022. 600. 154

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Operating instructions

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MI7033

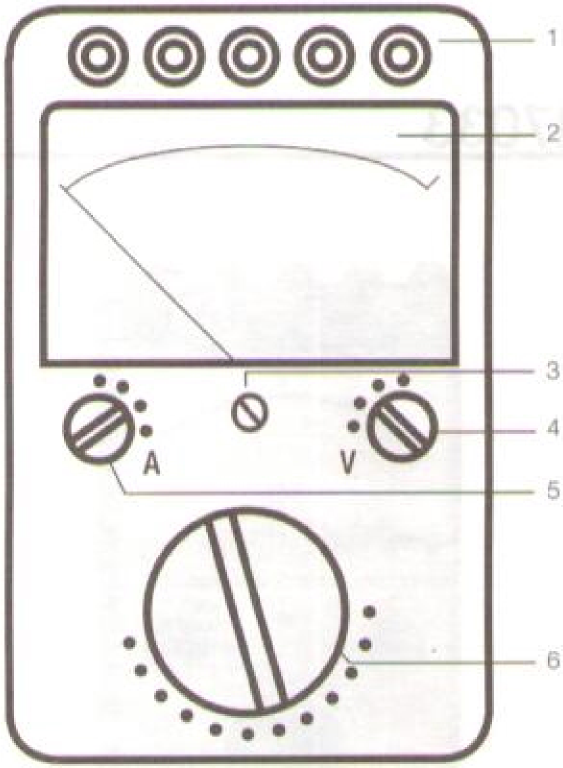


Fig. 1

Operating controls

1	Connection terminals	Current	I* (1), I (3)
		Voltage	L1 (2), L2 (5), L3 (8)
2	Mirror scale		
3	Mechnical zero adjuster		
4	Selector switch for voltage ranges		50 V / 100 V / 250 V / 500 V
5	Selector switch for current ranges		0.25 A /1 A /5 A / 25 A
6	Function switch		

Symbols

The position of the function switch is marked by symbols. Where:

O	Meter in the "OFF" position
⊣⊢ –1	Battery test for the voltage path of the meter
⊣⊢ –2	Battery test for the current path of the meter
≋	Measurement of the active power on a three-wire, three-phase systems, balanced load
≂	Measurement of the active power on a DC and single-phase AC system
U~	Measurement of AC voltage
I~	Measurement of AC current
U⎓	Measurement of DC voltage
I⎓	Measurement of DC current
cos φ ind	Measurement of the power factor, inductive
cos φ cap	Measurement of the power factor, capacitive
L1L2L3	Phase sequence indication
⚠	Danger warning ((Caution: Note documentation)

Contents

1 Safety precautions

The multi-function power meter MI 7033 is constructed and tested in compliance with the safety rules of DIN VDE 0410 / IEC 414 and VDE 0411 - 1 / EN 61010 - 1 / IEC 1010 - 1. When properly used, the safety of both the user and the meter is assured. Their safety is not assured, however, if the meter is misused or carelessly handled.

To maintain the technically safe and proper condition and to ensure safe operation, it is absolutely necessary to carefully and completely read these operating instructions before using the meter, and to follow them in all respects.

Please note the following safety precautions:

- The meter must only be operated by persons who understand the danger of shock hazards and know how to apply safety precautions. Shock hazards exist wherever voltages of more than 50 V can appear.
- When making measurements where shock hazards exist, do not work alone. A second person must be present.
- The *maximum permissible voltage* between any of the connectors and ground *is 650 V.*
- Take into account that unexpected voltages can appear on devices under test, capacitors may be charged dangerously, for instance.
- Verify that the test leads are in good condition, e.g. no cracked insulation, no open circuits etc.
- This meter must not be used for measurements on circuits with corona discharge (high voltage).
- Measurements under moist environmental conditions are not permitted.
- Absolutely verify that overloading of the nominal voltage and nominal current ranges does not exceed the permissible limits. See "Specifications" for limits.

Repair, replacement of parts and calibration

When opening the meter, live parts may be exposed. Therefore, the meter must be disconnected from all voltage sources prior to opening its case for repair, replacement of parts or calibration. If repair or calibration can then not be avoided unless the meter is open and live, this work must only be performed by a qualified person who understands the danger involved.

Faults and extraordinary stress

When it must be assumed that safe operation is no longer possible, take the meter out of service and secure it against accidental use. It must be assumed that safe operation is no longer possible,

- when the meter shows obvious signs of damage,
- when the meter no longer functions correctly,
- after prolonged storage under adverse conditions,
- after severe transportation stress.

2 Applications

The electronic multi - function power meter MI 7033 permits direct power measurements on DC systems as well as active power measurements on single - phase AC systems and on three - wire, three - phase systems of balanced load.
In addition, the MI 7033 power meter can be used to directly measure current and voltage on DC and single - phase AC systems.
Under consideration of correction factors, it is also possible to use the meter for reactive power measurements on three - phase systems of balanced load and also for interlinked voltages.
The MI 7033 power meter is particularly suited for industrial measurements, for service and mounting. Also in the laboratory and in the test room, diversified measuring tasks can be solved quickly and without problems.

3 Getting started

3.1 Description of the operating controls

There are five connection terminals (1, figure 1), arranged on the front of the power meter, two for current connection with the markings I* (1) and I (3) and three for voltage connection with the markings L1 (2), L2 (5) and L3 (8). They are contact-protected.
The operating panel of the power meter consists of:
One selector switch for the voltage ranges (4, figure 1), with the four ranges 50 V, 100 V, 250 V and 500 V.
One selector switch for the current ranges (5, figure 1), which can be switched in four ranges 0.25 A, 1 A, 5 A and 25 A. One function switch (6, figure 1) featuring 12 positions.

3.2 Installing the batteries

Caution: ⚠ Make an all-pole disconnection of the meter from the measuring circuits before you open the battery compartment on the bottom!

- Undo the slotted screw of the battery compartment cover using an adequate tool or a coin, and remove the cover.
- Install two 9-V flat cell batteries 6F22, 6LF22 or 6LR61 according to IEC 86-2 in the two compartments.

Caution: ⚠ Except for the specified 9-V flat cell batteries, no other voltage souces must be connected to the battery connection contacts. The connection contacts must not be connected with each other!

- Replace the cover and screw-tighten it.

3.3 Mechanical zero check

- ➪ Check that the meter is switched off.
- ➪ Place the meter in a horizontal position.
- ➪ Check the mechanical zero position of the pointer.
- ➪ If required, correct the zero position with the adjuster " ▷0◁ " on the front panel.

3.4 Battery test

- ➪ To test the battery for the voltage path and the battery for the current path, set the function switch to the positions " ⊣⊢ 1" and " ⊣⊢ 2", one after another. When, at a time, the pointer is within the battery section marked " ⊣⊢ " on the scale, the battery voltages are within the permissible range.
  It is assured that the error limits according to the data given in section 5. "Specifications" are maintained.

4 Measurement

4.1 Notes on measurements

- ➪ Prior to connecting the meter, check according to which of the circuitries shown in the following section the MI 7033 is to be connected.
- ➪ Find out whether direct connection of current path and voltage path is possible on the basis of the system on which the measurements are to be made and with respect to the power to be measured.

Caution: ⚠ In systems having a voltage of more than 600 V, measurements must, on principle, only be made via current and voltage transformers!

The nominal currents and nominal voltages of the meters correspond to those of commercial current transformers with secondary currents of 1 A and 5 A, and the standardized voltage transformers with secondary voltages of 100 V or 110 V.

- ➪ When using current transformers, consider the secondary load. Particularly with longer connection leads and with a transformer having a secondary current of 5 A, the power loss on the lines is often remarkable.
- ➪ Set up the current path mechanically solid and secure it against accidental opening. Lay out the cross sections of the leads and the connection points in such a way that they will not heat-up unpermissibly. For currents *above 5 A*, the *connections* must *always* be made *as screw connections* (e.g. with cable lugs), but not as plug connections.
- ➪ Prior to measuring, always set the selector switch for the current ranges and that for the voltage ranges to the highest range. Make sure that the *set nominal values* are *never exceeded by more than 1.2 times.*
- ➪ For power measurements on DC and single-phase AC systems, set the function switch to the " ≂ " position, for power measurements on three-wire, three-phase systems of balanced load to the " ≋ " position.
- ➪ To measure the power factor (cos φ), set the function switch to "cos φ ind" with inductive load, with capacitive load to "cos φ cap". The connection circuitries for active power and power factor measurements (cos φ) are identical and are shown later.
- ➪ Switch the meter off after the measurement to avoid unnecessary load on the batteries (function switch set to position " O ").

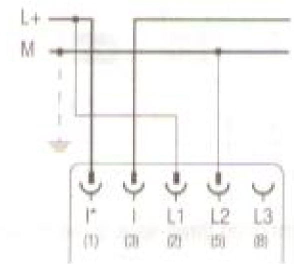
- The symbols used in the equations of the connection circuitries have the following meaning:

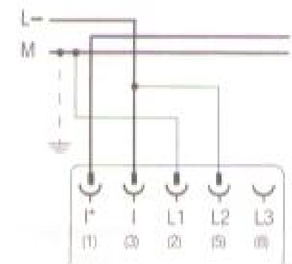
P	=	Active power in W
Q	=	Reactive power in var
I	=	Load current of a phase in A
U	=	Interlinked generator voltage with three-phase connection in V
cos φ	=	Power factor
α	=	Readout of the pointer deflection on the corresponding instrument scale in W, V or A
α φ	=	Readout of the pointer deflection on the cos φ scale
$c_{\approx}$, $c_{\simeq}$	=	Scale factor for power measurement
c_I, c_U	=	Scale constant for current and voltage measurement
$\ddot{u}_I$, $\ddot{u}_U$	=	Ratio of the current and/or voltage transformer

4.2 Connection circuitries

Current and voltage input takes place on the meter via connectors which are suited for both plugging (banana plugs) and as terminals (e.g. cable lugs). The current path is run to the two connectors **I*** (1) and **I** (3), the voltage path to connectors **L1** (2), **L2** (5) and **L3** (8). For DC current and for single-phase AC systems, the voltage must be applied to **L1** (2) and **L2** (5), for three-wire, three-phase systems (without neutral conductor) to **L1** (2), **L2** (5) and **L3** (8).
Following is a presentation of the wiring diagrams. The most important diagrams are also affixed to the rear of the meter.

Power measurement on DC systems

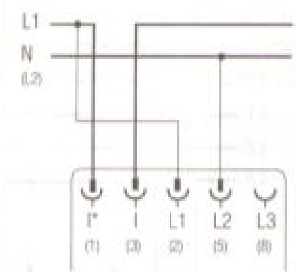




$P\,(W) = I \cdot U = \alpha \cdot c_{\simeq}$

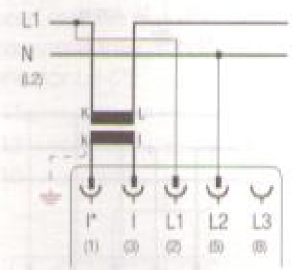
Active power and power factor measurement on single-phase AC systems

Direct connection



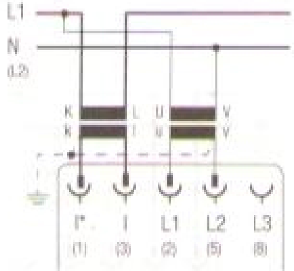
$P\,(W) = I \cdot U \cdot \cos\varphi$
$= \alpha \cdot c_{\simeq}$

Connection via current transformer:



$P\,(W) = I \cdot U \cdot \cos\varphi$
$= \alpha \cdot c_{\simeq} \cdot \ddot{u}_I$

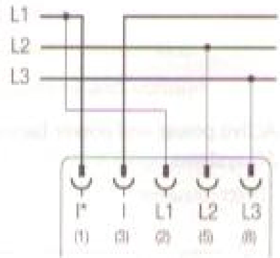
Connection via current and voltage transformers:



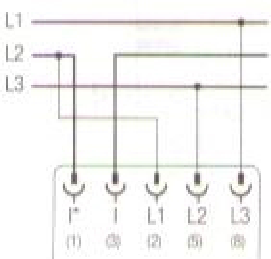
$P\ (W) = I \cdot U \cdot \cos\varphi$
$= \alpha \cdot c$ ≋ $\cdot\ \ddot{u}_I \cdot \ddot{u}_U$

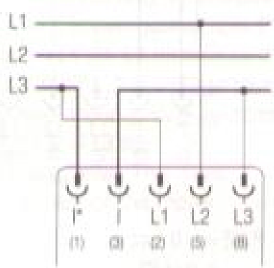
Active power and power factor measurement on three-wire, three-phase systems, balanced load

Direct connection:

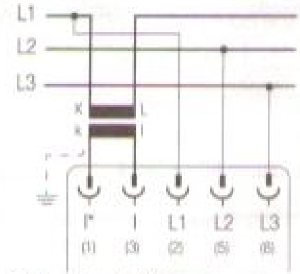


$P\ (W) = \sqrt{3} \cdot I \cdot U \cdot \cos\varphi$
$= \alpha \cdot c$ ≋



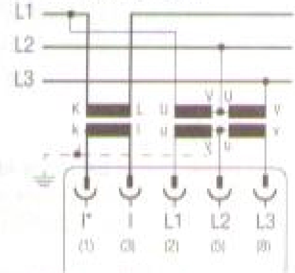


Connection via current transformers:



$P\ (W) = \sqrt{3} \cdot I \cdot U \cdot \cos\varphi$
$= \alpha \cdot c$ ≋ $\cdot\ \ddot{u}_I$

Connection via current and voltage transformers:

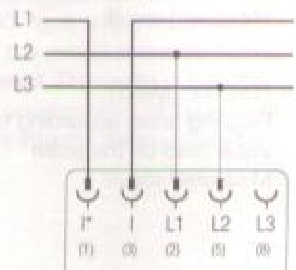


$P\ (W) = \sqrt{3} \cdot I \cdot U \cdot \cos\varphi$
$= \alpha \cdot c$ ≋ $\cdot\ \ddot{u}_I \cdot \ddot{u}_U$

Reactive power measurement on three-wire, three-phase systems of balanced load

It is easy to determine the reactive power on three-wire, three-phase systems of balanced load. Set the function switch to the " ≂ " position. To obtain the reactive power, multiply the found value (pointer deflection x scale factor) by the factor of $\sqrt{3}$. With a connection according to the following wiring diagram and a positive indication, the measured reactive power is inductive. With a negative pointer deflection, the measured reactive power is capacitive. To obtain a positive indication, transpose the connection L1 and L2 on the meter (cond. L2 to connector L2 (2)).

Direct connection:



$Q\ (var) = \sqrt{3} \cdot I \cdot U \cdot \sin\varphi$
$= \sqrt{3} \cdot \alpha \cdot c$ ≂

4.3 Measured results

To determine the measured active power, it is merely required to multiply the pointer deflection α with the constant c, and eventually with the transformer ratios. In any case, it applies:

$$P\,(W) = \alpha \cdot c \cdot \ddot{u}_I \cdot \ddot{u}_U$$

Example 1:

Direct connection of the meter for single-phase AC systems

Selected nominal current range	5 A
Selected nominal voltage range	100 V

a)	Function switch	in position „≂"
	Reading scale according to table	0 ... 500
	Value read off the scale	e.g. 350
	Measured result:	$P = \alpha \cdot c = 350 \cdot 1$ $= 350$ W
b)	Function switch	in position „U∼"
	Reading scale according to table	0 ... 100
	Value read off the scale	e.g. 100
	Measured result:	$U = \alpha \cdot c_U = 100 \cdot 1$ $= 100$ V
c)	Function switch	in position „I∼"
	Reading scale according to table	0 ... 500
	Value read off the scale	e.g. 500
	Measured result:	$I = \alpha \cdot c_I = 500 \cdot 0.01$ $= 5$ A
d)	Function switch	in position „cos φ ind"
	Reading scale according to table	cos φ
	Value read off the scale	e.g. 0.7
	Measured result:	$\cos\varphi = 0.7$

Example 2:

Meter connection for single-phase AC systems via current transformer

Switch positions, reading scale and read value same as in *Example 1*. But the current path is connected via a current transformer having a ratio of $\ddot{u}_I = 100\text{ A} / 5\text{ A} = 20$.

Measured result: $P = \alpha \cdot c \cdot \ddot{u}_I = 350 \cdot 1 \cdot 20 = 7000$ W

Exemple 3:

Meter connection for single-phase AC systems via current and voltage transformers

Switch positions, reading scale, read value and current transformer same as in *Example 2*. But the voltage path is connected via a voltage transformer having a ratio of $\ddot{u}_U = 1000\text{ V} / 100\text{ V} = 10$.

Measured result: $P = \alpha \cdot c \cdot \ddot{u}_I \cdot \ddot{u}_U = 350 \cdot 1 \cdot 20 \cdot 10 = 70000$ W

4.4 Internal consumption of the power meter and its influence on the accuracy

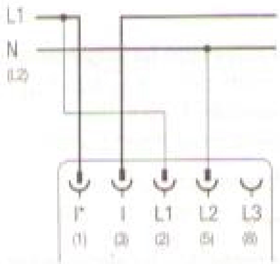
The MI 7033 power meter needs a certain amount of energy for the presentation of measured values. Due to the internal meter consumption, the measured value always includes an error. In most cases - particularly so when measuring higher power - the influence is so small that it can be neglected. When measuring smaller power (<100 W), it is recommended to consider the internal consumption of the power meter by mathematical correction of the measured result. Depending upon the connection circuit, either the internal consumption of the current path or that of the voltage path enters into the measurement.

The voltage path is connected in front of the current path

It follows:

a) The power output by the energy source =
meter indication +
internal consumption of the voltage path

b) The power drawn by the consumer =
meter indication –
internal consumption of the current path

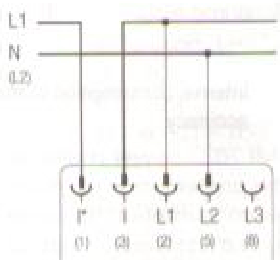


The voltage path is connected behind the current path

It follows:

a) The power output by the energy source =
meter indication +
internal consumption of the current path

b) The power drawn by the consumer =
meter indication –
internal consumption of the voltage path



See "Inputs" for the internal consumption of the power meter in section "5. Specifications".

4.5 Voltage and current measurement

Even if the meter is connected for a power measurement, you can use the power meter to measure voltages and currents on both DC systems and single-phase AC systems and/or three-wire, three-phase systems of balanced load. For DC and single-phase AC systems, the voltage must be applied to L1 (2) and L2 (5). Terminal L3 (8) must not be connected.
With three-wire, three-phase systems of balanced load (without neutral conductor), the voltages must be connected to terminals L1 (2), L2 (5) and L3 (8). With current measurements, the measuring current flows through connectors I* (1) and I (3).

4.5.1 Voltage measurement

On DC and single-phase AC systems

- Set the function switch to the U⎓ and/or U~ position and the selector switch for the voltage ranges to the range corresponding to the measured value. The selector switch for the current ranges may be set to any position.
- The voltage applied to terminals L1 (2) and L2 (5) can be read directly on the scale corresponding to the selected measuring range

On three-wire, three-phase systems of balanced load

- Set the function switch to the U~ position and the selector switch for the voltage ranges to the range corresponding to the measured value. The selector switch for the current ranges may be set to any position.
- Connect the voltage to terminals L1 (2), L2 (5) and L3 (8).
- Read the measured value off the scale corresponding to the selected measuring range
To determine the *phase voltage*, it is required to divide the *read voltage value by 3*.
To determine the *voltage of the outer conductors*, it is required to divide the *read voltage value by* $\sqrt{3}$.

4.5.2 Current measurement

- Set the function switch to the I⎓ and/or I~ position and the selector switch for the current ranges to the range corresponding to the measured value. The selector switch for the voltage ranges may be set to any position.
- Connect the current path to terminals I* (1) and I (3). Read the measured value off the scale corresponding to the measuring range and multiply it by the factor of 0.01 (see table in section 5. "Specifications").

4.5.3 Phase sequence indication

- Set the function switch to the L1L2L3 position.
- Connect all of the 3 outer conductors in proper sequence to terminals L1 (2), L2 (5) and L3 (8).
  With correct phase sequence, the pointer deflects up to the marking (83 % of full deflection), with incorrect phase sequence up to the marking (17 % of full deflection).
  The interlinked voltages must be > 30 V and must not exceed 650 V.
  The connected voltages may deviate from each other by a maximum of ± 5 %.

5 Specifications

Measuring ranges for DC and single-phase AC systems

Nominal current A	Nominal voltage V	Nominal power W	Factor c at a scale division of		
			0 ... 100	0 ... 250	0 ... 500
0.25	50	12.5	---	0.05	---
	100	25	---	0.1	---
	250	62.5	---	0.25	---
	500	125	---	0.5	---
1	50	50	---	---	0.1
	100	100	1	---	---
	250	250	---	1	---
	500	500	---	---	1
5	50	250	---	1	---
	100	500	---	---	1
	250	1250	---	5	---
	500	2500	---	10	---
25	50	1250	---	5	---
	100	2500	---	10	---
	250	6250	---	25	---
	500	12500	---	50	---

Measuring ranges for three-wire, three-phase systems, balanced load

Nominal current A	Nominal voltage V	Nominal power W	Factor c at a scale division of		
			0 ... 100	0 ... 250	0 ... 500
0.25	50	25	---	0.1	---
	100	50	---	---	0.1
	250	125	---	0.5	---
	500	250	---	1	---
1	50	100	1	---	---
	100	200	2	---	---
	250	500	---	---	1
	500	1000	10	---	---
5	50	500	---	---	1
	100	1000	10	---	---
	250	2500	---	10	---
	500	5000	---	---	10
25	50	2500	---	10	---
	100	5000	---	---	10
	250	12500	---	50	---
	500	25000	---	100	---

Measuring ranges

For DC and AC voltage

Nominal voltage V	Factor c at a scale division of		
	0 ... 100	0 ... 250	0 ... 500
50	---	---	0.1
100	1.0	---	---
250	---	1.0	---
500	---	---	1.0

For DC and AC current

Nominal current A	Factor c at a scale division of		
	0 ... 100	0 ... 250	0 ... 500
0.25	---	0.001	---
1	0.01	---	---
5	---	---	0.01
25	---	0.1	---

When measuring the power factor (cos φ), read the measured values off the cos φ scale without considering the factor c.

Inputs		
Voltage path	Nominal voltage U_N	50 V / 100 V / 250 V / 500 V
	Input resistance R_i	1 MΩ
Current path	Nominal current I_N	0.25 A / 1 A / 5 A / 25 A
	Input resistance R_i	8 mΩ
Voltage drop Δ_U at nominal current		2.1 mV / 8.4 mV / 42 mV/ 210 mV
Internal consumption P_i at nom. current		0.0005 VA / 0.0084 VA / 0.21 VA /5.25 VA
Electrical isolation		between voltage path and current path by optocoupler, test voltage 3 kV
Overload capacity		
Permissible continuous overload		on all nominal voltage and nominal current ranges 1.2 times the value of the selected nominal voltage and/or the selected nominal current. Exception 25 A range: Measurement 5 min at a maximum, interval 5 min
Accuracy		
Under reference conditions		Class 1.5 for power measurement Class 2.5 on all other ranges Class 5 for power factor measurement
On the 25 A range:		2 times the basic error (except for power factor measurement)
Reference conditions		
Ambient temperature		23 °C ± 2 K
Humidity		45 ... 55% RH
Position of use		horizontal
Frequency		45 Hz ... 65 Hz
Waveform on AC ~:		sinusoidal
Voltage For voltage measurement: For power factor measurement: 1) For phase sequence indication 2)		$0.8 \ldots 1.2 \cdot U_N$ $0 \ldots 1.0 \cdot U_N$ > 50 V > 30 V (dev. from each other max. ± 5%)
Current For current measurement: For power factor measurement:		$0 \ldots 1.2 \cdot I_N$ $0 \ldots 1.0 \cdot I_N$ $0 \ldots 1.2 \cdot I_N$ / 25 A : $0.3 \ldots 1.0 \cdot I_N$
Power factor For power factor measurement:		cos φ = 0 ... 0.866 ... 1 cos φ = 0 ... 0.95 ... 0.99
Battery voltage		6.6 ... 11 V (for each of the two batteries)
Other influence quantities		according to EN 60 051, IEC 51

Nominal ranges of use	
Temperature	0 ... 21 ... 25 ... 50 °C
Frequency	10 ... 16 ... 65 ... 400 Hz
For voltage measurement:	10 ... 16 ... 65 ... 200 Hz (... 400 Hz with ± 10% tolerance)
For current measurement:	10 ... 16 ... 65 ... 400 Hz
Influence quantities within the nominal ranges of use	
Temperature	for W: ± 1.5 % / 10 °K for V, A: ± 2.5 % / 10 °K
Other influence quantities	according to EN 60 051
Temperature ranges / climatic class	
Operational	0 ... +50 °C
Storage	−25 ... +65 °C
Climatic class	2z/0/50/75% with ref. to VDI / VDE 3540
Power supply	
Batteries	2 each 9-V flat cell batt. IEC 6F22, 6LF22 or 6LR61, each one for voltage and curr. path
Lifespan	200 h, approx.
Battery test	by battery test section on the scale
Electrical safety	
Protection class	II acc. to IEC1010-1/EN61010-1/VDE0411-1
Overvoltage category	III
Nominal voltage	300 V
Pollution degree	2
Nominal insulation voltage	650 V acc. to IEC 414/VDE 0410
Test voltage	3.7 kV acc. to IEC 1010-1/EN 61010-1
Mechanical configuration	
Indicator	Moving-coil movement
Scale length	96 mm
Protection type	IP 50 according to VDE 0470 Part 1
Dimensions	110 mm x 181 mm x 62 mm
Weight	ca. 0.8 kg

[1] The measurement is independent of the position of the selector switch for the voltage ranges. Symmetry error of the delta voltage with power factor measurement on three-phase systems is 0.5 % at a maximum.

[2] The measurement is of info. character only that is why no class accuracy is given. The indication is independent of the position of the selector switch for the voltage ranges.

6 Maintenance

6.1 Battery

If, when testing the battery, the pointer no longer reaches the battery test section " -|+ ", the corresponding battery must be replaced. Replace the exhausted battery with a new, 9-V flat cell battery 6F22, 6LF22 or 6LR61, as described in section 3.2 "Installing the batteries".

Caution: ⚠ Disconnect the meter from the measuring circuits before you open the battery compartment. Take care that the cover is replaced before you operate the meter again.