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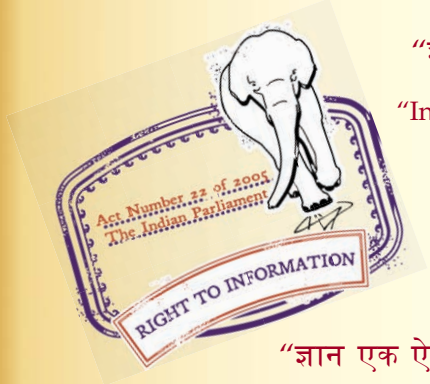

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Indian Standard

SAFETY REQUIREMENTS FOR INDICATING AND RECORDING ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

PART I COMMON SAFETY REQUIREMENTS FOR INSTRUMENTS

(First Reprint JANUARY 1990)

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Indian Standard

SAFETY REQUIREMENTS FOR INDICATING AND RECORDING ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

PART I COMMON SAFETY REQUIREMENTS FOR INSTRUMENTS

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Indian Standard

SAFETY REQUIREMENTS FOR INDICATING AND RECORDING ELECTRICAL MEASURING INSTRUMENTS AND THEIR ACCESSORIES

PART I COMMON SAFETY REQUIREMENTS FOR INSTRUMENTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 July 1979, after the draft finalized by the Electrical Instruments Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard (Part I) specifies common safety requirements for indicating and recording instruments and their accessories so as to ensure reasonable personal protection and protection against damage to the surrounding area. The safety of the instrument depends also upon matching its design to the installation where it is used.

0.3 This standard (Part I) covers only common safety requirements applicable to electrical measuring instruments. Part II of this standard will be dealing with safety requirements for instruments using a mains supply. Special safety requirements for instruments for use in particular environmental conditions would be added to the individual relevant specifications.

0.4 In the preparation of this standard (Part I) considerable assistance has been derived from IEC Pub 414 (1973) 'Safety requirements for indicating and recording electrical measuring instruments and their accessories', published by the International Electrotechnical Commission.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part I) covers common safety requirements and tests for compliance to the following electrical and electrically operated measuring instruments:

a) Direct acting indicating instruments;
b) Direct acting recording instruments;
c) Indirect acting instruments; and
d) Certain accessories used with these instruments.

1.1.1 This standard does not cover special requirements for instruments for use in particular environmental conditions, such as weather-proof, shock-proof, explosion-proof, vibration-proof instruments, intrinsically safe instruments or instruments for medical application.

1.1.2 This standard also does not cover requirements other than safety requirements of indicating and recording instruments.

2. TERMINOLOGY

2.0 For the purpose of this standard the following definitions shall apply.

2.1 Instruments

2.1.1 *Fixed Instrument* — An instrument designed to be permanently mounted on a support and which is intended to be connected to an external circuit by means of permanently installed leads.

2.1.2 *Portable Instrument* — An instrument specifically designed to be easily carried by hand.

NOTE — The instrument is intended to be connected and disconnected easily by the user.

2.1.3 *Electronic Device* — A part or an assembly of parts which uses electron or hole conduction in semiconductors, gases or in vacuum.

2.1.4 *Measuring Earth Terminal* — A terminal directly connected to a point of a measuring or control circuit or to a screening part which is intended to be earthed for measurement purposes.

2.1.5 *Protective Earth Terminal* — A terminal connected to specified conductive parts of an instrument for safety purposes, to be connected to an external protective system.

2.2 Circuit Terms

2.2.1 *Supply Mains* — Any power source which is not used solely to supply one instrument.

NOTE — This definition does not relate to the measured quantity but to the supply mains when it is used to energize auxiliary circuits of the instrument.

2.2.2 *Nominal Circuit Voltage (Circuit Insulation Voltage)* — The highest voltage with respect to earth which may be applied to a circuit of the instrument so that the instrument is unlikely to become dangerous to touch.

NOTE — This is the voltage for which the instrument has been constructed from the point of view of insulation.

2.2.3 *Safety Extra-low Voltage* — A nominal voltage between conductors and between conductors and earth not exceeding 32 V between conductors, or in the case of three phase circuits not exceeding 18·5 V between conductors and neutral.

NOTE — When safety extra-low voltage is obtained from a supply mains of higher voltage, a safety (isolating) transformer or a convertor with separate windings is used. The voltage limits are then based on the assumption that the safety transformer is supplied at its rated voltage.

2.2.3.1 *Extra-low voltage* — A voltage generally having the same limits as safety extra-low voltage but without any restriction on the method of obtaining it.

2.3 Constructional Terms

2.3.1 *Clearance* — The shortest distance measured in air between conductive parts.

2.3.2 *Creepage Distance* — The shortest distance measured over the surface of insulation between conductive parts.

2.3.3 *By Hand* — An operation which does not require the use of a tool, coin or any other object.

2.4 Safety Terms

2.4.1 *Accessible Part of an Instrument* — A part which may be touched by the standard test finger when the instrument is ready for use.

NOTE — 'Ready for use' for a fixed instrument denotes that it is appropriately mounted on its support. Therefore, fixed instruments are characterized by the fact that one part of the instrument may be accessible when ready for use, while the other part is inaccessible.

2.4.2 *Instrument Without Accessible Conductive Parts* — An instrument in which all parts other than terminals, that are accessible when the instrument is ready for use, are made of insulating material, except minor parts such as name-plates, screws or rivets which are isolated from measuring and/or auxiliary circuits (*see* **5.1.1**).

2.4.3 *Instrument with Accessible Conductive Parts* — An instrument in which conductive parts are accessible when the instrument is ready for use.

Small parts, such as name-plates, screws or rivets, which are isolated from measuring and/or auxiliary circuits, and also terminals are not considered to be accessible conductive parts (*see* **5.1.1**).

2.4.4 *Live Part* — A part, contact with which may cause a significant electric shock (*see* **5.1.2**).

2.4.5 *Inactive Part* — A part which is capable of carrying voltage or current but is not so used during correct operation of the instrument.

2.4.6 *Unsafe Temperature* — A temperature likely to cause burns and/or which may cause the operator to perform an involuntary dangerous movement.

3. GENERAL REQUIREMENTS AND TEST PROCEDURE

3.1 General Requirements — The instrument shall be so designed and constructed as not to present danger either in normal use or under specified overload conditions and especially to ensure personal safety against:

a) electric shock,

b) unsafe temperature, and

c) spread of fire.

3.2 General Test Conditions

3.2.1 Compliance with the requirements shall be checked by carrying out all the tests specified.

NOTE — Whenever particular tests are indicated in more than one of the following clauses, this does not necessarily imply that the test shall be carried out more than once.

3.2.2 The tests are type tests unless otherwise specified. A type test once carried out successfully on a particular type of instrument may be held to be valid for other instruments of the same design, having different measuring ranges. The type test shall be carried out on an instrument having the measuring range which is the most liable to fail of that design of instrument.

3.2.3 The tests specified in the following clauses shall be carried out on unused instruments in the condition as supplied.

3.2.4 Unless otherwise specified, the following conditions shall prevail in the test location:

a) Ambient temperature between 15 to 35°C;

b) Relative humidity not outside the range of 45 to 75 percent;

c) Air pressure between 86 to 106 kPa; and

d) Without dew, hoar-frost, percolating water, rain, solar irradiation, etc.

3.2.5 Tests shall be carried out on the complete instruments, that is with case and covers in position and the necessary accessories appropriately connected.

When an instrument has non-interchangeable accessories, they shall be connected to the instrument in the normal manner of use, and the tests shall be carried out on the combination. Interchangeable accessories and accessories of limited interchangeability shall be subjected to separate tests relating to their own characteristics.

4. HEATING

4.1 General — When under continuous load or continuous overload, no part of the instrument shall reach a temperature that may cause fire, or a hazard by physical contact with accessible parts, or deformation of the enclosure (including transparent windows) when subjected to external forces.

Compliance shall be checked under the overload conditions specified in the relevant standards.

NOTE — Instruments which are not designed for continuous operation or continuous overload are to be operated in their permissible mode of operation in such a manner that the greatest possible heating occurs.

4.2 Accessible Parts — When the instrument is under the conditions specified in **4.1**, the temperature rise of any part which is accessible when the instrument is ready for use shall be measured.

The temperature rise shall not exceed:

a) For accessible metal parts	25°C
b) For other accessible parts	35°C

If higher tempertures shall occur, the provisions of **9.3.4** shall apply.

4.3 Permanence of Insulation — Neither the insulation strength nor the creepage distances and clearances, if specified, shall be permanently and inadmissibly reduced, when the instrument is operated under the conditions specified in **4.1**.

After the test, and also when the instrument has cooled down to its initial temperature, it shall show no damage which might impair its safety as specified in this standard.

Compliance shall be checked by inspection and by performing the tests specified in **5.5**, **5.6** and **9**.

4.4 Mechanical Strength at Elevated Temperatures — When the instrument is under the conditions specified in **4.1**, the rigid test finger specified in Fig. 1 shall be applied with a force of 30 N directed inwards to different points of the surface for 10 seconds each time.

NOTE — For instruments with a door, this test is not to be applied to delicate parts (for example, the mechanism of recording instruments) which become accessible when the door is opened.

The instrument shall show no deformation which might impair its safety as specified in this standard.

5. PROTECTION AGAINST ELECTRIC SHOCK

5.1 Exterior of the Instrument

5.1.1 Live parts shall not be accessible when the instrument is ready for use. Live parts shall, therefore, be protected by covering or insulation.

In order to determine whether a part is accessible, either visual inspection shall be used or the jointed test finger or the rigid test finger as shown in Figures 2 and 1 respectively, shall be applied. In case of doubt, the latter shall be applied with a maximum force of 30 N.

NOTE — An electrical contact indication with a voltage of approximately 40 V is recommended to show contact with conductive parts.

This test is applied:

a) *For fixed instruments* — Only to those parts, which are accessible from the front when the instrument is mounted ready for use.

b) *For other instruments* — To all outer surfaces including the base.

5.1.2 The requirements of **5.1.1** do not apply to external terminals and sockets of measuring circuits if they are accessible for operational reasons.

NOTE — These terminals should be protected against unintended contact as far as possible by covering, recessing or by their positioning and arrangement.

5.1.2.1 For this test, measuring circuits are energized at their nominal circuit voltages (circuit insulation voltages) above earth.

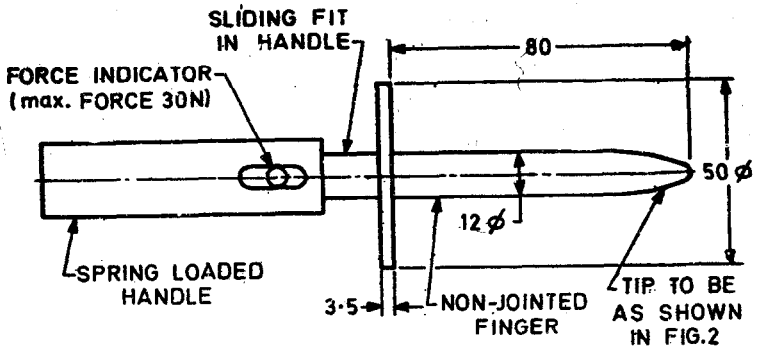
One pole of a test source is connected to all the measuring circuit terminals joined together, and the other pole is connected to earth and (if there is one) to the earth terminal of the instrument.

A voltmeter having an internal resistance of near to but not less than 50 kΩ is connected between earth and any conductive part which may be live.

The voltage of the test source is adjusted to be equal to the nominal circuit voltage (circuit insulation voltage) of the instrument. If the indication of the voltmeter does not exceed 15V, the conductive part is not considered to be live.

In general, and especially for an instrument having a nominal circuit voltage (circuit insulation voltage) higher than the voltage between its terminals, it may be assumed that live parts are isolated from any accessible conductive parts, including an earth terminal, if provided.

When an instrument has a measuring circuit connected to the earth terminal or to the enclosure, a test voltage equal to its rated voltage is applied between the terminals. The earth terminal and/or the enclosure are connected to earth and to one pole of the specified voltmeter.



Tolerances :

On angles ± 5

On linear dimensions:

Less than 25 : $\begin{matrix}+0\\-\cdot05\end{matrix}$

Over 25 : ± ·2

All dimensions in millimetres.

FIG. 1 TEST FINGER, RIGID

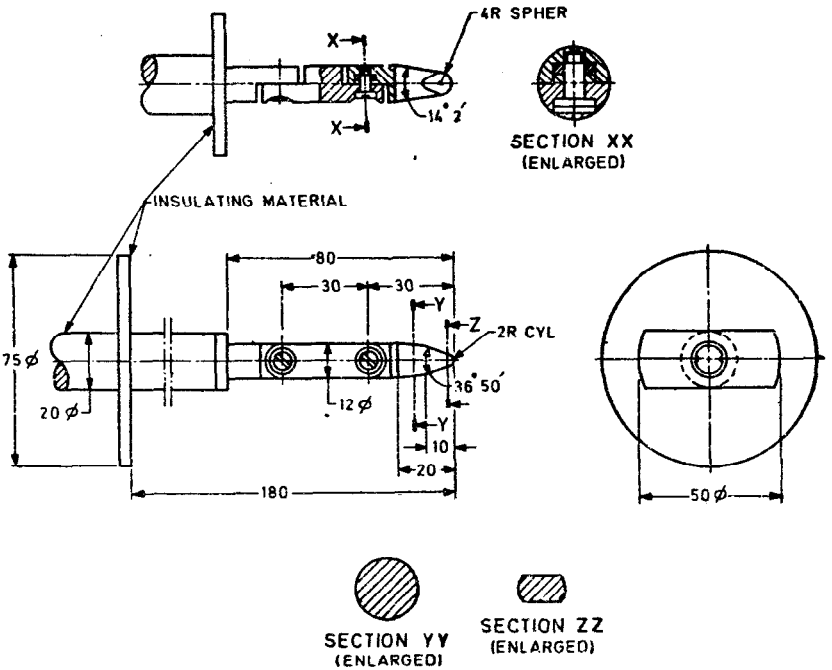
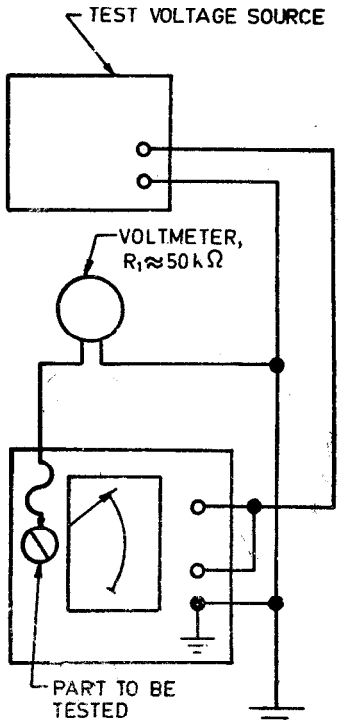


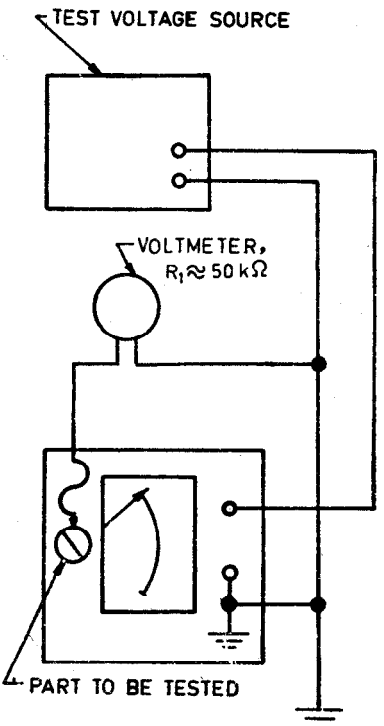
FIG. 2 TEST FINGER

The test circuits are shown in Figures 3 and 4.



The instrument with isolated measuring circuit

FIG. 3 CIRCUIT DIAGRAM FOR VOLTAGE TEST



The instrument with earthed measuring circuit

FIG. 4 CIRCUIT DIAGRAM FOR VOLTAGE TEST

5.1.3 In order to determine whether a part is live, the following test shall be carried out (*see also* **5.1.2.1**).

When an instrument has an earth terminal, it shall be earthed:

a) *Measuring circuits isolated from the case and from the earth terminal* — All the terminals of the measuring circuits shall be connected together and to one pole of a source of the nominal circuit voltage (circuit insulation voltage), the other pole of the source being earthed.

b) *Measuring circuits having a connection to the earth terminal and/or the case* — The measuring circuits of the instrument shall be energized at their rated voltages. This test shall not be carried out with current circuits having a connection to the earth terminal.

c) *Instruments having auxiliary circuits* — An additional test shall be carried out by energizing the auxiliary circuits under their normal condition of use, each pole of the supply being connected to earth in turn.

NOTE 1 — It may be necessary to ensure that the supply used for these tests is isolated from earth.

The voltage between any accessible conductive part and earth shall be measured by a voltmeter having an internal resistance of near to but not less than 50 kΩ. The part is not live if the voltage as measured in (a), (b) and (c) above does not exceed 15 V.

NOTE 2 — These values have been chosen so as to detect any accessible part having a voltage to earth exceeding 15 V and from which a current greater than 300 μA may be drawn.

5.1.4 Insulation used for protection against electric shock shall have adequate electrical and mechanical strength and shall be permanent. Tests for compliance may be agreed upon between the interested parties.

5.1.5 External handles, knobs and the like, operating mains voltage carrying component parts, shall be made of insulating material, unless they are connected to those component parts by an insulating shaft or other insulating means. Compliance shall be checked by inspection.

5.1.6 Operating shafts shall not be live. Compliance shall be checked by performing the tests specified in **5.1.3** after removing knobs, handles and the like, unless they are immovably fixed.

5.1.7 If a hole gives access to preset controls and the setting of this control requires a screw driver or other tool, the adjustment of the control shall not involve the risk of a shock. Compliance shall be checked by setting the control with any suitable tool. The tool shall not become live.

5.2 Interior of the Instrument — Parts of instruments which become accessible by manual opening of a door or removal by hand of a cover shall not be live. Parts which become accessible during normal operation shall not be live, even when the cover or door is opened by a key or the like. Terminals and sockets are excepted according to **5.1.2**. Compliance shall be checked by application of the test of **5.1.3**.

5.3 Safety Measures and Exemptions — Instruments shall be so constructed that they comply with the requirements of **5.4** and will withstand the tests specified in **5.5** and **5.6**.

The following types of instruments are exempted from the requirements of these clauses provided that they are marked with a figure '0' within a star in accordance with **9.2.**

a) Instruments which are intended to be connected to extra low voltage only (below 32 V),

NOTE — This may apply to instruments which are supplied by a battery.

b) Instruments with a built-in voltage generator (for example ohmmeters) having a maximum steady-state output current of 5 mA ac, 10 mA dc, or for a mixed current, 10 mA peak value.

In addition, instruments which are marked with Symbol C-4 (*see* **9.3.2**) are subjected to less severe voltage tests than specified in **5.5.**

NOTE — Instruments, one terminal of which is connected to the enclosure, shall not be subjected to the tests specified in **5.1** and **5.6** and special precautions are necessary when handling these instruments.

5.4 Connection to a Protective System

5.4.1 *Instruments with Accessible Conductive Parts* — All accessible conductive parts which may become live due to faults shall be bonded together and also to the means for effective connection to a protective system. The means for the effective connection to a protective system shall be provided in accordance with Table 1.

Protective earth terminals shall comply with the requirements specified in **8.2.** Compliance shall be checked as routine test by inspection and, in case of doubt, by measuring the resistance between the earth terminal and the accessible conductive parts. It shall not exceed 1Ω.

TABLE 1 MEANS FOR CONNECTION TO PROTECTIVE SYSTEMS

NOMINAL CIRCUIT VOLTAGE (CIRCUIT INSULATION VOLTAGE)	FIXED INSTRUMENTS	OTHER INSTRUMENTS
(1)	(2)	(3)
Up to and including 50 V*	None	None
Over 50 to 650 V	Means only†	Protective earth terminal
Over 650 V	Protective earth terminal	Protective earth terminal

*For dc instruments for telecommunication applications, the limit is extended to 60 V.

†'Means only' denotes that an earth terminal is not mandatory and that any effective method may be used.

NOTE — The methods are selected on the basis of the nominal circuit voltage of the measuring circuit or any auxiliary circuit whichever is greater.

5.4.2 *Instruments without Accessible Conductive Parts* — Instruments with a nominal circuit voltage (circuit insulation voltage) exceeding 650 V which are totally enclosed in insulating material shall have a protective earth terminal connected to the inactive interior conductive parts unless these are protected by insulation, capable of withstanding the voltage test specified in 5.5.

Compliance shall be checked by inspection and, if necessary, by applying a test voltage specified in Table 2 between the inactive parts and a foil as specified in 5.5.2.1(d).

5.5 Voltage Tests

5.5.1 *General* — By agreement between the manufacturer and the purchaser, instruments may be subjected to a humidity preconditioning before performing voltage tests.

5.5.2 *Points of Application of the Test Voltage*

5.5.2.1 The test voltage shall be applied between all measuring circuits connected together, and the reference test earth joined to the auxiliary circuits, if any.

NOTE — If it is impossible to connect the measuring circuits together, for example, because change-over switches are incorporated in the instrument or because the circuits have different nominal circuit voltages (circuit insulation voltages), each circuit shall be tested separately while the others are connected to the reference test earth.

The reference test earth consists of one or more of the following:

a) The earth terminal, if any;

b) For instruments with a conductive enclosure — this enclosure and pieces of conductive material in contact with it;

c) For instruments with an insulating enclosure having accessible conductive parts, isolated from the electrical circuits — the assembly of all of them connected together;

d) For instruments with an insulating enclosure — a metal foil covering the whole of the instrument and having a space only around the terminals and approaching them to within a distance of not more than:

   1) with test voltages up to and including 10 kV : 20 mm, and

   2) for higher test voltages, the distance shall be so dimensioned that no flash-over occurs between the foil and the terminals; and

e) The accessible components of the mechanical zero adjuster, of the index adjuster, and the range-changing switches, maintained at the same potential as the enclosure.

Wrapping in a metal foil is advisable.

The voltage test shall be carried out as:

1) a routine test for (a), (b), (c) and (e), and
2) a type test for (d).

5.5.2.2 *Instruments with several circuits* — When an instrument has several circuits, an additional test shall be carried out as specified in a) and b) below:

a) For wattmeters (var-meters) and phasemeters whose measuring circuits are intended to be connected to the same phase, a test voltage of at least 500 V or twice the nominal voltage shall be applied between the current and voltage circuits. This test is not applied when the current and voltage circuits are permanently joined together at one point.

For wattmeters (var-meters) having a winding which compensates for the consumption of the voltage circuit, the test voltage is limited to 50 V. Then they shall be marked with symbol F-33 of Table 3.

b) For instruments whose measuring circuits may be connected in different phases (for example, polyphase or multiple instruments), a test voltage shall be applied between these circuits. The value of this voltage corresponds to the nominal circuit voltage (circuit insulation voltage) specified in Table 2 which is equal to the rated voltage between phases or to the value immediately above it.

The measuring circuits of a polyphase instrument which are connected to the same phase shall be subjected to the test specified in **5.5.2.2**(a).

c) When the instrument includes one or several auxiliary circuits, a voltage test shall be carried out by applying the test voltage specified in **5.5.3** between the auxiliary circuits and all the other circuits connected to the reference test earth (*see* **5.5.2.1**).

Auxiliary circuits which are energized at extra low voltage, and having one pole connected to accessible conductive parts or other inactive conductive parts of the instrument, are not subjected to this test.

5.5.3 *Value of the Test Voltage* — The test voltage is determined in relation to the nominal circuit voltage (circuit insulation voltage) of the circuit. This voltage is selected from the values given in Table 1 and, except as exempted by **9.3.2** shall not be less than:

a) the upper limit of the measuring range for voltmeters,
b) the upper limit of the nominal range of use for wattmeters (var-meters), phasemeters and frequency meters, and
c) 250 V for ammeters, unless otherwise specified.

NOTE — For instruments which are intended to be connected via instrument transformers, a nominal circuit voltage (circuit insulation voltage) of at least 650 V is recommended in order to match the general insulation levels of these transformers.

For auxiliary circuits, the test voltage is a function only of the rated voltage of these circuits without taking account of the symbol for the voltage test. Then the rms value of the test voltage corresponds to that nominal circuit voltage (circuit insulation voltage) of Table 2 whose value is equal to or greater than the rated voltage of the auxiliary circuit.

TABLE 2 NOMINAL CIRCUIT VOLTAGE (CIRCUIT INSULATION VOLTAGE), MARKING AND TEST VOLTAGE OF MEASURING CIRCUITS

(*Clauses* 5.4.2, 5.5.2.2, 5.5.3, 5.5.4.3, 9.2)

Nominal Circuit Voltage (Circuit Insulation Voltage) of the Measuring Circuit(s)* (V)	Number Placed in Star in Accordance with 9.2	Test Voltage in kV (rms)†
(1)	(2)	(3)
50	No number	0·5
250	1·5	1·5
650	2	2·5
1 000	3	3·0
2 000	5	5·0
3 000	7	7·0
4 000	9	9·0
5 000	11	11·0
6 000	13	13·0
Instruments specified in 5.3 (a) and (b)	0	No voltage test

*For a given type of instrument, the nominal circuit voltage (circuit insulation voltage) of the measuring circuits is selected by the manufacturer from one of the values shown.

The value chosen should not be less than the rated value or the nominal voltage of the measuring circuits of the instrument as specified in 5.5.3. When it is higher, the instrument may be used in a circuit whose voltage to earth is correspondingly higher.

For example:

a) A voltmeter having a rated voltage of 10 V would normally have a nominal circuit voltage (circuit insulation voltage) of 50 V.

b) A similar voltmeter could however be manufactured for a nominal circuit (circuit insulation voltage) of 1 000 V. This instrument would still measure voltages up to 10 V but could do so in a circuit operating at up to 1 000 V above earth without danger to the user. This type of voltmeter is currently used in the electrolysis of metals.

†The test voltage, which is a function of the nominal circuit voltage (circuit insulation voltage) to which the instrument is subjected, is given. The value of the test voltage, expressed in kV is marked on the instrument by a number inside a star.

For example, the voltmeters just mentioned would provide the user with the following information:

a) No number inside the star shows that the voltage above earth of the measuring circuit is limited to 50 V, and

b) The number 3 inside the star shows that the measuring circuit of the voltmeter may be operated at up to 1 000 V above earth without being dangerous to the user.

Figures 5 and 6 show permissible methods of use of these two 10 V voltmeters.

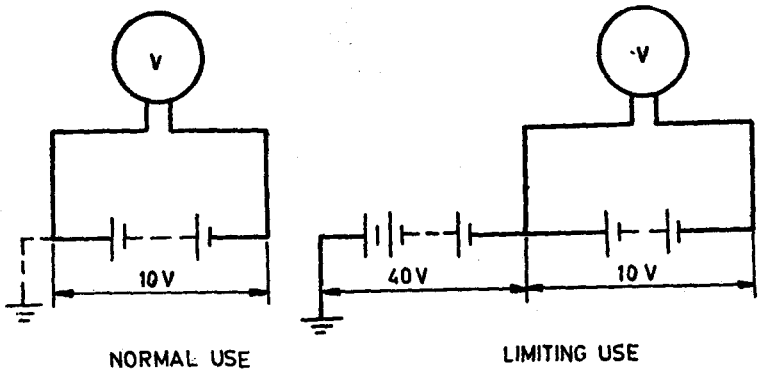
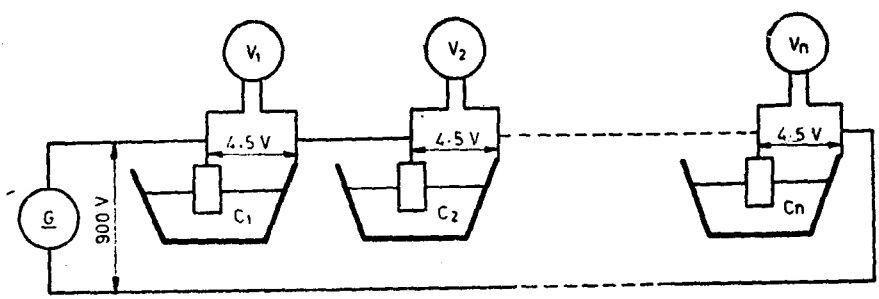


FIG. 5 EXAMPLE OF THE PERMISSIBLE USES OF A 0-10 V VOLTMETER MARKED BY A STAR WITHOUT NUMBER



$C_1, C_2, \ldots C_n$ = Electrolytic cells
$V_1, V_2 \ldots V_n$ = Cell voltmeters
G = Supply source for the cells.

FIG. 6 USE OF = 0-10 V VOLTMETERS MARKED BY THE NUMBER 3 INSIDE THE STAR [NOMINAL CIRCUIT VOLTAGE (CIRCUIT INSULATION VOLTAGE) = 1 000 V]

5.5.4 *Method of Test*

5.5.4.1 *Test voltage* — Voltages tests shall be performed with a test voltage of substantially sinusoidal waveform; its frequency shall be between 45 Hz and 65 Hz.

5.5.4.2 *Check of the available power of the testing apparatus* — The off-load voltage of the testing apparatus is initially set to 50 percent of the specified voltage. It is then connected to the instrument under test. The power of the supply source is considered sufficient when it is such that the voltage drop observed is less than 10 percent of that voltage.

5.5.4.3 *Application of the test voltage* — The test voltage shall be raised smoothly to its specified value in Table 2, by such steps that no appreciable transients occur, maintained for 1 minute and then lowered smoothly to zero.

5.5.5 *Conclusion of the Test* — During the voltage test, no breakdown or flashover shall occur.

5.5.6 *Repetition of Voltage Tests* — For repetition tests which are performed on unused instruments in the condition as supplied, the following apply, unless otherwise agreed to between the manufacturer and the purchaser:

a) Instruments, the test voltage of which does not exceed 2 kV, may be subjected to the necessary number of tests, each of them being performed at 100 percent test voltage; and

b) For instruments the test voltage of which exceeds 2 kV, two tests are permitted (that is, one repetition), each of them at 100 percent test voltage.

5.6 Insulation Resistance Test — By agreement between the manufacturer and the purchaser, instruments may be subjected to a humidity preconditioning before performing insulation resistance tests. The insulation resistance shall be measured between all circuits connected together and the reference test earth as defined in **5.5.2.1.**

The test shall be carried out under the same conditions as the voltage test of **5.5.2.1**, except that the auxiliary circuits shall be connected to the measuring circuits.

The measurement of the insulation resistance shall be made 1 minute after the application of a direct voltage of about 500 V.

The insulation resistance so measured shall not be less than 5 MΩ.

6. PROTECTION AGAINST THE SPREAD OF FIRE

6.1 Insulation used for supporting parts intended to be connected to the supply mains, and insulation used as external covers and cases, especially those which support external terminals, shall be made of materials which do not involve danger under conditions arising from short circuits inside the instrument or from heat developed by external leads not properly fastened.

These materials shall be such that they do not soften to such an extent as to impair the safety or to cause further short circuits, and shall be either non-flammable or self-extinguishing.

Compliance tests may be agreed upon. The recommended tests shall be as specified in **29** of IS : 302-1973*.

*Specification for general and safety requirements for light electrical appliances (*fourth revision*).

7. COMPONENT PARTS AND ACCESSORIES

7.0 In general, component parts of, and accessories used with, the instruments shall comply with their relevant requirements. Furthermore, the following requirements shall apply.

7.1 Moving Parts — Moving parts liable to cause personal injury shall be so arranged or enclosed as to provide adequate protection in normal use against this danger. Protective enclosures, guards and the like shall have adequate mechanical strength. They shall not be removable by hand.

Compliance shall be checked by inspection and by manual test.

7.2 Current Circuits — Current circuits inside the instrument or accessory shall be so designed and constructed as to provide for adequate protection against any danger arising from interruption of these circuits during operation. Connections shall be securely fastened. Range changing switches incorporated in the current measuring circuits shall be so designed that the current flow is not interrupted when these switches are operated.

Compliance shall be checked by inspection after the overload tests prescribed in the relevant standards.

NOTE — For particular instruments, more severe overload conditions may be agreed upon for the purpose of this test.

7.3 Batteries — Batteries shall be so arranged that there is no risk of the accumulation of flammable gases.

Instruments containing batteries holding liquid shall be so designed that safety may not be impaired by leakage of the liquid.

Compliance shall be checked by inspection.

7.4 Screw Connections — Screw connections transmitting contact pressure and screw fixings which during the life of the instrument are to be loosened and tightened readily, especially terminal screws and screws for fixing levers, knobs and the like, shall screw into a metal nut or metal insert.

Compliance shall be checked by inspection. Strength tests may be agreed upon.

8. CONNECTION DEVICES

8.1 Accessible Terminals — Accessible screw terminals shall be so enchored, fitted or designed that the fixed parts shall not work loose when the screws are tightened or loosened.

Accessible screw terminals of portable instruments shall allow connection to be made with sufficient contact pressure without deterioration

of the conductor. Furthermore, they shall allow a conductor to be connected without special preparation (for example, soldering of the end of the conductor, use of cable lugs or bending of eyelets) and shall prevent the bare conductors or strands of conductors from slipping out when the screws are tightened. Compliance shall be checked by inspection and by manual test.

8.2 Protective Earth Terminals — For protective earth terminals, the following shall apply:

a) The earth terminal shall be at least of an equivalent size to the live terminals and shall accommodate a conductor of the same size with a lower limit of 4 sq mm and an upper limit of 16 sq mm;

b) All parts of the earth terminals shall be such that there is no danger of corrosion resulting from contact with the copper of the earth conductor (or any other metal in contact with them);

c) Except for portable instruments, it shall not be possible to loosen the earth terminal screw by hand; and

d) The protective function shall not be interrupted by the presence of switching device or a fuse in the instrument or accessory.

Compliance shall be checked by inspection and by manual test.

9. MARKING

9.1 General — In respect of safety, the instrument shall be marked in accordance with **9.2** to **9.4**.

The marking on the instrument shall be easily discernible, legible and indelible. The information shall be shown on the scale plate or on the exterior surface of the instrument. Marking according to **9.3** shall be visible when the instrument is ready for use.

Compliance is checked by inspection as a routine test.

9.2 Nominal Circuit Voltage (Circuit Insulation Voltage) and Corresponding Test Voltage of the Measuring Circuits — The test voltage corresponding to each nominal circuit voltage (circuit insulation voltage) is given in Table 2.

The value of the test voltage shall be marked on the instrument, inside a star, in accordance with Table 2. In the absence of such a number inside the star, the test voltage is 0·5 kV. The figure '0' within the star indicates that no voltage test is to be carried out.

Symbols C-1 to C-3 of Table 3 shall be used.

9.3 Warning Symbols — Warning symbols shall be discernible on the instrument when ready for use and shall contrast well with the background.

9.3.1 If, to ensure that there is no danger to the instrument in use, it is necessary for the user to refer to the instruction manual, the instrument shall be marked with symbol F-33 of Table 3.

NOTE — Marking with this symbol does not exempt the instrument from any safety requirements contained in this standard.

9.3.2 When it is known that the instrument may be dangerous to touch when in use, because the voltage to earth of the measuring circuit is greater than the nominal circuit voltage (circuit insulation voltage) of the instrument, the instrument shall be marked with the symbol of the high voltage flash (Symbol C-4 of Table 3).

The colour of the symbol shall be non-fading, contrasting and preferably red.

NOTE — Precautions shall be taken when handling such an instrument, and with fixed instruments, particular care should be taken in their installation so as to ensure safety.

9.3.2.1 Instruments shall be subjected to a voltage test in accordance with their nominal circuit voltage (circuit insulation voltage) even when marked with symbol C-4 in accordance with **9.3.2**. The minimum test voltage shall be 2 kV.

9.3.2.2 The exemption given in **9.3.2** dealing with the use of symbol C-4 does not apply to instruments which are intended to be opened during normal operation, for example, recording instruments (*see* **5.5.3**). It may, however, apply to their accessories.

9.3.2.3 Symbol C-4 shall be marked adjacent to the terminals of instruments with a built-in voltage generator (for example, ohmmeters) and to the enclosure of instruments (for example, electrostatic instruments) with one terminal connected to the enclosure (*see* **5.3**), if they are intended to be operated at voltages exceeding the limit of extra-low voltage.

9.3.3 When the voltage to earth of a measuring circuit of a portable instrument can be changed using an accessory of limited interchangeability, so that it operates at a voltage higher than its nominal circuit voltage (circuit insulation voltage), the accessory shall be marked with Symbol C-7 of Table 3. This symbol shall also be applied to interchangeable accessories when their voltage rating exceeds 650 V in order to warn the user of the instrument.

NOTE — When such accessories are used with wattmeters, volt ampere meters, and power-factor indicators, care should be taken that the voltage between the current and voltage circuits remains compatible with the voltage test of **5.5.2.2**.

9.3.4 If accessible parts of an instrument may attain higher temperatures than specified in **4.2**, the instrument shall be marked with Symbol C-5 of Table 3.

TABLE 3 GRAPHICAL SYMBOLS

(*Clauses* 3.2.2, 5.5.2.2, 9.2, 9.3.1 *and* 9.4)

No.	Item	Symbol
B	*Type of Supply*	
B-1	Direct current circuit	
B-2	Alternating current circuit (single-phase)	
B-3	Direct and alternating current circuit	
B-4	Three-phase alternating current circuit (general symbol)	
C	*Safety*	
C-1	Test voltage 500 V	
C-2	Test voltage above 500 V (for example, 2 kV)	
C-3	Instrument not subjected to a voltage test	
C-4	High voltage flash	
C-5	Higher temperatures of accessible parts	
C-6	Additional insulation	
C-7	High voltage on accessory and/or on instrument	
F	*General Symbols*	
F-31	Earth terminal	
F-33	Reference to a separate document	

9.4 Protective Earth Terminals — Protective earth terminals shall be marked with Symbol F-31 of Table 3.

NOTE — If this symbol for the protective earth terminals is not used in an Indian Standard, it may be modified provisionally by being placed inside a circle.

The symbol shall be placed adjacent to or on the terminal but not on removable parts, such as screws. It may also be used to mark other means for connection to a protective system (*see* **5.4.1**).

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