

# METRAport<sup>®</sup> 3E

Analog Multimeter

3-348-328-02

5/3.99





- 1 ON/OFF switch
- 2 Range switch
- 3 Potentiometer for electrical zero
- 4 Eye for fastening of the carrying strap
- 5 Setscrew for mechanical zero
- 6 Socket for mains adapter connection
- 7 Scale
- 8 Cover of battery compartment
- 9 „+ 10 A“ connection socket for the highest current range
- 10 Melting fuse for measuring circuit
- 11 Connection socket for all measuring ranges except 10 A; high potential
- 12 Connection socket for all measuring ranges
- 13 Potentiometer full scale deflection setting at resistance measurement

## 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 may 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; see Chapter 4 "Overload Protection (Protective Means)".

## Meaning of symbols on the device



Warning concerning a point of danger



Fuse



Earth



Indicates EU conformity

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## 1 Application

The multimeter is an analog multimeter with an electronic amplifier. It offers a great number of applications in the field of the electrotechnical practice, e.g. in research and development, manufacture, operation, test room and service as well as in the field of training and further education.

## 2 Description

The multimeter features 46 measuring ranges for DC and AC voltages up to 1000 V, AC voltage levels from -40 to +62 dB, DC and AC currents up to 10 A and resistances up to 20 M $\Omega$ . It has a constant input resistance of 10 M $\Omega$  on all voltage measuring ranges.

All measuring ranges are selected with a central range switch. They are clearly arranged in the turning area of the switch. Measuring unit and indicating unit are housed in two different case halves which are connected with each other across a joint with a stepped stop device. An optimum reading angle can thus be set in all positions of use for easy reading. Several well-tuned protection means protect the instrument against damage through improper handling and overload within the specified limit values for overload:

- Overdimensioned precision resistors
- Melting fuse in conjunction with protective power diodes
- Overvoltage arrester

The instrument operates independent of the mains on a commercially available 9 V flat cell battery according to IEC 6 F 22. But it can just as well be operated on the mains with a mains adapter which is available as accessory. Thanks to the low power consumption of the electronic components, a long battery life is assured.

The rugged design of the multimeter assures fine protection in the case of rough mechanical duty. In closed condition, the instrument offers additional mechanical protection for the measuring unit and the indicating unit. The connection sockets are protected against accidental contact. Both the special measuring leads the connection plugs of which are protected against accidental contact (lead set KS 17) and all measuring leads with conventional banana plugs (4 mm diameter) can be used.

### 3 Technical Data

#### Measuring ranges

Voltage <sup>1)</sup>	Level <sup>2)</sup>		Input Resistance R <sub>i</sub>	Overload-protected to
	Const.	Measuring Span		
100 mV 	-20 dB	-40 ... -18 dB	10 MΩ / /50 pF	250 V 
300 mV 	-10 dB	-30 ... - 8 dB		250 V 
1 V 	0 dB	-20 ... + 2 dB		250 V 
3 V 	+10 dB	-10 ... +12 dB		250 V 
10 V 	+20 dB	0 ... +22 dB		1200 V 
30 V 	+30 dB	+10 ... +32 dB		1200 V 
100 V 	+40 dB	+20 ... +42 dB		1200 V 
300 V 	+50 dB	+30 ... +52 dB		1200 V 
1000 V 	+60 dB	+40 ... +62 dB		1200 V 

<sup>1)</sup> The voltage measuring ranges 100 mV ... 10 V can also be used for current measurements as shown in the following table (e.g. reverse currents or leak currents). The accuracy of these measuring ranges then corresponds to class 5.

Frequency range on AC: 15 ... 100 Hz

Overload protection same as on the voltage measuring ranges.

<sup>2)</sup> Measuring value = indicated value + constant ; 0 dB  $\triangleq$  0.775 V, that is 1 mW an 600 Ω

Range	Current at Full Scale Value	R <sub>i</sub>
100 mV 	10 nA	10 MΩ
300 mV 	30 nA 	
1 V 	100 nA 	
3 V 	300 nA 	
10 V 	1 μA 	
30 V 	3 μA 	

Current	Input Resistance $R_i$	Voltage Drop $\Delta U$	Overload-protected to
10 $\mu A$ 	10.0 $k\Omega$	100 mV	250 V  <sup>3)</sup>
100 $\mu A$ 	1.0 $k\Omega$	100 mV	250 V  <sup>3)</sup>
1 mA 	100.0 $\Omega$	100 mV	250 V  <sup>3)</sup>
10 mA 	10.0 $\Omega$	100 mV	250 V  <sup>3)</sup>
100 mA 	1.2 $\Omega$	120 mV	250 V  <sup>3)</sup>
1 A 	270.0 m $\Omega$	270 mV	250 V  <sup>3)</sup>
10 A 	13.0 m $\Omega$	130 mV	—

Resistance Range	Reading Range	Mid-Scale Value ( $R_i$ )	Open-Circ. Voltage $U_0$	Short-Circ. current $I_k$	Overload-protected to
$\Omega$ x 1	1 $\Omega$ ... 2 $k\Omega$	45.6 $\Omega$	100 mV	2.2 mA	250 V  <sup>3)</sup>
$\Omega$ x 10	10 $\Omega$ ... 20 $k\Omega$	456.0 $\Omega$	100 mV	0.22 mA	250 V  <sup>3)</sup>
$\Omega$ x 100	100 $\Omega$ ... 200 $k\Omega$	4.56 $k\Omega$	100 mV	22 $\mu A$	250 V  <sup>3)</sup>
$k\Omega$ x 1	1 $k\Omega$ ... 2 $M\Omega$	45.6 $k\Omega$	1 V	22 $\mu A$	250 V  <sup>4)</sup>
$k\Omega$ x 10	10 $k\Omega$ ... 20 $M\Omega$	456.0 $k\Omega$	1 V	2.2 $\mu A$	250 V  <sup>4)</sup>

<sup>3)</sup> Protected by G type melting fuse link FF 1.6/250 G in conjunction with protective power diodes.

<sup>4)</sup> up to 5 min.

### Accuracy at reference conditions to IEC 60051/EN 60051

Class 1.5 for DC variables; class 2.5 for AC variables and class 1.5 for resistance (inherent deviation referred to the scale length 69 mm) corresponding to 10% error of the measured value on the range of the bolder drawn scale arc at a max.

### Reference conditions

Ambient temperature	+23 °C ± 2 K
Position	Device and scale horizontal ± 1°
Frequency	45 ... 65 Hz
Waveform	sinusoidal
Battery voltage	7.5 V ± 0.1 V
For other influencing variables	according to IEC 60051/EN 60051

The multimeter is calibrated in rms values. It operates with full-wave rectification which values the arithmetic mean value.

## Influencing variables and rated operating ranges

Temperature	+5 ... +23 ... +35 °C
Limit temperatures	for accuracy +5 ... +35 °C
	for operation -25 ... +40 °C
	for storage -25 ... +65 °C
Position	additional influence effect max. $\pm 1\%$ of the scale length when the scale is inclined to the horizontal between 0 and $\pm 120^\circ$
Frequency	additional influence effect
	max. $\pm 5\%$ of full scale value on the ranges
	100 mV; 3 V ... 1000 V: 15 Hz ... 1 kHz
	10 $\mu\text{A}$ ... 10 A: 15 Hz ... 1 kHz
300 mV; 1 V: 15 Hz ... 200 Hz	
Auxiliary voltage	No additional influence effect when the electrical zero is set, and when the full scale value is set with resistance measurement.
Series-mode interference voltage attenuation	on $V_{\text{DC}}$ > 60 dB with AC 50 Hz
	on $V_{\text{AC}}$ > 120 dB with DC
Common-mode voltage attenuation	> 120 dB with DC and 50 Hz AC
Composite voltages and composite currents	see Chapter 5.5
Other influencing variables	according to IEC 60051/EN 60051

## Power supply

Battery operation	nominal voltage 9 V—; 9 V flat cell battery according to IEC 6 F 22) manganese-dioxide cell, alkaline-manganese cell or NiCd storage battery.
Battery duration	with manganese dioxide cell: approx. 500 hours with alkaline manganese cell: approx. 1000 hours with NiCd storage battery: approx. 200 hours on the range $\Omega \times 1$ : $\frac{1}{4}$ of the mentioned operating hours
Battery test	indication must be within battery test zone
Mains operation/ mains adapter	NA 2-9/20
Output voltage of mains adapter	approx. 10 V—

## Fuse

G type melting fuse link	FF 1.6/250 G protects the ranges 10 $\mu$ A ... 1 A and $\Omega \times 1$ ... $\Omega \times 100$ in conjunction with power diodes
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Switching capacity of the melting fuse:

750 A—/1500 A~ on 250 V (one half wave on ohmic load) Overload limit of the melting fuse in conjunction with the power diodes: max. 200 A~ on 250 V (one half wave on ohmic load)

## Electrical Safety

Protection class	II acc. to IEC 61010-1/EN 61010-1/VDE 0411-1	
Overload classification	II	III
Nominal voltage	600 V	300 V
Ccontamination level	2	
Test voltage	3.7 kV~	

## EMC

Interference emission	EN 50081-1:1992/EN 55022:1987 class B
Interference immunity	EN 50082-1:1992/IEC 801-2:1991 8 kV air discharge/IEC 801-3:1984 3 V/m/ IEC 801-4:1988 0.5 kV

## Mechanical Design

Dimensions	146 x 118 x 44 mm (instrument folded)
Weight	approx. 0.45 kg without battery

## 4 Overload Protection (Protective Means)

### 4.1 Internal Resistance

The voltage measuring ranges and the highly resistive resistance measuring ranges can continuously be overloaded because of the very high internal resistance and the overdimensioned precision resistors.

Ranges 100 mV ... 3V $\approx$	max. 250 V $\approx$ continuously (rms value with sinusoidal form)
Ranges 10 V ... 1000 V $\approx$	max. 1200 V $\approx$ continuously (rms value with sinusoidal form)
Ranges k $\Omega$ x 1 und k $\Omega$ x 10	max. 250 V $\approx$ up to 5 min. (rms value with sinusoidal form)

### 4.2 Melting Fuse FF 1.6/250 G

A superquick-action fuse FF 1.6/250 G protects the current measuring ranges 10  $\mu$ A ... 1 A $\approx$  and the resistance measuring ranges  $\Omega$  x 1 ...  $\Omega$  x 100 in conjunction with power diodes.

#### Loading capacity

Ranges 10 $\mu$ A ... 1 A $\approx$	1.2 A continuously; 2 A to 5 min.
Ranges $\Omega$ x 1 ... $\Omega$ x 100	2 A to 5 min.
Overload limit	max. 200 A $\approx$ (one half wave) on 250 V <sub>eff</sub> and ohmic load

The 10 A range is not fitted with protective means.

**Loading capacity** max. 12 A continuously, 20 A to 30 s

The fuse is located immediately behind the connection terminal „+“. When the fuse has blown, only the 10 A range and the battery test continue to function.

### 4.3 Overvoltage Arrester

The overvoltage arrester responds at voltage peaks above approximately 2.5 kV and protects the insulation from being damaged.

## 5 Operation

### 5.1 Controls

#### ON/OFF switch

The toggle switch is used to turn the instrument on and off. When the mains adapter is not connected then this switch should be switched to the "0" position because the instrument is not operated for extended periods of time in order to avoid unnecessary load on the battery. Apart from that, even a leakproof battery may leak when the instrument remains turned on for several days with a discharged battery. Damages caused by leaking batteries are not covered by the instrument warranty.

When the instrument is closed, the battery is automatically disconnected. The average lifespan of a manganese-dioxide cell is 500 operating hours, that of an alkaline-manganese cell 1000 operating hours and that of a NiCd storage battery 200 operating hours.

#### Range switch

The multimeter has only one rotary switch. All measuring ranges are selected with it. Without disconnecting the measured variable, it is possible to switch from the DC voltage ranges to the corresponding AC voltage ranges or from the DC current ranges to the corresponding AC current ranges. The measuring circuit is not interrupted when changing the current measuring ranges. When making current and voltage measurements, take care that the range switch is **first set to the highest measuring range**. Then work down to lower measuring ranges until optimum display is obtained.



#### Attention!

When the measuring voltage, e.g. 250 V<sub>~</sub>, is applied, do not switch to the resistance measuring ranges. From the range  $\Omega \times 100$  on there is danger of damaging the contacts of the range switch.

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#### Potentiometer

for setting of the electrical zero.

#### Eye for fastening of the carrying strap

The carrying strap can be fastened at the eyes. It allows for the instrument to be carried around the neck. Both hands are free for measuring.

#### Setscrew

for setting of the mechanical zero.

## Socket for mains adapter NA 2-9/20

Only the jack of the mains adapter NA 2-9/20 may be plugged onto socket. For safety reasons, the use of other power supply units is not permitted.

## Analog indication

Indication of the measured value is effected by a moving-coil core magnet movement withspring-loaded jewel bearings on a mirrorbacked scale of a maximum length of 101 mm.

## Connection sockets

The instrument has three connection sockets which are protected against accidental contact. They have the following functions:

- Socket „+ 10 A“ = connector for the highest current meas. range 10 A $\approx$ .
- Socket „+“ = connector for all measured variables; high potential (except for the range 10 A $\approx$ ).
- Socket „ $\rightarrow$ “ = common connector for all measuring ranges to which earth potential of the measured variable has to be applied. This input is connected with the shielding within the instrument.

Special measuring leads the connection plugs of which are protected against accidental contact (lead set KS 17) as well as all leads with banana plugs (4 mm diameter) can be plugged onto the sockets.

**Melting fuse** for measuring circuit (see also Chapter 4.2).

**Potentiometer** for full scale deflection setting when measuring resistance

## 5.2 Starting the Instrument

### Installing the battery

- ⇨ To install or replace the battery, the battery compartment must be opened.



#### Attention!

Remove the measuring leads from the measuring circuit prior to removing the cover of the battery compartment!

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- ⇨ Close the instrument
- ⇨ Put a coin or a similar object into the slot between the case and the cover of the battery compartment and press **down**.
- ⇨ Open the instrument completely and remove the cover of the battery compartment.
- ⇨ Install a 9 V flat cell battery into the battery compartment.



#### Attention!

Only use a leak-proof, 9 V flat cell battery according to IEC 6 F 22!

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- ⇨ Reattach the cover of the battery compartment and press onto it until it engages.

### Checking the mechanical zero

Put the multimeter into its position of use, turn off switch and check the mechanical zero position of the pointer. Correct with the adjustment screw, if required.

### Checking the battery voltage

If the pointer is within the zone marked with the battery symbol „“ after the instrument has been turned on then the battery voltage is sufficient that is, it is assured that the error limits according to the data given in Chapter 3 "Technical Data" are maintained.

### Checking the electrical zero

- ⇒ With switch turn on the instrument (position „I“).
- ⇒ Short the measuring input (sockets „+“ and „ $\rightarrow$ “).
- ⇒ Set the range switch to the range 100 mV  $\overline{\text{---}}$ .
- ⇒ Check the zero position of the pointer and correct with potentiometer „e0“ if required.

The zero point is so stable that a check after extended periods is sufficient. A correction is normally required only when there were heavy changes in the ambient temperature.

### Connecting the mains adapter

The mains adapter NA 2-9/20 is used for power supply from the 250 V mains.

- ⇒ Plug the jack of the mains adapter into the socket and push until it engages.
- ⇒ Plug the mains adapter into the mains receptacle plug.



#### Attention!

For safety reasons, it is required to use only the special mains adapter NA 2-9/20 for external power supply. The use of other power supply units is not permitted!

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The battery is disconnected when the jack is plugged into socket. A NiCd storage battery can only be charged outside the instrument by means of a separate battery charger.

## 5.3 Voltage Measurement

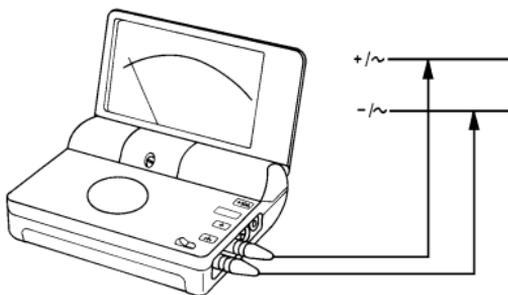


### Attention!

Regardless of the magnitude of the voltage being measured, for safety reasons, the sum of the voltage being measured and the voltage to earth must not exceed 1000 V CAT I, 600 V CAT II, 300 V CAT III when the multimeter is connected directly!

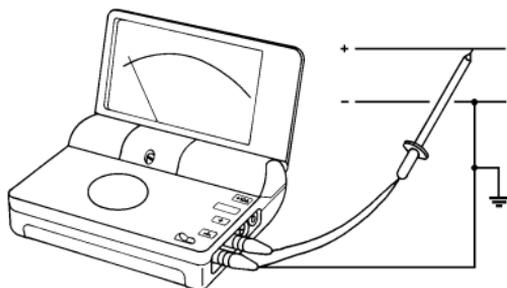
If possible, take the connection socket, marked "↗", immediately to earth or to the point having the lowest potential to earth when making any voltage measurements. The ranges 100 mV ... 3 V can continuously be overloaded up to 250 V<sub>rms</sub>, the ranges 10 V ... 1000 V up to 1200 V<sub>rms</sub> continuously.

### 5.3.1 DC and AC Voltages up to 1000 V (Direct Connection)



- Set the range switch to position 1000 V<sub>DC</sub> or 1000 V<sub>AC</sub>.
- Connect the measuring leads to the instrument: the (black) measuring lead to socket "+", and the (red) measuring lead to socket "↗". For safety reasons, leads with connection plugs that are protected against accidental contact (KS 17) should be used.
- Apply the voltage to be measured to the measuring leads. With DC voltage note the polarity!
- Set switch to position "I".
- Work down to lower voltage ranges until optimum indication is obtained.
- Read the measuring voltage on the VA scale.

### 5.3.2 DC Voltages up to 30 kV with High Voltage Probe HV 30



⇒ Set the range switch to position 30 V $\overline{\text{---}}$ , 100 V $\overline{\text{---}}$  or 300 V $\overline{\text{---}}$ .

Measuring Range	3 kV	10 kV	30 kV
Range Switch at position	30 V $\overline{\text{---}}$	100 V $\overline{\text{---}}$	300 V $\overline{\text{---}}$
Reading on V, A scale	0 ... 30	0 ... 100	0 ... 30
Multipl. Factor	x 0,1	x 0,1	x 1

Additional error in indication < 6 % of the full scale value. Furthermore, class 5 applies to the instrument as it is used as current measuring instrument with 30, 100 and 300 V $\overline{\text{---}}$  for the full scale value (Chapter 3 "Technical Data", Footnote 1) on the voltage measuring ranges 3, 10 and 30  $\mu\text{A}$ .



#### Attention!

For safety reasons, observe the following when measuring voltages above 1000 V to earth:

Lay the multimeter onto an insulated surface and connect the measuring leads in such a way that the protective lead of the probe and the „ $\text{⏏}$ ” socket are directly taken to the protective conductor (earth) potential. First, set the range switch to one of the positions indicated above, and only then turn on the voltage and scan with the probe respectively.

**Do not touch the instrument when the voltage to be measured is applied!**

## 5.4 Current Measurement



### Attention!

The multimeter should be connected into the line having the lowest voltage to earth. For safety reasons, the voltage to earth must not exceed 1000 V CAT I, 600 V CAT II, 300 V CAT III!

The measuring circuit must be set up mechanically solid and protected against accidental opening. The conductor cross sections and the connection points must be designed in such a way that there will be no unpermissible warm-up. The current measuring ranges 10  $\mu\text{A}$  ... 1 A are protected by a 1.6 A super-quick-action melting fuse (FF 1.6/250 G) in conjunction with power diodes. The maximum breaking capacity of the: protective means is 200 A $\sim$  (one half wave) at a nominal voltage of 250 V and ohmic load. Also see Chapter 4.2.

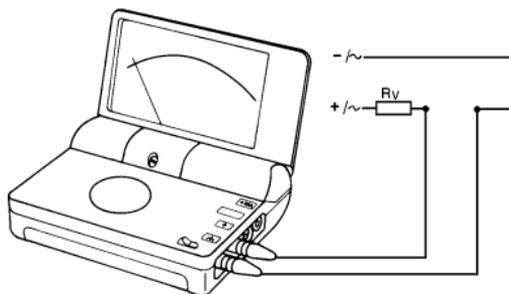


### Attention!

Upon cut-out of the protective means, first eliminate the cause of overload and only then put the instrument back to serviceable condition!

The 10 A range is not fitted with protective means.

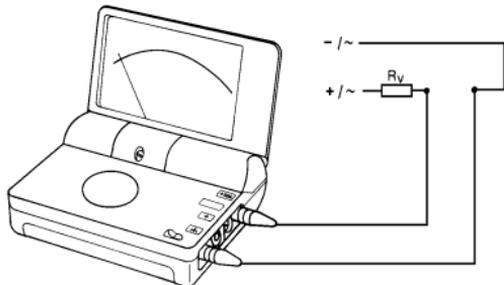
### 5.4.1 DC and AC Currents up to 1 A (Direct Connection)



- ✦ Disconnect the power supply to the measuring circuit and/or power consumer ( $R_v$ ), and discharge all capacitors, if available.
- ✦ Set the range switch to position 1 A $\sim$  or 1 A $\sim$ .
- ✦ Connect the measuring leads to the instrument: The (black) measuring lead to socket „-“ and the (red) measuring lead to socket „+“.
- ✦ Interrupt the measuring circuit and safely connect the measuring leads (without transient resistor!) in series with the power consumer  $R_v$ . With DC current note the polarity!
- ✦ Set switch to position „|“.

- ⇒ Reconnect the power supply to the measuring circuit.
- ⇒ Work down to lower current measuring ranges until optimum indication is obtained. Switching over does not interrupt the measuring circuit.
- ⇒ Read the measured value on the V, A scale.

#### 5.4.2 DC and AC Currents up to 10 A (Direct Connection)

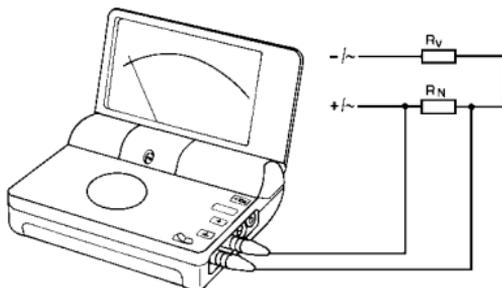


#### Attention!

The 10 A range is not fitted with protective means. Maximum loading capacity: 12 A continuously and 20 A up to 30 seconds.

- ⇒ Disconnect the power supply to the measuring circuit and/or power consumer ( $R_V$ ), and discharge all capacitors, if available..
- ⇒ Set the range switch to position 1/10 A $\text{---}$  or 1/10 A $\text{~}$ .
- ⇒ Connect the measuring leads to the instrument: The (black) measuring lead to socket „-“ and the (red) measuring lead to socket „+10 A“.
- ⇒ Interrupt the measuring circuit and safely connect the measuring leads (without transient resistor!) in series with the power consumer  $R_V$ . With DC current note the polarity!
- ⇒ Set switch to position „I“.
- ⇒ Reconnect the power supply to the measuring circuit.
- ⇒ Read the measured value on the V, A scale 0 ... 100.

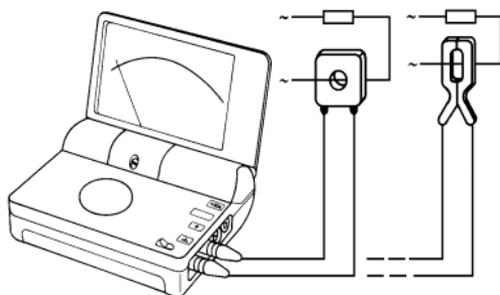
### 5.4.3 DC and AC Currents above 10 A with External Shunt



Measurements of currents above 10 A are possible with shunts ( $R_N$ ), e.g. 100 A/100 mV.

- Set the range switch to position 100 mV, for instance, depending on the voltage drop at the shunt.
- Then proceed according to Chapter 5.4.1.

### 5.4.4 AC Currents with (Clip-on) Current Transformers





### Attention!

Prior to closing the primary circuit, verify that the secondary circuit is closed. If current transformers are operated in open state on the secondary side, e.g. due to defective or not connected leads, due to a blown fuse because of prior overload, or due to a wrong position of the range switch (not on the current range), dangerously high voltages can appear at the connection terminals. Therefore, first check that the current circuit of the measuring instrument and the secondary winding of the transformer which is connected to the instrument form an uninterrupted measuring circuit. This can be done for all measuring ranges by means of a resistance measurement as described in Chapter 5.6.

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Clip-on current transformers allow for measurements of AC currents without the need to interrupt the operating circuit. For the use of both bushing type current transformers and clip-on current transformers the maximum permissible operating voltage is the rated voltage of the current transformer. Take into account the additional error in indication.

- ⇨ Set the range switch to position ... A $\sim$ .
- ⇨ Read the measured value and consider the transformer ratio.

## 5.5 Measurement of Composite Voltages and Composite Currents

The multimeter allows for separate measurements of DC and AC components of composite voltages and composite currents.



### Attention!

The sum of the DC and AC components of the measured variable shall not exceed the permissible limit values for overload according to Chapter 4, and/or the response values of the protective means!

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### 5.5.1 Composite Voltages

Perform the measurement in accordance with Chapter 5.3.

#### DC voltage measurement with superimposed AC voltage

The AC voltage component may be 5 times the full scale value on 50 Hz and 50 times the full scale value from 500 Hz on. The additional error is then smaller than 1.5% of the full scale value.

#### AC voltage measurement with superimposed DC voltage

The sum of the AC voltage and the superimposed DC voltage shall not exceed the permissible limit values for overload according to Chapter 4.

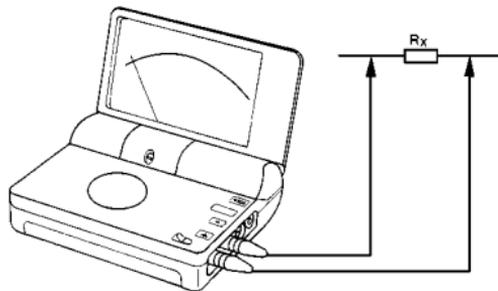
### 5.5.2 Composite Currents

Perform the measurements according to Chapter 5.4.

On the  $10 \mu\text{A} \approx \dots 100 \text{ mA} \approx$  measuring ranges, the sum of DC and AC component causes an erroneous indication from the threefold full scale value on up due to the response of the protective means.

On the  $1 \text{ A} \approx$  and  $10 \text{ A} \approx$  measuring ranges, the total current may be as high as 1.2 times the full scale value continuously and 2 times the full scale value temporarily.

## 5.6 Resistance Measurement



For resistance measurement, the resistance  $R_x$  to be measured is switched in parallel to the internal resistance. That is why with open input terminals ( $R_x = \infty$ ) the scale value  $\infty$  (full scale deflection) is indicated. The polarity of the voltage to be measured corresponds to the markings on the connection sockets „+“ and „-“. The resistance measuring ranges  $\Omega \times 1$  10 and  $\Omega \times 100$  are protected by a superquick-action melting fuse FF 1,6/250 G in conjunction with power diodes. The overload limit of the protective means is 200 A $\approx$  at a maximum (one half wave) on 250 V $_{\text{eff}}$ . The ranges  $k\Omega \times 1$  and  $k\Omega \times 10$  can be loaded up to 250 V $_{\text{eff}}$  for 5 minutes.



### Attention!

Upon cut-out of the protective means, first eliminate the cause of overload and only then put the instrument back to serviceable condition.

On the ranges  $\Omega \times 1$ ,  $\Omega \times 10$  and  $\Omega \times 100$  the open-circuit voltage at the sockets is approximately 100 mV. The voltage across the device under test can be read on the 0 ... 100 graduation, whereby 100 scale parts correspond to 100 mV.

On the ranges  $k\Omega \times 1$  and  $k\Omega \times 10$  the open-circuit voltage at the sockets is approximately 1 V. The voltage across the device under test can be read on the 0 ... 100 graduation, whereby 100 scale parts correspond to 1 V. Because the open-circuit voltage is approximately 100 mV on the ranges  $\Omega \times 1$ ,  $\Omega \times 10$  and  $\Omega \times 100$ , resistance measurements are possible on circuit boards that are also equipped with semi-conductors.

- ⇨ Set the range switch to position  $\Omega \times 1 \dots k\Omega \times 10$ .
- ⇨ Set switch to position „I“.
- ⇨ With adjustment potentiometer, adjust to full scale deflection  $\infty$ .
- ⇨ Connect the measuring leads to the sockets „+“ and „ $\rightarrow$ “.
- ⇨ Connect the resistance to be measured  $R_x$  to the measuring leads.
- ⇨ Read the resistance value on the  $\Omega$  scale giving consideration to the multiplication factor.



### Attention!

Only electrically dead items may be measured. External voltages would falsify the measured result.

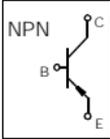
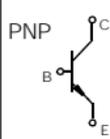
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After the range switch has been switched from one resistance measuring range to another, always check the full scale deflection  $\infty \Omega$  and correct with potentiometer, if required.

## 5.7 Test of Diodes and Transistors

The resistance measuring ranges  $k\Omega \times 1$  and  $k\Omega \times 10$  are also suited for coarse functional tests of diodes and transistors. A short circuit or an interruption of a diode and/or a diode path between base, collector and emitter of a transistor can be found in a simply way with a "resistance measurement". The polarity of a diode and the base connection of a transistor can also be found in this way. The device under test cannot be destroyed as the measuring voltage is 1 V at a maximum and the measuring current. 2.2  $\mu\text{A}$  or 22  $\mu\text{A}$  at a maximum. From this limitation of the measuring voltage and the measuring current it follows, however, that semi-conductors with relatively high reverse and/or residual current, such as power diodes and power transistors, for instance, and also rectifiers with several series-connected elements cannot be tested as, due to the small measuring current, the difference between the readings in forward and/or reverse direction are not sufficiently marked.

- ⇨ Set the range switch to position  $k\Omega \times 1$  or  $k\Omega \times 10$ .
- ⇨ Set switch to position „I“.
- ⇨ With adjustment potentiometer adjust to full scale deflection  $\infty$ .
- ⇨ Connect the measuring leads to the sockets „+“ and „ $\rightarrow$ “.
- ⇨ Connect diode or transistor according to the following table and measure both in forward and reverse direction.

Measurement in	Diode		Transistor			
						
	on socket					
Forward direction	+		+			+
Reverse direction		+		+	+	

B= Basis C= Collector E= Emitter

- Read the resistance value on the  $\Omega$ -scale and the voltage on the V, A scale with the 100 part graduation.

### Valuation of a diode and/or the diode path of a transistor

A diode and/or a transistor functions when the indication on the V, A scale during a measurement in forward direction is smaller than the indication during a measurement in reverse direction. The qualitative behaviour and the technical data of the semi-conductor can, however, not be judged by the degree of deflection; mainly the current gain of a transistor is not picked up. When measuring in reverse direction, the multimeter indicates the voltage on the diode path on the  $k\Omega \times 10$  range (1 V for full scale value). The reverse current flowing thereby is the difference between the full scale value (graduation 100) and the indication. One graduation corresponds to 10 mV and/or 22 nA. A diode and/or a transistor is interrupted when  $\infty$  or the same value close to  $\infty$  is indicated on the  $\Omega$ -scale in both directions (insulation resistance). A diode and/or a transistor has a short between the connection electrodes when 0 or the same value close to 0 is indicated on the  $\Omega$ -scale in both directions.

## 6 Maintenance

### 6.1 Battery

The state of the battery should be checked from time to time. A discharged or deteriorating battery shall not be left in the battery compartment. When a check of the battery voltage according to Chapter 5.2 shows that the pointer is beyond the zone for the battery check then the battery needs to be replaced as described in Chapter 5.2.



#### Attention!

Install a leak-proof battery only. Use a 9 V flat cell battery according to IEC 6 F 22. Instead of a manganese dioxide cell an alkaline-manganese cell or a NiCd storage battery can be used as well. A NiCd storage battery is particularly recommended at ambient temperatures below 0 °C.

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### 6.2 Melting Fuse

The built-in melting fuse for the measuring circuit can be checked for continuity on the resistance measuring ranges, preferably on the  $\Omega \times 1$  range. With the measuring sockets „+“ and „ $\rightarrow$ “ shorted, the resistance of the fuse must be indicated to be approximately 0,2  $\Omega$ .

The melting fuse blows when one of the current measuring ranges (except for the range 10 A  $\approx$ ) or one of the resistance measuring ranges  $\Omega \times 1 \dots \Omega \times 100$  and higher is overloaded unpermissibly high. The fuse is located immediately behind the „+“ connection terminal. When the fuse has blown, only the battery voltage check and the 10 A range continue to function. Replace the G type melting fuse link FF 1.6/250 G as follows:

- ↪ Disconnect the measuring instrument from the measuring circuit!
- ↪ Open the G type cover cap of the fuse holder with the aid of an adequate tool by maRing left turns.
- ↪ Remove the fuse and replace it with a new one.



#### Note!

In the cover of battery compartment two spare fuses are available. Opening this cover of battery compartment is described in Chapter 5.2, "Installing the battery".

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- ↪ Insert the G type cover cap together with the fuse.



### **Attention!**

Absolutely verify that only the specified fuse FF 1.6/250 G will be used. If a fuse of other breaking characteristics, other nominal current or other switching capacity is used, then there is danger of damaging power diodes, resistors or other components!

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## **6.3 Housing**

No special maintenance is required for the housing. Excessive contamination has an adverse effect on isolation and reduces input resistance. The surface must be kept clean for this reason. Use a slightly dampened cloth for cleaning. Avoid the use of cleansers, abrasives or solvents.

## **7 Repair and Replacement Parts Service DKD Calibration Lab and Rental Instrument Service**

When you need service, please contact:

GOSEN-METRAWATT GMBH  
Service-Center  
Thomas-Mann-Straße 16 - 20  
D-90471 Nürnberg  
Phone +49 911 86 02 - 410 / 256  
Fax +49 911 86 02 - 2 53  
e-mail fr1.info@gmc-instruments.com

This address is only valid in Germany.

Please contact our representatives or subsidiaries for service in other countries.

## **8 Product Support**

When you need service, please contact:

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