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Indian Standard

ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V a.c. AND 1 500 V d.c. — EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES

PART 5  RESISTANCE TO EARTH

ICS 17.220.20; 29.080.01; 29.240.01

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 2
NATIONAL FOREWORD

This Indian Standard (Part 5) which is identical with IEC 61557-5 : ‘2007 ‘Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures — Part 5: Resistance to earth’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Measuring Equipment for Basic Electrical Quantities Sectional Committee and approval of the Electrotechnical Division Council.

This standard supersedes IS 9223 : 1989 ‘Portable earth resistance meters (first revision)’.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Corresponding Indian Standard</th>
<th>Degree of Equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61010-1 : 2001 Safety requirements for electrical equipment for measurement, control and laboratory use — Part 1: General requirements</td>
<td>IS 9249 (Part 1) : 1979 Safety requirements for indicating and recording electrical measuring instruments and their accessories: Part 1 Common safety requirements for instruments</td>
<td>Technically Equivalent</td>
</tr>
<tr>
<td>IEC 61557-1 Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures — Part 1: General requirements</td>
<td>IS/IEC 61557-1 : 2007 Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures: Part 1 General requirements</td>
<td>Identical</td>
</tr>
</tbody>
</table>

Only the English language text the International Standard has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in IEC Standard.

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 ‘Rules for rounding off numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
1 Scope

This part of IEC 61557 specifies the requirements for equipment for measuring earth resistance using an a.c. voltage.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61010-1:2001, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements

IEC 61557-1, Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 1: General requirements

3 Terms and definitions

For the purposes of this document, the definitions given in IEC 61557-1 and the following definitions apply.

3.1 **series interference voltage**
extraneous voltage superimposed on the measuring voltage

3.2 **auxiliary earth electrode**
additional earth electrode for a current required for the purpose of measurements

3.3 **auxiliary earth electrode resistance**
\( R_H \)
resistance of an additional earth electrode through which current flows that is required for the purpose of measurements

3.4 **probe**
additional earth electrode used as a probe for sampling potentials during measurements
3.5 probe resistance $R_s$

earth electrode resistance of an additional earth electrode used as a probe for sampling potentials during measurements

4 Requirements

The following requirements as well as those given in IEC 61557-1 shall apply.

4.1 The output voltage present across the terminals E and H shall be an a.c. voltage without a d.c. component.

The frequency and the waveform shall be chosen so that electrical interference, particularly from installations operating with system frequency, will not adversely influence the measurement result to an excessive degree.

4.2 If the influence of interference voltages from distribution systems as a.c. currents or as d.c. currents exceeds the requirements of 4.3, this shall be stated by the manufacturer in the operating instructions.

4.3 The maximum percentage operating uncertainty within the measurement range to be marked or stated shall not exceed ±30 % with the measured value as fiducial value, as determined in accordance with Table 1.

Table 1 – Calculation of operating uncertainty

<table>
<thead>
<tr>
<th>Intrinsic uncertainty or influence quantity</th>
<th>Reference conditions or specified operating range</th>
<th>Designation code</th>
<th>Requirements or test in accordance with the relevant parts of IEC 61557</th>
<th>Type of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic uncertainty</td>
<td>Reference conditions</td>
<td>$A$</td>
<td>Part 5, subclause 6.1 R</td>
<td>R</td>
</tr>
<tr>
<td>Position</td>
<td>Reference position ± 90°</td>
<td>$E_1$</td>
<td>Part 1, subclause 4.2 R</td>
<td>R</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>At the limits stated by the manufacturer</td>
<td>$E_2$</td>
<td>Part 1, subclauses 4.2, 4.3 T</td>
<td>R</td>
</tr>
<tr>
<td>Temperature</td>
<td>0 °C and 35 °C</td>
<td>$E_3$</td>
<td>Part 1, subclause 4.2 T</td>
<td>T</td>
</tr>
<tr>
<td>Series interference voltage</td>
<td>See 4.2 and 4.3</td>
<td>$E_4$</td>
<td>Part 5, subclauses 4.2, 4.3 T</td>
<td>T</td>
</tr>
<tr>
<td>Resistance of the probes and auxiliary earth electrodes</td>
<td>0 to 100 $\times$ $R_A$ but $\leq$ 50 kΩ</td>
<td>$E_5$</td>
<td>Part 5, subclause 4.3 T</td>
<td>T</td>
</tr>
<tr>
<td>System frequency</td>
<td>99 % and 101 % of the nominal frequency</td>
<td>$E_7$</td>
<td>Part 5, subclause 4.3 T</td>
<td>T</td>
</tr>
<tr>
<td>System voltage</td>
<td>85 % and 110 % of the nominal voltage</td>
<td>$E_8$</td>
<td>Part 5, subclause 4.3 T</td>
<td>T</td>
</tr>
<tr>
<td>Operating uncertainty</td>
<td>$B=\pm(A+1.15\sqrt{E_1^2+E_2^2+E_3^2+E_4^2+E_5^2+E_7^2+E_8^2})$</td>
<td></td>
<td>Part 5, subclause 4.3 T</td>
<td>R</td>
</tr>
</tbody>
</table>

$A$ = intrinsic uncertainty

$E_n$ = variations

$B\% = \pm \frac{B}{\text{fiducial value}} \times 100\%$
The operating uncertainty shall apply under the rated operating conditions given in IEC 61557-1 and the following:

- injection of series interference voltages with system frequencies of 400 Hz, 60 Hz, 50 Hz, $16\frac{2}{3}$ Hz or with d.c. voltage respectively across the terminals E (ES) and S or to the earth resistance loop. The r.m.s. value of the series interference voltage for equipment with auxiliary probes shall be 3 V. For equipment using current clamps, the presence of interfering disturbances shall be clearly indicated, if the influence quantity will exceed the specified value of the variation $E_4$ and of operating uncertainty;
- resistance of the auxiliary earth electrode and of the probes: $0$ to $100 \times R_A$ but $\leq 50 \, \Omega$;
- system voltages between 85 % and 110 % of the nominal voltage and between 99 % and 101 % of the nominal system frequency for measuring equipment with a mains supply and/or measuring equipment deriving its output voltage directly from the distribution system.

4.4 The measuring equipment shall be capable of determining whether the maximum permissible resistances of the probes and auxiliary earth electrodes are exceeded.

4.5 No hazardous touch voltages shall appear during the measurements.

This can be achieved by a suitable design of the source for the output voltage by:

- limiting the open-circuit value of the output voltage to an r.m.s. value of 50 V or a peak value of 70 V;
  
  NOTE The open-circuit voltage during measurements in agricultural plants should not exceed an r.m.s. value of 25 V or a peak value of 35 V.
- limiting the r.m.s. (peak) value of the short-circuit current to 3.5 mA (5 mA) when the value of the voltage exceeds 50 V (70 V) or 25 V (35 V).

When no compliance with the above condition exists, then an automatic disconnection of the measurement process shall operate within a time period permissible according to Figure 1 of IEC 61010-1.

4.6 The user shall not be exposed to a voltage exceeding the permissible touch voltage and the measuring equipment shall recover within specification, when any plug or socket of the measuring equipment, intended for connection to the distribution system’s power supply is connected to 120 % of its nominal voltage. Protective devices shall not be activated.

5 Marking and operating instructions

5.1 Marking

In addition to the marking in accordance with IEC 61557-1, the following information shall be provided on the measuring equipment.

5.1.1 Measurement range within which the maximum operating uncertainty applies.

5.1.2 Frequency of the output voltage.

5.1.3 Designation of the terminals (as far as applicable):

- E: terminal for the earth electrode;
- ES: terminal for the probe placed nearest to the earth electrode;
- S: terminal for a probe;
- H: terminal for the auxiliary earth electrode.
5.2 Operating instructions

The operating instructions shall state the following in addition to the statements in IEC 61557-1.

5.2.1 The range of applications (e.g. for agricultural plants or others) for the equipment for measuring earth resistance.

5.2.2 If applicable, the influence of series interference voltages that are larger than the values stated under 4.3.

5.2.3 A statement relating to the correct operation of the hand-driven generator (if provided).

5.2.4 The designations of terminals when different from 5.1.3.

6 Tests

In addition to IEC 61557-1 the following tests shall be executed.

6.1 The operating uncertainty shall be determined in accordance with Table 1. In this process, the intrinsic uncertainty shall be determined under the following reference conditions:

- nominal value of the supply voltage;
- nominal r.p.m. of the hand-driven generator when used as a supply;
- nominal frequency of the power supply in the case of mains-operated measuring equipment according to 4.3;
- reference temperature 23 °C ± 2 °C;
- reference position in accordance with the manufacturer’s statement;
- resistances of probes and auxiliary earth electrodes 100 Ω;
- interference voltage 0 V.

The operating uncertainty thus evaluated shall not exceed the limits specified in 4.3.

6.2 A check as to whether the conditions for the open-circuit voltage, short-circuit current and disconnect delay stated under 4.5 are met in each of the measurement ranges (routine test).

6.3 A check as to whether exceeding the permissible maximum resistances for probes and auxiliary earth electrodes is indicated (type test).

6.4 The overload protection in accordance with 4.6 shall be tested (type test), when any plug or socket of the measuring equipment, intended for connection to the distribution system’s power supply is connected to 120 % of its nominal voltage. Protective devices shall not be activated.

6.5 Compliance with the tests in this clause shall be recorded.
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BUREAU OF INDIAN STANDARDS

Headquarters:
Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402
Website: www.bis.org.in

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