Measuring Instrument Meters

Objectives: At the end of this lesson you shall be able to
- **state the use of meters**
- **list the basic parts of a simple meter**
- **list the minimum specifications of any meter**
- **list the symbols used on meter dial and interpret their meaning.**

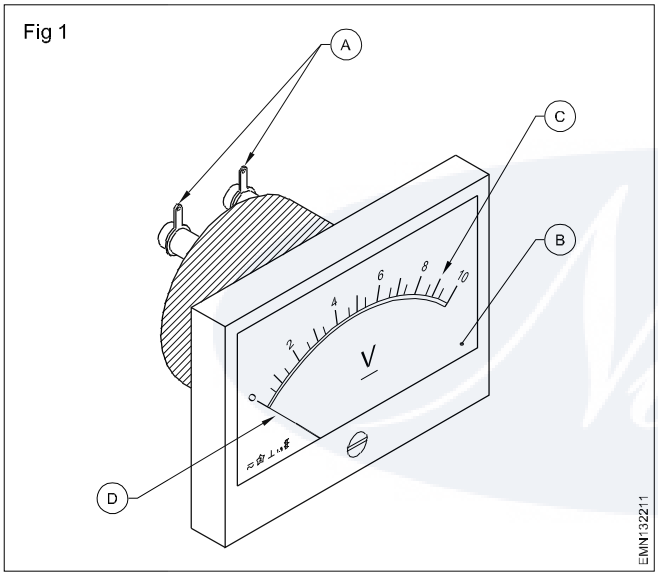
Meters

Meters are instruments used to measure electrical quantities like voltage, current, resistance etc.,

Measurement of electrical quantities is necessary while installing, operating, testing & repairing electrical & electronic equipments and circuits.

A simple meter is shown in Fig 1.

Fig 1



The electrical quantity to be measured is given to the input terminals (A) of the meter. The internal meter movement or mechanism moves the pointer(D) over the graduated scale(C) marked on a plate called the dial plate(B). The pointer stops at a point on the scale which corresponds to the magnitude of the input given at the input terminals(A).

Any simple meter must have the following minimum specifications.

[1] The electrical parameter it can measure.

Example: DC voltage, AC voltage, DC current, AC current, resistance and so on.

[2] The maximum quantity that it can measure.

Example: 10 volts, 100 volts, 1 ampere and so on.

The simple meter shown in Fig 1 can measure DC voltage. This can be found out from the symbol **V** marked on dial plate of the meter. All meters will have such symbols by which the user can identify the electrical parameter that the meter can measure. The different symbols used and their meanings are shown in Charts 1 at the end of this lesson.

Example 1: *A symbol V on a meter dial indicates,*

V for measuring voltage

~ for measuring AC.

This means, a meter with V symbol is for measuring AC voltage.

Example 2: *A symbol V on the meter dial indicates,*

V for measuring voltage

~ for measuring AC

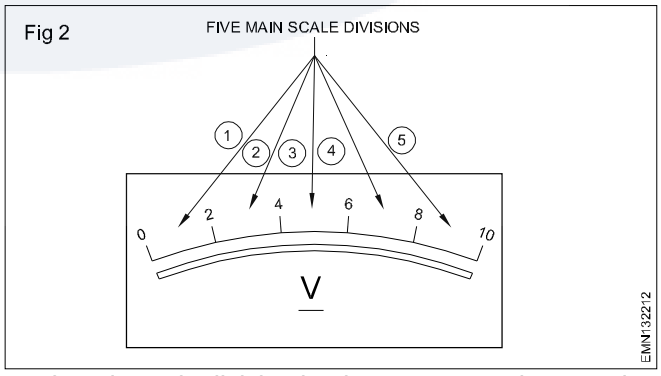
⎓ for measuring DC.

This means, a meter with V symbol is for measuring AC and DC voltages.

The meter scale as shown in Fig 1, is graduated/marked from 0 to 10. This means that this meter can measure up to a maximum of 10 volts. This is referred to as the maximum measurable value in that meter.

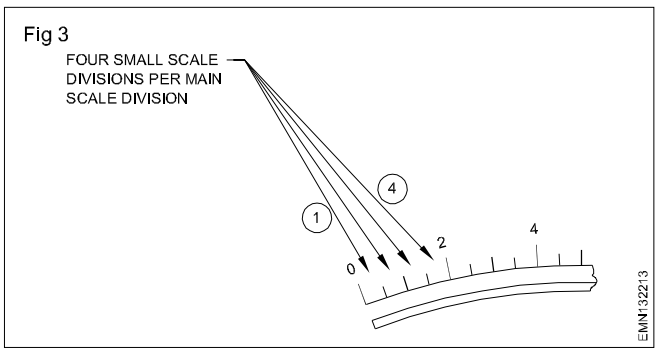
The meter scale of 0 to 10 is divided to 5 parts in steps of 2 volts as shown in Fig 2. Each division is called the Main Scale Division (MSD) of the meter scale.

Fig 2



Each main scale division in Fig 2 corresponds to 2 volts. Further each main scale division (say 0 to 2) is further divided into 4 more divisions as shown in Fig 3. These divisions are called Small Scale Divisions (SSD).

Fig 3



Each small scale division therefore corresponds to,

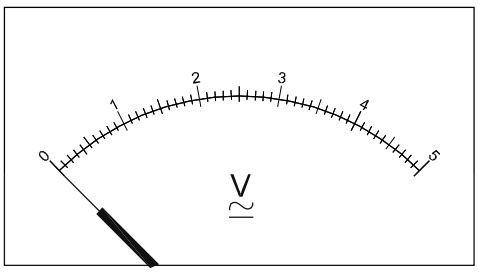
$$\frac{\text{Value of one main scale division}}{\text{Number of small scale division per main scale division}}$$

for fig.1, each SSD is, $\frac{2 \text{ volts}}{4} = 0.5 \text{ volts}$

Hence the smallest voltage that can be accurately measured using this meter is 0.5 volts. This is nothing but the value of one small scale division of the meter.

Example: *To find the maximum and minimum values that can be measured using a meter having a graduated scale as shown in Fig 4.*

Fig 4



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Maximum quantity the meter shown in Fig 4 can measure is equal to the full scale deflection value or the highest numeric on the right edge of the of scale = 5 volts.

Minimum quantity the meter can measure is equal to value of one small scale division

$$= \frac{\text{value of one main scale}}{\text{No. of small scale div/main div}}$$

$$= \frac{1 \text{ Volt}}{10 \text{ div}} = 0.1 \text{ volts.}$$

The minimum values that can be measured using the meter in Fig 4 is 0.1 volts and the maximum values that can be measured is 5 volts.

On the dial scale of any meter, in addition to the symbols indicating the electrical parameter (voltage, current etc) it can measure and the type of parameter (AC, DC, AC/DC), there are several other symbols. One of the important symbols to be identified before using the meter is the position symbol.

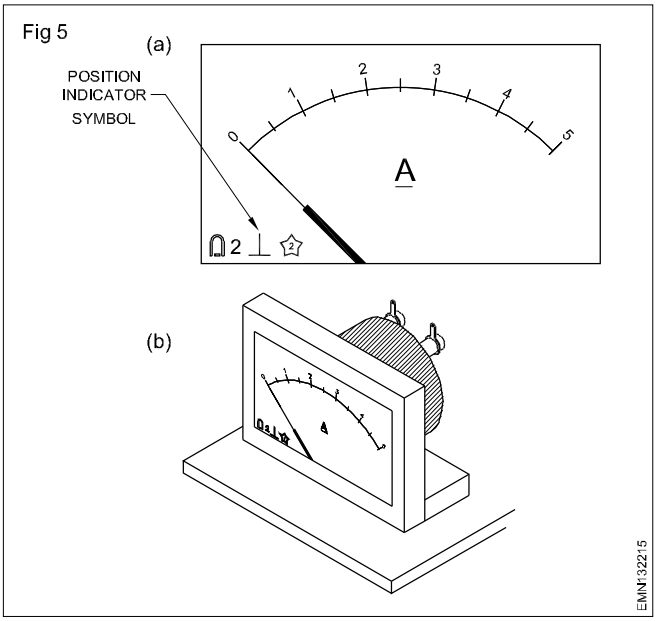
Fig 5(a) indicates a typical position symbol on the dial plate of a meter.

'⊥' symbol on the dial plate indicates that, the meter has to be positioned vertically (at right angle to the Table) as shown in Fig 5(b). If this meter is placed horizontally while taking measurement then, the readings shown by the meter will not be accurate.

Other symbols indicating the position in which a meter is to be kept while taking readings is given in the Chart 1 of this lesson.

[H.I Use Chart 1 and elaborate the meaning of the symbols in the classroom.]

Fig 5



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CLASSROOM EXERCISE

For a meter with dial plate markings as shown in Figure 6, referring to Chart 1 of this lesson, find;

i) the nature and type of electrical parameter it can measure

ii) the position in which the meter is to be kept while using

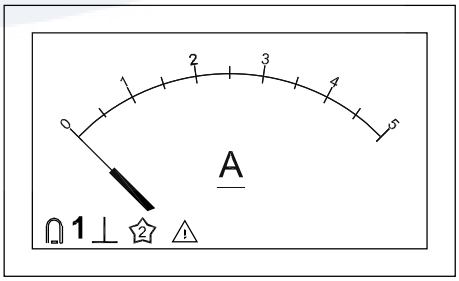
iii) the type of mechanism used for the pointer movement

iv) the percentage of error indicated in the meter reading

v) the maximum test voltage that can be applied

vi) the minimum and maximum quantity the meter can accurately measure.

Fig 6



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The meters discussed so far, can measure only one range of values. The meter shown in Fig 1 can measure 0 to 10 volts. The meter shown in Fig 4 can measure 0 to 5 volts. Such meters are called Single range meters. These meters are generally mounted on electrical panels, and on the front panel of power supply units. Hence, these meters are commonly referred to as panel meters.

One of the most common errors in meters is the Mechanical Zero error. This error is caused due to the mechanical movements involved in the meters. This error in meters is correctable. The steps involved to correct this error is called Mechanical zero setting of meters.

All meters will have a screw on it as shown in Fig 6. Keeping the terminals of the meter open, the screw is turned slowly to bring the pointer exactly to 0 position on

the meter scale. This means, with no voltage applied, the meter is made to show exactly zero volts.

Care has to be taken while turning this screw as this screw is directly connected with the sensitive and delicate meter movement. Turning the screw in large amounts or in jerks may damage the meter movement permanently making the meter unusable.

Before using a meter for measurements, it is necessary to check if the meter needle is moving freely over the graduated scale. There are possibilities that the meter movement may be sticky due to dust collection on the meter movement or due to the bent pointer needle.

A simple way to check sticky pointer/meter movement is to hold the meter in hand and tilt the meter back and forth gently, checking for the free movement of the pointer. If the pointer is not moving freely, it is advised not to use that meter for making measurements.

Voltmeters used for measuring DC voltages will have their input terminals marks +ve and -ve. For making voltage measurement, the +ve terminal of the meter must be connected to the +ve terminal of the battery and the -ve terminal of the meter to the -ve terminal of battery. If the terminals are reversed, the meter deflects below zero. This may cause temporary or sometimes permanent damage to the meter movement.

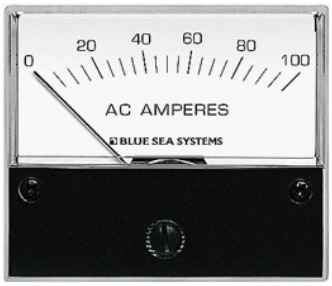
Measuring Instruments

a Introduction

- The instruments, which are used to measure any quantity are known as Measuring Instruments.
- Measurement of electrical quantities is necessary while installing, operating, testing & repairing electrical & electronic equipment's and circuits.
- To make electrical measurements the most popular instruments used are called Meters. Meter is a tool used to measure the basic electrical quantities such as Current, Potential difference (Volt) and Resistance.
- Following are the most commonly used electronic instruments.
  - i Voltmeter
  - ii Ammeter
  - iii Ohmmeter
  - iv Multi-meter
  - v Clamp Meter

b Ammeter

- Ammeter is an electronic instruments device used to determine the electric current flowing through a circuit. Ammeters measuring current in milli-ampere range is known as milli-ammeters.
- Ammeters are connected in series to the circuitwhose current is to be measured. Hence this electronic instruments are designed to have as Very Low resistance/ loading as possible.



- There are two types of ammeters: DC ammeter, and AC ammeter.
- DC ammeter measures the DC current that flows through any two points of an electric circuit. Whereas, AC ammeter measures the AC current that flows through any two points of an electric circuit.
- An example of practical AC ammeter is shown in figure which is a (0?100A) AC ammeter. Hence, it can be used to measure the AC currents from zero Amperes to 100 Amperes.

c Voltmeter

- Voltmeter is an electronic instruments used in an electric circuit to determine the potential difference or voltage between two different points.
- Voltmeters are usually connected in parallel (shunt) to the circuit. Hence they are designed to have High resistance as possible to reduce the loading effect.
- There are two types of voltmeters: DC voltmeter, and AC voltmeter i.e RMS value of Voltage.

- DC voltmeter measures the DC voltage across any two points of an electric circuit, whereas AC voltmeter measures the AC voltage across any two points of an electric circuit.
- An example of practical DC voltmeter is shown in figure which is a (0?10V)DC voltmeter. Hence, it can be used to measure the DC voltages from zero volts to 10 volts.

d Ohmmeter

- Ohmmeter is used to measure the value of Resistance between any two points of an electric circuit. It can also be used for finding the value of an unknown resistor.
- There are two types of ohmmeters: series ohmmeter, and shunt ohmmeter.
- In series type ohmmeter, the resistor whose value is unknown and to be measured should be connected in

series with the ohmmeter. It is useful for measuring high values of resistances.

- In shunt type ohmmeter, the resistor whose value is unknown and to be measured should be connected in parallel (shunt) with the ohmmeter. It is useful for measuring low values of resistances.
- An example of practical shunt ohmmeter is shown in the figure, which is a (0?100?)shunt ohmmeter. Hence, it can be used to measure the resistance values from zero ohms to 100 ohms.

e Multimeter

- Multi-meter is an electronic instrument used to measure the quantities such as voltage, current & resistance one at a time.
- This Multi-meter is also Known as Volt-Ohm-Milliammeter (VOM).
- It can be used to measure DC & AC voltages, DC & AC currents and resistances of several ranges.
- A practical multi-meter is shown in the figure, which can be used to measure various high resistances, low resistances, DC voltages, AC voltages, DC currents, & AC currents. Different scales and range of values for each of these quantities are marked in the figure.

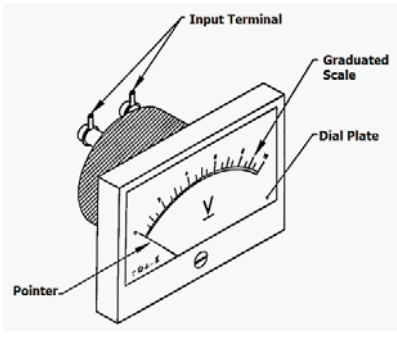
f Clamp meter

- A clamp meter is an electrical test tool that combines a basic digital multi-meter with a current sensor. It is also called a Tong Tester.
- Clamps measure current. Probes measure voltage. Having a hinged jaw integrated into an electrical meter allows technicians to clamp the jaws around a wire, cable or other conductor at any point in an electrical system, then measure current in that circuit without disconnecting/de-energizing it.
- Beneath their plastic mouldings, hard jaws consist of ferrite iron and are engineered to detect, concentrate and measure the magnetic field being generated by current as it flows through a conductor.

Principle and parts of simple meter

a Simple meter

- The electrical quantity to be measured is given to the Input Terminals of the meter. The internal meter movement or mechanism moves the Pointer over the Graduated Scale marked on a plate called Dial Plate.
- The pointer stopes at a point on the scale which corresponds to the magnitude of the input given at the input terminals.
- Any simple meter must have the following minimum specifications.
- The electrical parameter it can measure. Example: DC Voltage, AC Voltage, DC Current, AC Current, Resistance and so on.
- The maximum quantity that it can measure. Example: 10Volts, 100 Volts, 1 Ampere and so on.
- The simple meter shown figure can measure DC voltage. This can be found out from the symbol Vmarked on dial plate of the meter.
- All meters will have such symbols by which the user can identify the electricl parameter that the meter can measure.



b Graduated scale

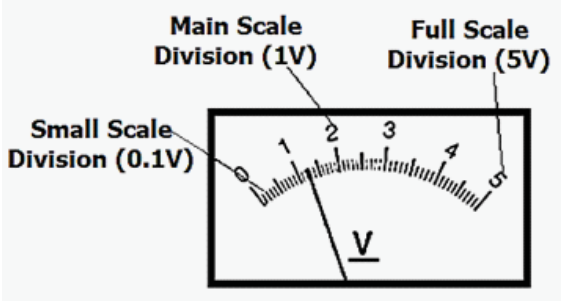
- The meter scale as shown in figure is graduated/ marked from 0 to 5. This means that this meter can measure up to a maximum of 5 Volts. The maximum reading of an analog meter is called Full Scale Deflection (FSD).

- The meter scale of 0 to 5 is divided to parts in steps of 1Volts. Each division is called Main Scale Division (MSD).
- Each Main Scale Division (MSD) is equal to,

$$\frac{\text{Full Scale Deflection}}{\text{Number of Main Scale Division}} = \frac{5}{5} = 1 \text{ Volts}$$

- Each main scale division corresponds to 1 volts. Further each main scale division (say 0 to 1) is further divided into 10 more divisions. These divisions are called Small Scale Divisions (SSD).
- Each Small Scale Division (SSD) therefore corresponds to,

$$\frac{\text{Value of one Main Scale Division}}{\text{Number of Small Scale Division per Main Scale Division}} = \frac{1}{10} = 0.1 \text{ Volts}$$

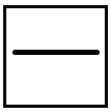


- Hence the smallest voltage that can be accurately measured using this meter is 0.1 Volts.

Symbol on meters

- The different symbols used and their meanings are detailed below:
- The following symbols indicate the reading of AC/DC:

Indicating the reading of AC/DC

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
	DC voltage or Current		AC voltage or current
	DC voltage or Current		AC/DC voltage or current

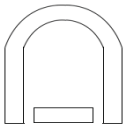
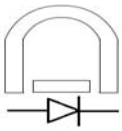
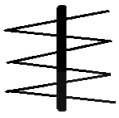
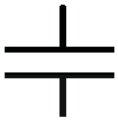
- The following symbols indicate type of meter:

Indicates type of meter

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
V	Voltmeter	A	Ammeter
mV	Milli - Voltmeter	mA	Milli - Ammeter
µV	Micro - Voltmeter	µA	Micro - Ammeter
Ω	Ohmmeter	OHMS	Ohmmeter

- The following symbols indicate the type of mechanism/ Principle of the meter pointer movement associated with the meter:

Type of mechanism/principle of the meter pointer movement

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
	Moving coil with permanent magnet		Hot wire
	Moving coil with rectifier		Bimetalic
	Moving iron		Electro static

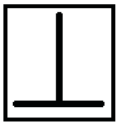
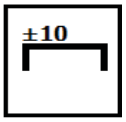
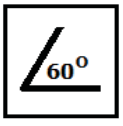
- The following symbols indicate percentage error in the indicated meter reading:

Percentage of Error

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
	± 1% Error expressed as a percentage of the end value of measuring range		±1.5 % Error expressed as a percentage of the end value of measuring range
	±2.5% Error expressed as a percentage of the end value of measuring range		± 1.5 % Error expressed as a percentage of the true value

- The following symbols indicate the placement position of the meter:

Placement position of the meter

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
	Vertical postition		Horizontal position
	Horizontal position with ± 10 error permissible		Inclind position

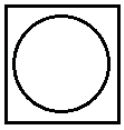
- The following symbols indicate special instructions that go with the meter:

Indicates special instructions that go with the meter

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
	No test voltage		Test voltage 1 Kilo volts
	Test voltage 2Kilo volts		Test voltage 500 volts

- The following symbols indicate special instructions that go with the meter:

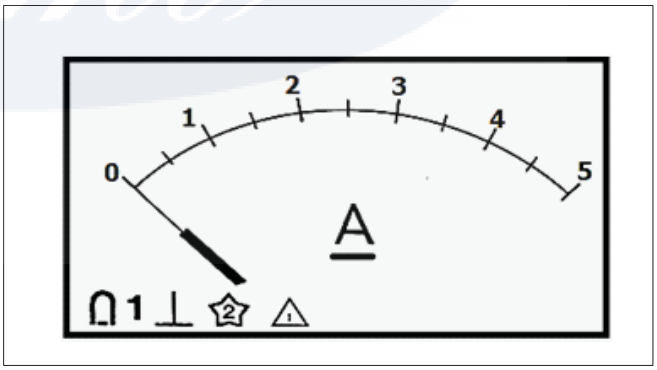
Indicates special instructions that go with meter

Symbol	Meaning of the symbol	Symbol	Meaning of the symbol
	Magnetic shield		Electrostatic shield
	Attention read instructions before use		

Simple Example:

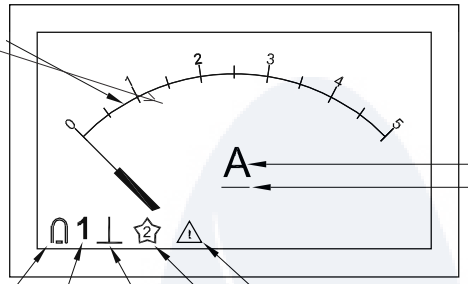
For a meter with dial plate markings as shown in figure, the following specifications can be identified:

- The nature and type of electrical parameter it can measure - DC Current, 0 - 5 Ampere.
- The position in which the meter is to be kept while using - Vertical Position.
- The type of mechanism used for the pointer movement - Moving Coil with Permanent Magnet.
- The percentage of error indicated in the meter reading - ±1% Error Expressed as a Percentage of the End Value of Measuring Range.
- The maximum test voltage that can be applied - Test Voltage 2 Kilovolts.



- The special instructions of the meter -Attention read instructions before use.
- The minimum and maximum quantity the meter can accurately measure - Minimum Quantity (SSD) - 0.5 A, Maximum Quantity (FSD) - 5 A.

SYMBOLS ON METERS



Indicates type of meter

Symbol on meter dial	Meaning of the Symbol
V	VOLTMETER
mV	milli–VOLTMETER
µV	micro–VOLTMETER
A	AMMETER
mA	milli–AMMETER
µA	micro–AMMETER
Ω	OHMMETER
OHMS	OHMMETER

Indicates the reading of AC/DC

Symbol	Meaning of the Symbol
	DC VOLTAGE OR CURRENT
	DC VOLTAGE OR CURRENT
	AC VOLTAGE OR CURRENT
	AC / DC VOLTAGE OR CURRENT

Indicates the type of mechanism / principle of the meter pointer movement associated with the meter.

Symbol	Meaning of the Symbol
MC	MOVING COIL
	MOVING COIL WITH PERMANENT MAGNET
	MOVING COIL WITH RECTIFIER
	MOVING COIL WITH THERMAL CONVERTER/ THERMO COUPLE
	MOVING COIL WITH THERMAL CONVERTER ISOLATED
	MOVING COIL QUOTIENT MEASURING
	INDUCTION TYPE
	INDUCTION QUOTIENT MEASURING
	HOT WIRE
	BIMETALL IC
	VIBRATING REED

Symbol	Meaning of the Symbol
M I	MOVING IRON
	MOVING IRON
	MOVING IRON QUOTIENT MEASURING
	MOVING COIL NEEDLE / MAGNET
	MOVING MAGNET QUOTIENT MEASURING
	ELECTRO DYNAMIC CORELESS
	ELECTRO DYNAMIC QUOTIENT MEASURING CORELESS
	ELECTRO DYNAMIC WITH IRON CORE
	ELECTRO DYNAMIC QUOTIENT MEASURING WITH IRON CORE
	ELECTRO STATIC

Indicates percentage error in the indicated meter reading.

Symbol	Meaning of the Symbol
1	±1% error expressed as a percentage of the end value of measuring range
1.5	± 2.5 % error expressed as a percentage of the end value of measuring range
1.5	± 1.5 % error expressed as a percentage of the total scale length of width.
1.5	± 1.5 % error expressed as a percentage of true value.

Indicates the placement position of the meter

Symbol	Meaning of the Symbol
	VERTICAL POSITION
	VERTICAL POSITION PERMISSIBLE DEPARTURE ± 2° FROM VERTICAL POSITION
	HORIZONTAL POSITION
	HORIZONTAL POSITION PERMISSIBLE DEPARTURE ± 10 ° FROM HORIZONTAL POSITION
60°	INCLINED POSITION ANGLE OF INCLINATION 60° FROM HORIZONTAL

Indicates special instructions that go with the meter.

Symbol	Meaning of the Symbol
0	NO TEST VOLTAGE
	TEST VOLTAGE 500VOLTS
	TEST VOLTAGE 1KILOVOLTS
	TEST VOLTAGE 2KILOVOLTS

Indicates special instructions that go with the meter.

Symbol	Meaning of the Symbol
	MAGNETIC SHIELD
	ELECTROSTATIC SHIELD
!	ATTENTION READ INSTRUCTIONS BEFORE USE..