IEC 61557-9

Edition 2.0 2009-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

withdrawn

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 9: Equipment for insulation fault location in IT systems

Sécurité électrique dans les réseaux de distribution basse tension de 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection – Partie 9: Dispositifs de localisation de défauts d'isolement pour réseaux IT

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INTERNATIONAL
ELECTROTECHNICAL
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COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX S

ICS 25.040.40

ISBN 978-2-88910-536-6

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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 9: Equipment for insulation fault location in IT systems

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International Standard IEC 61557-9 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

This second edition cancels and replaces the first edition published in 1999. It is a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) scope complemented;
b) normative references complemented;
c) terms and definitions of Clause 3 complemented;
d) revision of requirements;
e) revision of marking and operating instructions;
f) revision of Clause 6 "Tests";

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g) revision of Table 1;

h) addition of Annex A;

i) addition of Annex B;

j) addition of Annex C.

The text of this standard is based on the following documents:

FDIS	Report on voting
85/337/FDIS	85/341/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part is to be used in conjunction with IEC 61557-1:2007.

A list of all parts of the IEC 61557 series, published under the general title *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,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under http://webstore.iec.ch in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition; or
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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 9: Equipment for insulation fault location in IT systems

Withdrawn

1 Scope

This part of IEC 61557 specifies the requirements for insulation fault location systems which localize insulation faults in any part of the system in unearthed IT a.c. systems and unearthed IT a.c. systems with galvanically connected d.c. circuits having nominal voltages up to 1 000 V a.c., as well as in unearthed IT d.c. systems with voltages up to 1 500 V d.c., independent of the measuring principle.

NOTE 1 IT systems are described in IEC 60364-4-41 amongst other literature. Additional data for a selection of devices in other standards should be noted.

NOTE 2 Further information on insulation fault location can be found in the following standards: IEC 60364-4-41:2005, 411.6, and IEC 60364-5-53:2001, 531.3.

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 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60721-3-1, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 1: Storage*

IEC 60721-3-2, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

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

IEC 61326-2-4, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-4: Particular requirements – Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9*

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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*

IEC 61557-8:2007, *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 8: Insulation monitoring devices for IT systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61557-1, in IEC 61557-8 and the following apply.

3.1
insulation fault location system
device or combination of devices used for insulation fault location in IT systems. The insulation fault location system is used in addition to an insulation monitoring device. It injects a locating current between the electrical system and earth and locates insulation faults

NOTE The requirements for insulation monitoring devices are defined in IEC 61557-8.

3.2
locating current
I_L
r.m.s. value of the current that is injected by the locating current injector during the location process. The locating current can be generated by

– an independent locating voltage source, or
– an independent locating current source, or
– it can be driven directly from the system to be monitored

3.3
locating voltage
U_L
r.m.s. value of the voltage present at the measuring terminals of the locating current injector during the measurement when the device has an independent locating voltage or current source

NOTE In a fault-free, de-energized system, this represents the voltage present between the terminals of the locating device to the system to be monitored and the terminals for the connection to the PE conductor.

3.4
response sensitivity
value of the evaluating current or insulation resistance at which the evaluator responds under specified conditions

NOTE Response sensitivity can either be a fixed threshold or a response curve.

3.5
insulation fault locator
device or part of a device for the location of the insulation fault

3.6
locating current sensor
sensor for the detection of the locating current used for the location of the insulation fault

3.7
locating current injector
device or part of a device, which function it is to inject the locating current in the IT system in order to locate the insulation fault

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3.8
passive locating current injector
locating current injector that generates the locating current directly from the system to be monitored

3.9
active locating current injector
locating current injector that generates the locating current from a locating voltage source which is independent from the system to be monitored

4 Requirements

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

4.1 Equipment for insulation fault location

Equipment for insulation fault location shall be capable of localizing symmetrical as well as asymmetrical insulation faults in an IT system and to give a warning, if the insulation resistance in a part of the installation falls below the response sensitivity.

If equipment for insulation fault location has a self-test function, the self-test shall not produce an insulation fault to earth.

NOTE 1 See also IEC 61557-8:2007, 4.1.

NOTE 2 Insulation monitoring devices may be deactivated during the location process.

NOTE 3 Warning indication can be done by a lamp, a buzzer or by any other kind of indication.

NOTE 4 Insulation fault locating systems may have a self-test function. Checking the response sensitivity is not necessary.

NOTE 5 Insulation fault location systems with an active locating current source may also be used for insulation fault location in de-energized systems.

4.2 Response sensitivity

Insulation fault location systems shall be designed in such a manner that the response sensitivity stated by the manufacturer will be met under the specified system conditions, at a total symmetrical system leakage capacitance of 1 µF upstream the evaluating current sensor (C_{Lu} = 1 µF, C_{Ld} = 0 µF according to Figure C.2).

Information on the influence of the system leakage capacitances higher than 1 µF on the response sensitivity as well as possible interference from the distribution system on the insulation fault location process shall be stated by the manufacturer.

NOTE The total leakage capacitance is the sum of the leakage capacitances of all phase conductors, including the neutral conductor to PE.

4.3 Warning device

Insulation fault location systems shall contain a visual warning device, which indicates if an insulation fault is detected or allow connection to such a device for the indication of a fault. If externally connectable audible signalling devices are provided, they may be fitted with a resetting facility. In this case, after clearing a fault or resetting the device, the audible signal shall sound if a new fault occurs.

4.4 Locating current I_L

The maximum locating current I_L shall be limited to 500 mA, r.m.s., to ensure that the locating current does not produce touch voltages above the conventional voltage limit (50 V a.c., 120 V

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d.c.) under the first fault in the distribution system. The locating current shall not increase above 500 mA, r.m.s., under foreseeable component failures in the locating current injector. When the locating current is adjustable, unintentional changes of the setting shall be prevented by suitable means.

4.5 Locating voltage U_L

If an active locating voltage or locating current is used, the locating voltage U_L shall be equal or below 50 V a.c. or 120 V d.c. (see IEC 60364-4-41) under no load conditions.

If an active locating voltage U_L above 50 V a.c. or 120 V d.c. is used the locating current shall not exceed 3,5 mA a.c., (r.m.s.) or 10 mA d.c. through a pure resistance of 2 000 Ω.

4.6 Indication of the insulation value

When insulation fault location systems include means for the indication of the insulation value, the uncertainty of the indicated value shall be stated by the manufacturer.

4.7 PE connection

Contrary to IEC 61557-1, the PE connection of insulation fault location systems (locating current injector) is a measuring connection and shall be treated as functional earth connection (FE). If the insulation fault location system has accessible parts which are earthed for protective purposes, these connections shall be treated as protective connections (PE).

4.8 Clearances and creepage distances

Insulation fault location systems shall have minimum clearances and creepage distances in accordance with IEC 60664-1 and IEC 60664-3, or only IEC 61010-1. Clearances and creepage distances shall be selected in accordance with

– overvoltage category III,
– pollution degree 2, and
– pollution degree 1 for circuits inside the housing which are coated according to IEC 60664-3.

NOTE For accessible parts on the outside of the housing, creepage distances of pollution degree 3 are recommended to withstand higher environmental requirements.

Where different voltages are used in one device, clearances and creepage distances shall be designed for the highest voltage.

4.9 Electromagnetic compatibility (EMC)

Insulation fault location systems shall comply with the requirements for electromagnetic compatibility (EMC) in accordance with IEC 61326-2-4.

4.10 Additional requirements

Additional requirements for insulation fault location systems are listed in Table 1.

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Table 1 – Requirements for Insulation Fault Location Systems (IFL)

	Requirements for type test	Requirements for routine tests
Response sensitivity	According to 6.1.1	According to 6.2.2
Locating current I_L	According to 6.1.2	Not applicable
Locating voltage U_L	According to 6.1.3	Not applicable
Warning device	According to 6.1.4	According to 6.2.3
Relative uncertainty of the indicated insulation value [a]	According to 6.1.5	Not applicable
Locating current injector	According to 6.1.6	According to 6.2.4
Dielectric test	According to 6.1.7	According to 6.2.5
Electromagnetic compatibility	According to 6.1.8	Not applicable
Marking and operating instructions	According to 6.1.11	According to 6.2.6
Minimum permanently admissible nominal voltage	$1{,}15 \times U_n$ of the highest nominal voltage U_n [b]	Not applicable
Climatic environmental conditions	– Operation: class 3k5 (IEC 60721-3-3: -5 °C to +45 °C) [c] – Transport: class 2k3 (IEC 60721-3-2: -25 °C to +70 °C) – Storage: class 1k4 (IEC 60721-3-1: -25 °C to +55 °C)	

a The relative uncertainty is evaluated under the conditions of 4.5 and in addition:

– operation temperatures between –5 °C and +45 °C;

– at the voltages U_s and U_n and the leakage capacitances C_e stated by the manufacturer in the operating instructions.

b U_n is the phase-to-phase voltage in a three-phase system or the phase-to-neutral voltage in a one-phase system.

c Except condensation and the formation of ice.

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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 insulation fault location systems, if applicable.

5.1.1 Type of device as well as mark of origin or name of the manufacturer.

5.1.2 Type of IT system to be monitored (if the insulation fault location system is designed for a specific type of IT system).

5.1.3 Wiring diagram or number of the wiring diagram or number of the operating instructions.

5.1.4 Nominal system voltage U_n or range of the nominal voltage.

5.1.5 Nominal value of the rated supply voltage U_S or range of the rated supply voltage.

5.1.6 Nominal frequency of the rated supply voltage U_S and the nominal voltage U_n or working range of frequencies for the rated supply voltage or nominal voltage.

5.1.7 Response sensitivity or range of response sensitivity under specified conditions (see 4.2).

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5.1.8 The serial number, the year of manufacture or the type designation mandatory on the outside and, if necessary, on the inside.

5.1.9 All data of 5.1 shall be indelibly marked on the insulation fault location system.

5.2 Operating instructions

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

5.2.1 Maximum value of the locating voltage U_L in case when it is independent from the voltage in the system to be monitored.

5.2.2 Maximum value of the locating current I_L in cases where it is independent from the voltage in the system to be monitored.

5.2.3 Response sensitivity.

5.2.4 Technical data of the interface for the connection of an external warning device, including rated voltage and rated current, rated insulation voltage and explanation of the interface function.

NOTE The information for contact circuits should be in accordance with IEC 61810-2 or IEC 60947-5-1 and IEC 60947-5-4.

5.2.5 Wiring diagram when this is not marked on the device in accordance with 5.1.3.

5.2.6 Information on the influence of system leakage capacitances, of the system voltage and of the type of distribution system on the response sensitivity.

5.2.7 Locating voltage according to 6.1.7 and conformity to the relevant EMC standards.

5.2.8 Functional description of the insulation fault location system.

5.2.9 An indication that the system to be monitored including any connected appliances might be influenced by insulation fault location systems, for example influence on residual current devices (RCDs).

5.2.10 An indication that insulation monitoring devices may be influenced by insulation fault location systems, if applicable.

5.2.11 If the insulation monitoring device is deactivated during the fault indication, it shall be explained in the operating instructions.

5.2.12 The maximum operating uncertainty for the response sensitivity under specified conditions.

5.2.13 The maximum operating uncertainty for the indication of the insulation value, if applicable.

6 Tests

The following tests in addition to those required according to IEC 61557-1 shall be executed (see also Table 1).

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6.1 Type test

The type tests shall be carried out according to 6.1.1 to 6.1.12.

6.1.1 Response sensitivity of the insulation fault location system

The response sensitivity shall be tested at the lowest and at the highest value of the nominal system voltage U_n and of the rated supply voltage U_S and under the conditions of 4.2.

For this test, the insulation resistance shall be simulated as follows:

– single pole (from one phase of U_n);
– symmetrically (same resistor from all phases of U_n).

The measuring device used for testing shall be able to accommodate slow continuous or fine-step changes of the insulation resistance as well as a connection of system leakage capacitances according to 4.2. Capacitors with an insulation resistance of at least 100 MΩ and a tolerance limit of ±10 % maximum shall be used for simulating system leakage capacitances.

During testing, the insulation faults are simulated by externally connected test resistors. The response sensitivity shall be determined at the lower and the upper value of the voltage of the system to be monitored by reducing the test resistances slowly. The response sensitivity shall be determined with symmetrical and single pole test resistances. If the measuring principle depends on the magnitude of the system leakage capacitance, the specified response sensitivity shall be tested by connecting capacitors step by step.

When the insulation fault location system is provided with adjustable response sensitivity, the tests shall be performed at the lowest and at the highest value for a value which is adjustable continuously and for all values with fixed selectable response sensitivities.

The tests shall be performed under the climatic environmental conditions of Table 1.

The response sensitivity shall be compared with the values stated by the manufacturer.

6.1.2 Locating current I_L

Compliance with the requirements in 4.4 and 4.5 shall be verified.

The locating current shall be measured in an IT system with no leakage capacitance and with an insulation resistance >100 MΩ as follows:

– If the location current is driven directly from the system to be monitored or if an independent locating voltage source is used with a locating voltage equal or below 50 V a.c or 120 V d.c:
  – set the voltage of the IT system to the maximum nominal system voltage of the device;
  – connect an Ampere Meter (mA meter) between one phase conductor and the PE conductor and measure the r.m.s value of the locating current. The measured value shall not be higher than the value stated by the manufacturer in the operating instructions and shall not be higher than 500 mA.
– If an independent locating voltage source is used with a locating voltage above 50 V a.c. or 120 V d.c.:
  – connect a resistor of 2 kΩ in series with an Ampere Meter (mA meter) between the interconnected system terminals and the earth terminal and measure the r.m.s. current of the locating current. The measured value shall not be higher than 3,5 mA a.c. (r.m.s.) or 10 mA d.c.

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6.1.3 Locating voltage U_L

Compliance with 4.5 shall be verified, if applicable. The locating voltage is measured using a voltmeter, which is connected between the connections of the locating current injector to the system to be monitored and the PE conductor under no load condition.

6.1.4 Warning device

Compliance with the requirements given in 4.3 shall be verified.

6.1.5 Equipment for indication of the insulation value

Compliance with 4.6 shall be verified.

6.1.6 Locating current injector

Compliance with 4.4 shall be verified.

6.1.7 Dielectric test

Insulation fault detection systems shall be tested in accordance with IEC 61010-1.

6.1.8 Electromagnetic compatibility (EMC)

The electromagnetic compatibility shall be tested in accordance with IEC 61326-2-4.

6.1.9 Loss of locating current sensor connection

If provided, it shall be verified that loss of the connection to the locating current sensor is indicated according to 4.1.

For this test, interruption and short circuit of the connection shall be simulated.

6.1.10 Additional requirements

Compliance with the requirements given in 4.6, 4.7, 4.8 and 4.10 shall be verified.

6.1.11 Marking and operating instructions

Compliance with the requirements given in 5.1 and 5.2 shall be verified by visual inspection.

6.1.12 Record of the type test

The results of the type test shall be documented.

6.2 Routine tests

6.2.1 General

Routine tests shall be carried out according to Table 1.

NOTE Engineering and statistical analyses may show that routine tests on each insulation fault location system may not always be required, in which case sampling tests may be made instead. These tests should be carried out either during the manufacturing process or at the end.

6.2.2 Response sensitivity

The response sensitivity shall be verified for compliance on each insulation fault location system. The routine test shall be carried out in accordance with 6.1.1 and at the specified conditions of 4.2. In this test the following conditions apply:

Withdrawn

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