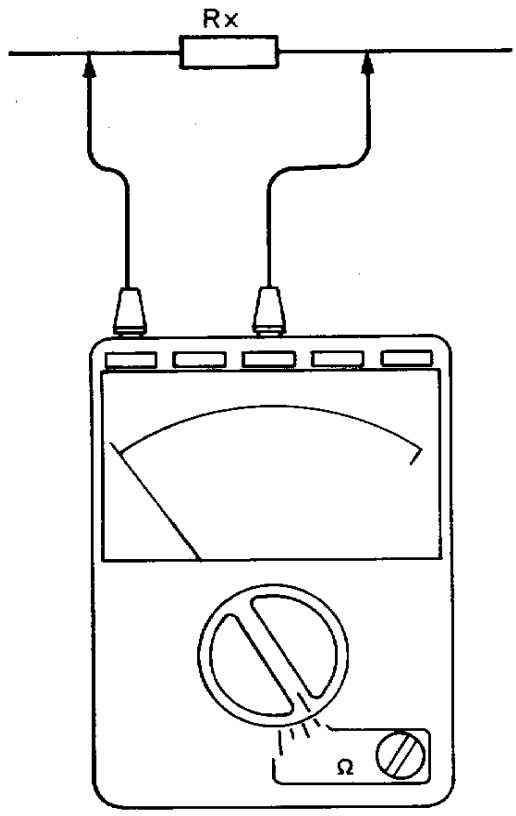


- Set the range switch to the position 15 A ⎓ or 15 A ∼.
- Plug the test leads into the apparatus; (black) test lead to socket „⊥“ and (red) test lead to socket „+ 15 A ⎓≂ “.
- Disconnect the supply to the test circuit or consumer (R_V) and discharge all capacitors, if any.
- Disconnect test circult and connect test leads safely (no contact resistance) in series to the consumer R_V. In the case of direct current, observe the correct pole signs. Negative to socket „⊥“ and positive to „+ 15 A ⎓≂ “.
- Re-connect the supply to the test circuit.
- Read off the measured value:
  in the case of DC on the second scale from the top 0 ...15 V, A ⎓
  in that of AC on the fourth scale from the top 0 ... 15 V, A ∼.

Attention!

The measuring ranges 15 A ⎓ and 15 A ∼ can be under permanent load up to 12 A ⎓ and loaded for 15 minutes up to 15 A ≂ max.! The measuring circuit will not be interrupted if a current measuring range other than 15 A ⎓ or 15 A ∼ is selected in error.

4.5 Resistance Measurements



Resistance is measured with DC voltage from the 1.5 V miniature battery. The table of measuring ranges in Kapitel 5 gives the maximum measuring currents for full deflection and a battery voltage of 1.5 V.
Socket polarity is as follows:
Positive pole on socket „⊥“
Negative pole on socket „Ω“

- ➪ Set range switch, depending on the measured value expected, to one of the ranges Ω x 1 ... Ω x 1000.
- ➪ Plug in the test leads to sockets „⊥“ and „Ω“.
- ➪ Short-circuit the test leads.
- ➪ Using the potentiometer knob, set the pointer of the measuring mechanism to full deflection 0 Ω.
  If it is no longer possible to set for full deflection, or if the reading does not remain constant after setting, the battery should be replaced observing the procedure described in Kapitel 4.2.
- ➪ Connect up the resistance to be measured R_x to the test leads.

Attention!
Only "dead" objects are to be measured. External voltages would falsify the results of measurement. They could also damage the apparatus or destroy it, as well as endanger the operator!

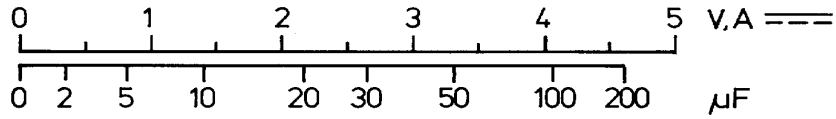
- ➪ Read off the value displayed on the Ω scale and multiply by the factor corresponding to the measuring range set.

If possible, the measuring range should be selected in such a way as to obtain a reading in the range 5 ... 50. The measuring error, in relation to the actual resistance value, is smallest in the middle of the deflection range. During resistance measuring operations of a longer duration, the full deflection 0 Ω should always be checked if possible after moving the range switch from one resistance range to another and, if necessary, it should be re-set.

Note!
Contact resistance at the battery connecting terminals can, particularly in low ohmic resistance ranges, cause the setting of full deflection 0 Ω to fluctuate. Consequently, good contact should be ensured, for example by removing and refitting the battery (cf. Kapitel 4.2).

4.6 Estimated Capacitance Measurement

Capacitance values can be determined in the resistance ranges by estimated measurement. When doing so, proceed exactly as when measuring resistance in accordance with Kapitel 4.5. The resistance R_x is to be replaced by the capacitance to be measured, after prior discharge. When the capacitor is connected, the pointer of the instrument swings to a maximum value and then returns to the initial position (mechanical zero point). The point of return of the pointer deflection gives a means of measuring the capacitance. It is to be determined on the scale: 0 ... 5 V, A ⎓. The measured value can be determined using the following comparative scale and the factor for capacitance measurement corresponding to the measuring range selected:



Measuring Range	Factor for Capacitance Measurement	Measuring Limit
Ω x 1000	µF x 1	2 ... 200 µF
Ω x 100	µF x 10	20 ... 2000 µF
Ω x 10	µF x 100	200 ... 20000 µF
Ω x 1	µF x 1000	2000 ... 200000 µF

Before the measurement is repeated, the capacitor must be redischarged!

Example

Selected measuring range: Ω x 100
Return point of needle: 3.3 on the upper scale 0 ... 5 V, A ⎓

Capacitance determined over the comparative scale: 50 µF
Multiplied by the factor for capacitance measurement: 50 µF x 10 = 500 µF

4.7 Measurement of Gain and Attenuation

In communications engineering, gain or attenuation is almost exclusively given as a logarithm of the ratio between a measured voltage and a given reference voltage in dB. In recurrent networks, it is thereby possible to determine the total gain or attenuation in a simple manner by adding or subtracting the individual values. The reference voltage is 0.775 V (1 mW for 600 Ω); attenuation at this voltage is 0 dB.
For gain and attenuation measurement, proceed exactly as described in Kapitel 4.3.1 for AC voltage measurement; the measured values, however, are to be read off the dB scale.
The range – 15 ... + 6 dB shown on the scale corresponds to the AC voltage range 1.5 V. In the case of the higher voltage measuring ranges 5 V ∼, 15 V ∼, 50 V ∼ ..., 10 dB, 20 dB, 30 dB ... are to be added to the value read; cf. the table in Kapitel 5 showing the voltage measuring ranges.
If a DC voltage is superposed on the AC voltage to be measured, this can be cancelled out by using a suitable capacitor, which is to be series connected to the measuring input.
The operating voltage of the series connected capacitor must be at least of the same magnitude as the peak value for the voltage applied. If there is an additional error of 1 % of the measured value, it can be calculated from the following formula. In mentionned formula, R_i is the internal resistance of the measuring instrument in the selected measuring range.

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

Example:

For a 1 kHz superposed AC voltage, we have for the measuring range 50 V ∼, a series connected capacitor of C_V = 0.0056 µF = 5.6 nF

Attention!

The capacitor is loaded up to the value of the DC voltage component. The load can assume a magnitude that can be **lethal** and retain this load for quite some time. The capacitor must therefore be discharged after measurement!

4.8 Testing Diodes and Transistors

The resistance range Ω x 1000 is suitable for approximate functional testing of diodes and transistors. By using a resistance measurement (cf. Kapitel 4.5) it is simple to determine a short-circuit or interruption of current in a diode or a diode path between base, collector and emitter in a transistor. This test also enables the polarity of a diode and the base connection of a transistor to be determined.

Attention!

The positive pole is at socket „⊥“
The negative pole is at socket „Ω“

The test-piece will not be destroyed as the voltage does not exceed 1.75 V and the test current 100 µA.

5 Specifications

Measuring Range

Voltage	Output [1]	Internal Resistance approx.	
		⎓	∼
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 MΩ	650 kΩ
500 V≂	+35 ... + 56 dB	10 MΩ	2 MΩ
1000 V⎓	—	20 MΩ	—

[1] Input resistance in relation to voltage at ⎓ : 20.0 kΩ/V. at ∼ : 4.0 kΩ/V

Current	Voltage Drop approx.	
	⎓	∼
50 µA⎓	0.158 V	—
1.5 mA≂	1.16 V	1.21 V
15 mA≂	1.25 V	1.25 V
150 mA≂	1.25 V	1.25 V
1.5 A≂	1.27 V	1.27 V
15 A≂	0.25 V	0.25 V

Resistance	Measuring Range	Value in Mid-Scale (R_i)	Max. Meas. 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 of 1.5 V ∼; 0 dB ≙ 1 mW at 600 Ω

[2] For battery voltage of 1.5 V

Capacitance [3]	Measuring Range
µF x 1000	2000 ... 200000 µF
µF x 100	200 ... 20000 µF
µF x 10	20 ... 2000 µF
µF x 1	2 ... 200 µF

[3] Estimated measurement in the resistance measurement ranges; determination of measured values via comparative scale, cf. Kapitel 4.5.

Accuracy

Under reference conditions
acc. to IEC/EN 60051

Class 2.5 for ⎓ and ∼;
max. additional reading error in the ranges
1000 V ⎓ and 15 A ∼: ± 1 %;
1.5 V ∼ : + 1 /– 2.5 %
Class 2.5 for Ω
(error in relation to scale length 52 mm)

Reference conditions

Ambient temperature	+ 23 °C ± 2 K
Operating position	horizontal
Frequency	40 ... 60 Hz
Curve form	for ∼: sine

The instrument possesses half-wave rectification and is calibrated in r.m.s. values. It evaluates the arithmetical mean of a half-wave and indicates varying values for undulatory voltage or current, irrespective of the polarity of connection.

For other
limiting quantities

according to IEC/EN 60051

Limiting parameters and rated service ranges

Temperature
at ⎓: 0 ... +23 ... +40 °C
at ∼: +13 ... +23 ... +35 °C

Frequency
Ranges 1.5 V ... 500 V:
35 ... 40 ... 60 ... 3000 Hz
Ranges 1.5 mA ... 1.5 A:
35 ... 40 ... 60 ... 1000 Hz
Ranges 15 A:
40 ... 45 ... 60 ... 1000 Hz

For other limiting quantities
according to IEC/EN 60051

Overload capacity

Range	Constant load 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 ≂
1.5 mA —	15 mA ≂
15 mA —	50 mA ≂
150 mA —	400 mA ≂
1.5 A —	1.8 A ≂
15 A —	12 A ≂
	15 A ≂
	max 15 min.

Range	Constant load up to
—	—
—	—
1.5 V ∼	25.0 V ≂
5 V ∼	50.0 V ≂
15 V ∼	150.0 V ≂
50 V ∼	250.0 V ≂
150 V ∼	300.0 V ≂
500 V ∼	600.0 V ≂
—	—
—	—
1.5 mA ∼	15.0 mA ≂
15 mA ∼	50.0 mA ≂
150 mA ∼	400.0 mA ≂
1.5 A ∼	1.80 A ≂
15 A ∼	12.00 A ≂
	15.00 A ≂
	max 15 min.

Battery

for Resistance Measurement
1 miniature cell 1.5 V acc. to IEC R 6, leak-proof

Electrical Safety

Protection Class	II acc. to IEC 61010/EN 61010-1 /VDE 0411-1
Overvoltage Categorie	II III
Nominal Voltage	600 V 300 V
Test Voltage	3.7 kV ∼
Contamination Level	2

Mechancal Construction

Protection Type	Housing IP 50, connections IP 20 acc. to EN 60529/VDE 0470 Part 1
Scale Length	A, V – 0 ... 5.0: approx. 83 mm
	A, V – 0 ... 15.8: approx. 77 mm
	A, V∼ 0 ... 5.0: 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	approx. 0.30 kg without battery

6 Maintenance

6.1 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. Check and replace the battery as indicated in Kapitel 4.2.

6.2 Housing

No special maintenance is required for the housing. Keep outside surfaces clean. Use a slightly dampened cloth for cleaning. Avoid the use of cleansers, abrasives or solvents.

7 Repair and Replacement Part Service

When you need service, please contact:

GOSSEN-METRAWATT GMBH
Service
Thomas-Mann-Straße 20
90471 Nürnberg, Germany
Phone +49 911 86 02 - 410 / 256
Fax +49 911 86 02 - 2 53
e-mail fr1.info@gmc-instruments.com

This address is for Germany only. Abroad, our representatives or establishments are at your disposal.

8 Product Support

When you need service, please contact:

GOSSEN-METRAWATT GMBH
Hotline Produktsupport
Phone +49 911 86 02 - 112
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