BS EN 61557-9:2015

BSI Standards Publication

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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National foreword

This British Standard is the UK implementation of EN 61557-9:2015. It is identical to IEC 61557-9:2014. It supersedes BS EN 61557-9:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/85, Measuring equipment for electrical and electromagnetic quantities.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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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 (IEC 61557-9:2014)

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
(IEC 61557-9:2014)

Elektrische Sicherheit in Niederspannungsnetzen bis AC 1 000 V und DC 1 500 V - Geräte zum Prüfen, Messen oder Überwachen von Schutzmaßnahmen - Teil 9: Einrichtungen zur Isolationsfehlersuche in IT-Systemen
(IEC 61557-9:2014)

This European Standard was approved by CENELEC on 2015-01-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Foreword

The text of document 85/486/FDIS, future edition 3 of IEC 61557-9, prepared by IEC/TC 85 "Measuring equipment for electrical and electromagnetic quantities" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61557-9:2015.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-10-15
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-01-15

This document supersedes EN 61557-9:2009

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD).

Endorsement notice

The text of the International Standard IEC 61557-9:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60364-4-41:2005	NOTE	Harmonized as HD 60364-4-41:2007.
IEC 60664-1	NOTE	Harmonized as EN 60664-1.
IEC 60664-3	NOTE	Harmonized as EN 60664-3.
IEC 60947-5-1:2003	NOTE	Harmonized as EN 60947-5-1:2004.
IEC 60947-5-4:2002	NOTE	Harmonized as EN 60947-5-4:2003.
IEC 61140	NOTE	Harmonized as EN 61140.
IEC 61810-2:2011	NOTE	Harmonized as EN 61810-2:2011.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60068-2-1	-	Environmental testing -- Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-2	-	Environmental testing -- Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-6	-	Environmental testing -- Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-27	-	Environmental testing -- Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60364-7-710 (mod)	2002	Electrical installations of buildings -- Part 7-710: Requirements for special installations or locations - Medical locations	HD 60364-7-710	2012
			+AC	2013
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	-	-
IEC 60664	series	Insulation coordination for equipment within low-voltage systems	EN 60664	series
IEC 60721-3-1	-	Classification of environmental conditions -- Part 3: Classification of groups of environmental parameters and their severities -- Section 1: Storage	EN 60721-3-1	-
IEC 60721-3-2	-	Classification of environmental conditions -- Part 3: Classification of groups of environmental parameters and their severities -- Section 2: Transportation	EN 60721-3-2	-
IEC 60721-3-3	-	Classification of environmental conditions -- Part 3: Classification of groups of environmental parameters and their severities -- Section 3: Stationary use at weatherprotected locations	EN 60721-3-3	-
IEC 61010-1	2010	Safety requirements for electrical equipment for measurement, control and laboratory use -- Part 1: General requirements	EN 61010-1	2010
IEC 61010-2-030	-	Safety requirements for electrical equipment for measurement, control and laboratory use -- Part 2-030: Particular requirements for testing and measuring circuits	EN 61010-2-030	-
IEC 61010-2-032	-	Safety requirements for electrical equipment for measurement, control, and laboratory use -- Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement	EN 61010-2-032	-

IEC 61010-031	-	Safety requirements for electrical equipment for measurement, control and laboratory use - - Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test	EN 61010-031	-
IEC 61326-2-2	-	Electrical equipment for measurement, control and laboratory use - EMC requirements -- Part 2-2: Particular requirements - Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems	EN 61326-2-2	-
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	EN 61326-2-4	-
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	EN 61557-1	2007
IEC 61557-8	-	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	EN 61557-8	-
CISPR 11	-	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement	EN 55011	-

CONTENTS

ELECTRICAL SAFETY IN LOW VOLTAGE DISTRIBUTION SYSTEMS UP TO 1 000 V AC AND 1 500 V DC – EQUIPMENT FOR TESTING, MEASURING OR MONITORING OF PROTECTIVE MEASURES –

Part 9: Equipment for insulation fault location in IT systems

1 Scope

This part of IEC 61557 specifies the requirements for the insulation fault location system (IFLS) which localizes 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.

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 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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60364-7-710:2002, *Electrical installations of buildings – Part 7-710: Requirements for special installations or locations – Medical locations*

IEC 60529, *Degree of protection provided by enclosures (IP Code)*

IEC 60664 (all parts): *Insulation coordination for equipment within low-voltage systems*

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 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61010-2-030, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits*

IEC 61010-031, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for measurement and test*

IEC 61010-2-032, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement*

IEC 61326-2-2, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-2: Particular requirements – Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low-voltage distribution systems*

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*

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, *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*

CISPR 11, *Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement*

3 Terms, definitions and abbreviations

3.1 Terms, definitions, symbols and units

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

3.1.1
insulation fault location system
IFLS
device or combination of devices used for insulation fault location in IT systems, where the insulation fault location system is used in addition to an insulation monitoring device and is used to locate insulation faults

Note 1 to entry: An IFLS injects a locating current between the electrical system and earth.

3.1.2
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

3.1.3
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 1 to entry: 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.

3.1.4
response sensitivity
value of the evaluating current or insulation resistance at which the evaluator responds under specified conditions

Note 1 to entry: Response sensitivity can either be a fixed threshold or a response curve.

3.1.5
insulation fault locator
device or part of a device for the location of the insulation fault

3.1.6
locating current sensor
sensor for the detection of the locating current used for the location of the insulation fault

3.1.7
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

3.1.8
passive locating current injector
locating current injector that generates the locating current directly from the system to be monitored

3.1.9
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

3.1.10
equipment for insulation fault location in medical locations
specific insulation fault location equipment dedicated to locating insulations faults in IT systems of group 2 medical locations complying with Annex A

3.1.11
response time
t_{al}
time required by insulation fault location equipment to respond under the conditions of A.2.2.1

3.1.12
group 2 medical locations
medical locations, where applied parts are intended to be used in applications such as intracardiac procedures, operating theatres and vital treatment, where discontinuity (failure) of the supply can cause danger to life

Note 1 to entry: An intracardiac procedure is a procedure, whereby an electrical conductor is placed within the cardiac zone of a patient or is likely to come into contact with the heart, such conductor being accessible outside the patient's body. In this context, an electrical conductor includes insulated wires, such as cardiac pacing electrodes or intracardiac ECG-electrodes, or insulated tubes filled with conducting fluids.

[SOURCE: IEC 60364-7-710:2002, 710.3.7]

3.1.13
portable equipment for insulation fault location
equipment used for temporary insulation fault location in IT systems instead of, or additionally, to fixed installed insulation fault location equipment

3.2 Abbreviations

For the purposes of this document, the terms and abbreviations given in Table 1 apply.

Table 1 – Abbreviations

Abbreviation	Term	Clause (in this part 9)	Other referenced standard
C_{Ld}	System leakage capacitance downstream of the evaluating current sensor	Figure C.2	
C_{Lu}	System leakage capacitance upstream of the evaluating current sensor	Figure C.2	
EMC	Electromagnetic Compatibility	4.5	IEC 60050-161:1990, 161-01-07
FE	Functional Earth	4.6.3	IEC 61010-1
IFL	Insulation Fault Locator	3.1.5, C.1	
IFLS	Insulation Fault Location System	3.1.1, Annex C	
I_L	Locating current	4.4.2, C.1	
IMD	Insulation Monitoring Device	Annex C	IEC 61557-8, 3.1.14
IP	Degree of protection of enclosure	4.8.3	IEC 60050-246:2008, 426-04-02
LCI	Locating Current Injector	3.1.7, C.2	
LCS	Locating Current Sensor	3.1.6, C.1	
LLW	Local Location Warning	4.2.2	
PE	Protective Earth	4.6.3	IEC 60050-195:1998, 195-02-09
PIFL	Portable Insulation Fault Locator	Annex C	
PLCS	Portable Locating Current Sensor	B.2.2.1	
R_F	Insulation resistance	6.2.2, C.2	IEC 61557-8, 3.1.2
RLW	Remote Location Warning	4.2.3	
T	Transformer in an IT system	Annex C	

4 Requirements

4.1 General requirements

In addition to the requirements of Clause 4 of IEC 61557-1:2007, the requirements of Clause 4 apply.

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 location 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.

NOTE 2 Insulation monitoring devices (IMDs) can 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 An IFLS can have a self-test function. Checking the response sensitivity is not necessary.

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

4.2 Mandatory functions provided by an IFLS

4.2.1 Location warning

An IFLS 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. The location warning shall be either a local location warning or a remote location warning or both together.

4.2.2 Local location warning (LLW)

This functions aims at issuing a warning signal when the insulation resistance between the system and earth falls below the response sensitivity.

This function will include the localization of an insulation fault in an IT system including symmetrical and asymmetrical insulation faults, an assessment of this fault and a local warning.

A local warning should be made by visual indicators or audible signals generated by the product implementing the function.

NOTE Usually this function is provided by the IFLS.

4.2.3 Remote location warning (RLW)

This functions aims at issuing a remote warning signal if the insulation resistance between the system and earth falls below the response sensitivity.

This function will include the localization of an insulation fault in an IT system including symmetrical and asymmetrical insulation faults, an assessment of this fault and a remote warning.

A relay contact output or an electronic switching output or a data communication can be used to report the warning remotely.

NOTE The warning output could also be used in some applications for switching.

4.3 Optional functions provided by IFLS

4.3.1 Indication of the insulation value

When an IFLS includes means for the indication of the insulation value, the uncertainty of the indicated value shall be stated by the manufacturer.

4.3.2 Performance of the IFLS in case of the interruption of the connection to the locating current sensor (LCS)

If provided an indication if the connection to one or more LCSs is lost in a manner that the location function is not ensured shall be issued.

4.4 Performance requirements

4.4.1 Response sensitivity

An IFLS 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 system leakage capacitance is the sum of the leakage capacitances of all phase conductors, including the neutral conductor to PE.

4.4.2 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 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 (LCI). When the locating current is adjustable, unintentional changes of the setting shall be prevented by suitable means.

4.4.3 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.

4.5 Electromagnetic compatibility (EMC)

An IFLS shall comply with the EMC requirements in accordance with IEC 61326-2-4.

4.6 Safety requirements

4.6.1 General

In addition to the safety requirements of IEC 61010-1 and IEC 61010-2-030 the following safety requirements apply.

4.6.2 Clearances and creepage distances

An IFLS shall have minimum clearances and creepage distances in accordance with IEC 61010-1 and IEC 61010-2-030.

Clearances and creepage distances for fixed installed equipment according to Table 3 can be dimensioned in accordance with IEC 60664 series.

Clearances and creepage distances shall be selected for:

– overvoltage or measuring category III or II, depending on the overvoltage or measuring category in the system to be monitored;
– pollution degree 2.

NOTE Pollution degree 3 can be used for accessible parts on the outside of the housing.

A division into circuits with different nominal insulation voltages is permissible in device combinations for example for IT systems with nominal voltages U_n higher than 1 000 V a.c. and 1 500 V d.c., when the electrical connection is made via resistive, capacitive or inductive voltage dividers and if, in the case of a fault, the occurrence of inadmissibly high touch voltages or inadmissibly high currents to earth are prevented by circuit design features. Such circuit design features (see IEC 61140) can be, for example, additionally provided in the form of reliable voltage dividers or a duplication of the resistors (protective impedance) in the voltage divider.

4.6.3 Protection class and earth connection of the IFLS

Contrary to IEC 61557-1, the PE connection of an IFLS (LCI) is a measuring connection and shall be treated as functional earth connection (FE). If the IFLS has accessible parts which are earthed for protective purposes, these connections shall be treated as protective earth connections (PE).

4.7 Climatic environmental conditions

The IFLS shall operate at least under the following climatic conditions:

– operation: class 3K5 according to IEC 60721-3-3, -5 °C to +45 °C, except condensation and formation of ice,
– transport: class 2K3 according to IEC 60721-3-2, -25 °C to +70 °C,
– storage: class 1K4 according to IEC 60721-3-1, -25 °C to +55 °C.

4.8 Mechanical requirements

4.8.1 General

Instead of the requirements of 4.10 of IEC 61557-1:2007 the requirements of 4.8.2 and 4.8.3 apply.

4.8.2 Product mechanical robustness

Requirements of Table 2 shall be tested as type-tests.

Table 2 – Product mechanical requirements

Mechanical robustness, in operation test	Standard and level	Test parameters	Other information
Behaviour to vibrations	IEC 60068-2-6 Test Fc	2 Hz to 13,2 Hz- amplitude ± 1 mm 13,2 Hz to 100 Hz – acceleration ± 0,7 g. For severe vibration conditions such as e.g. diesel engines, air compressors etc.: 2,0 Hz to 25,0 Hz – amplitude ± 1.6 mm 25,0 Hz to 100 Hz – acceleration ± 4 g NOTE More severe conditions may exist for example on exhaust manifolds of diesel engines especially for medium and high speed engines Values may be required to be in these cases 40 Hz to 2 000 Hz – acceleration ± 10,0g at 600 °C, duration 90 min.	Duration in case of no resonance condition 9 min at 30 Hz. Duration at each resonance frequency at which Q ≥ 2 is recorded – 90 min. During the vibration test, functional tests are to be carried out. Tests to be carried out in three mutually perpendicular planes. As a guide, it is recommended that Q does not exceed 5. Where a sweep test is to be carried out instead of the discrete frequency test and a number of resonant frequencies are detected close to each other, duration of the test is to be 120 min. Sweep over a restricted frequency range between 0,8 times and 1.2 times the critical frequencies can be used where appropriate. NOTE Critical frequency is a frequency at which the equipment being tested can exhibit: – Malfunction and/or performance deterioration – Mechanical resonances and/or other response effects occur, e.g. chatter
Behaviour to shocks	IEC 60068-2-27 Test Ea	10 gn / 11 ms, 3 pulses	

4.8.3 IP protection class requirements

The manufacturer shall document equipment IP protection class according to IEC 60529. The minimum requirements are given in Table 3, which specifies minimum IP requirements for the different kinds of IFLS housings.

Table 3 – Minimum IP requirements for IFLS

Kind of IFLS	Front panel	Housing, except front panel
Fixed installed IFLS panel mounted devices.	IP 40	IP 2X
Fixed installed IFLS modular devices snapped on DIN rails within distribution panel.	IP 40	IP 2X
Fixed installed IFLS housing devices snapped on DIN rails within distribution panel.	IP 2X	IP 2X
Portable IFLS	IP 40	IP 40

5 Marking and operating instructions

5.1 Marking

In addition to the marking in accordance with Clause 5 of IEC 61557-1:2007, the following information shall be provided on the IFLS, if applicable.

– type of device as well as mark of origin or name of the manufacturer,
– type of IT system to be monitored (if the IFLS is designed for a specific type of IT system),
– nominal system voltage U_n or range of the nominal voltage,
– nominal value of the rated supply voltage U_S or range of the rated supply voltage,
– 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,
– the serial number, the year of manufacture or the type designation mandatory on the outside and, if necessary, on the inside.

All data of 5.1 shall be indelibly marked on the IFLS.

5.2 Operating instructions

The operating instructions shall state the following information in addition to the requirements given in 5.2 of IEC 61557-1:2007.

– maximum value of the locating voltage U_L in case when it is independent from the voltage in the system to be monitored;
– maximum value of the locating current I_L in cases where it is independent from the voltage in the system to be monitored;
– response sensitivity;
– 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;
– wiring diagram,
– information on the influence of system leakage capacitances, of the system voltage and of the type of distribution system on the response sensitivity;
– locating voltage according to 4.4.3 and conformity to the relevant EMC standards;
– functional description of the IFLS;
– an indication that the system to be monitored including any connected appliances might be influenced by the IFLS, for example influence on residual current devices (RCDs);
– an indication that IMDs may be influenced by the IFLS, if applicable;

– if the IMD is deactivated during the fault indication, it shall be explained in the operating instructions;
– the maximum operating uncertainty for the response sensitivity under specified conditions;
– the maximum operating uncertainty for the indication of the insulation value, if applicable.

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

6 Tests

6.1 General

The tests according to Clause 6 of IEC 61557-1:2007 and the tests detailed in 6.2 and 6.3 shall be performed.

6.2 Type tests

6.2.1 General

Operation within the following climatic environmental conditions shall be verified according to Table 4. The environmental conditions for storage tests (product not powered) are shown in Table 5.

Table 4 – Reference conditions for tests in operation

Climatic characteristics	Basic standard	Level / Class	Test specification
Exposed to the cold	IEC 60068-2-1	Ad	–5° C; 96 h;voltage tests
Exposed to dry heat	IEC 60068-2-2	Bd	+45° C; 96 h; voltage tests

Table 5 – Reference conditions for storage tests

Climatic characteristics	Basic standard	Level / Class	Test specification
Exposed to the cold	IEC 60068-2-1	Ab	–25° C; 96 h
Exposed to dry heat	IEC 60068-2-2	Bb	+70° C; 96 h

6.2.2 Test of response sensitivity of the IFLS

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 4.4.1.

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

– single pole resistor (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 4.4.1. 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 IFLS 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 4.7.

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

6.2.3 Test of the locating current I_L

Compliance with the requirements in 4.4.2 shall be verified.

The locating current shall be measured in an IT system with no system 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 amperemeter 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 amperemeter 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.

6.2.4 Test of the locating voltage U_L

Compliance with 4.4.3 shall be verified, if applicable. The locating voltage is measured using a voltmeter, which is connected between the connections of the LCI to the system to be monitored and the PE conductor under no load condition.

6.2.5 Test of the location warning

Compliance with the requirements given in 4.2.1 shall be verified.

6.2.6 Test of the indication of the insulation value

If provided, compliance with 4.3.1 shall be verified.

6.2.7 Test of the performance of the LCI

Compliance with 4.4.2 shall be verified.

6.2.8 Voltage test

The IFLS shall be tested in accordance with IEC 61010-1.

6.2.9 Test of the electromagnetic compatibility (EMC)

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

6.2.10 Test of the loss of LCS connection

If provided, it shall be verified that loss of the connection to the LCS according to 4.3.2 is indicated.

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

6.2.11 Test of the protection class and the earth connection of the IFLS

Compliance with 4.6.3 shall be verified

6.2.12 Inspection of the marking and operating instructions

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

6.2.13 Mechanical test

6.2.13.1 Shock and vibration test

Shock and vibration tests shall be performed to verify the requirements of 4.8.2.

6.2.13.2 Validation of the IP requirements

The requirements of 4.8.3 shall be verified by visual inspection.

6.2.14 Record of the type test

The results of the type test shall be documented.

6.3 Routine tests

6.3.1 General

Routine tests shall be performed on each IFLS.

If engineering and statistical analyses show that routine tests on each IFLS are not always required, in this case sampling tests could be made instead. These tests shall be carried out either during the manufacturing process or at the end.

6.3.2 Test of the response sensitivity

The response sensitivity shall be verified for compliance on each IFLS. The routine test shall be carried out in accordance with 6.2.2 and at the specified conditions of 4.4.1.

In this test the following conditions apply:

– room temperature (23 ± 3) °C at 1,0 times U_n and 1,0 times U_S or the lowest and highest rated value of U_n and U_S for a device with several rated voltages or with a range of rated voltages;

– at a minimum of three settings including the minimum, the maximum and at a point in the centre of the setting of the response sensitivity for devices with continuously adjustable response sensitivity;

– at each step for devices with stepwise adjustment of the response sensitivity.

During this test, the limits shall be reduced to such a degree that the requirements are met.

6.3.3 Test of the location warning

The location warning function according to 4.2.1 shall be tested.

6.3.4 Test of the self-test function

If applicable, compliance with 4.1 shall be verified.

6.3.5 Voltage test

The dielectric test shall be performed in accordance with Annex F of IEC 61010-1:2010.

6.3.6 Compliance with the tests of Clause 6

The compliance with the tests of Clause 6 should be recorded.

7 Overview of requirements and tests for IFLSs

Table 6 gives an overview of the requirements for IFLS and the tests that shall be performed for IFLSs.

Table 6 – Requirements and tests on IFLSs

Characteristics	Requirements	Type tests	Routine tests
Local location warning	4.2.2	6.2.5	6.3.3
Remote location warning	4.2.3	6.2.5	6.3.3
Indication of the insulation value	4.3.1	6.2.6	Not applicable
Performance of the IFLS in case of the interruption of the LCS	4.3.2	6.2.10	Not applicable
Response sensitivity	4.4.1	6.2.2	6.3.2
Locating current	4.4.2	6.2.3	Not applicable
Locating voltage	4.4.3	6.2.4	Not applicable
EMC	4.5	6.2.9	Not applicable
Clearances and creepage distances	4.6.2	6.2.8	6.3.5
Protection class and earth connection	4.6.3	6.2.11	Not applicable
Climatic environmental conditions	4.7	6.2	Not applicable
Mechanical requirements	4.8	6.2.13	Not applicable
Marking and operating instructions	5	6.2.12	6.3.6

Annex A
(normative)

Equipment for insulation fault location in medical locations

A.1 Scope

This Annex A specifies the additional requirements for equipment for insulation fault location which is used in unearthed IT a.c. systems of group 2 medical locations in accordance with IEC 60364-7-710.

The information and requirements specified herein replace or supplement the corresponding clauses and subclauses of the main text of this standard, as indicated.

A.2 Requirements

A.2.1 General

In addition to Clause 4, the requirements or modifications detailed in A.2.2 and A.2.3 apply.

A.2.2 Performance requirements

A.2.2.1 Response sensitivity

The minimum response sensitivity shall be 50 kΩ or U_n / 50 kΩ at a total upstream system leakage capacitance (sum of the leakage capacitances of all phase conductors to earth) of 0,5 μF.

A.2.2.2 Locating current I_L

The locating current shall be limited to 1 mA peak.

A.2.2.3 Locating voltage U_L

If an active locating voltage or locating current is used, the locating voltage U_L shall be below 25 V a.c. peak or d.c. according to IEC 60364-7-710.

A.2.2.4 Response time t_{al}

The response time under the conditions of A.4.2 shall be stated by the manufacturer.

A.2.2.5 Indication of the fault position

An indication shall take place that indicates in which section of the installation the insulation fault has been detected.

A.2.3 Electromagnetic compatibility (EMC)

Equipment for insulation fault location in medical locations shall comply with IEC 61326-2-4 and also with CISPR 11.

A.3 Marking and operating instructions

The requirements of Clause 5 apply.

A.4 Tests

A.4.1 General

The tests of Clause 6 and the following type tests under consideration of Clause A.2 apply.

A.4.2 Type tests

The response time t_{al} shall be tested at the nominal system voltage and at a total system leakage capacitance of 0,5 μF symmetrically distributed from all phase conductors upstream the evaluating current sensor by suddenly reducing the insulation resistance from nearly infinity to 25 kΩ.

Table A.1 shows additional requirements applicable to equipment for insulation fault location in medical locations.

Table A.2 shows emission test for equipment for insulation fault location in medical locations.

Table A.1 – Additional requirements applicable to equipment for insulation fault location in medical locations

	Requirements for type tests	Requirements for routine tests
Response sensitivity	According to 6.2.2 and A.2.2.1	According to 6.3.2 and A.2.2.1
Locating current I_L	According to 6.2.3 and A.2.2.2	Not applicable
Locating voltage U_L	According to 6.2.4 and A.2.2.3	Not applicable
Electromagnetic compatibility	According to 6.2.9 and A.2.3 (Table A.2)	Not applicable

Table A.2 – Emission test for equipment for insulation fault location in medical locations

Test No.	Access	Test	Specification	Class	Comment	Basic Standard
1	Complete device	Radiated disturbance emission	30 MHz to 230 MHz 230 MHz to 1 000 MHz	B	At rated voltage	CISPR 11
2	Supply connections and main connections	Conducted disturbance emission	150 kHz to 30 MHz	B	At rated voltage	CISPR 11

Annex B
(normative)

Portable equipment for insulation fault location

B.1 Scope

This Annex B specifies the additional requirements for portable equipment for insulation fault location which is used in unearthed IT systems.

This portable equipment can be used instead of or in combination with fixed equipment for insulation fault location.

The information and requirements specified herein replace or supplement the corresponding clauses and subclauses of the main text of this standard, as indicated.

B.2 Requirements

B.2.1 General

The requirements of Clause 4 and in addition the following requirements apply.

B.2.2 Performance requirements

B.2.2.1 Portable locating current sensor (PLCS)

If an PLCS is used as evaluating current sensor, it shall comply with IEC 61010-2-032.

The PLCS shall be current sensor type A according to IEC 61010-2-032.

B.2.2.2 Probe assemblies

If hand-held probe assemblies or assemblies for the connection of the portable devices to the system to be monitored are used, they shall comply with IEC 61010-031.

The probe assemblies shall be of type A according to IEC 61010-031.

B.3 Marking and operating instructions

In addition to Clause 5 the following information on operating instructions apply.

– Information on the influence of electromagnetic fields in the vicinity of the locating current sensor shall be included in the operating instructions.
– Information on the influence of the load current in the current carrying parts of the system to which the locating current sensor shall be applied shall be included in the operating instructions.
– Information shall be added where the locating current sensor for example is erroneously applied to one single d.c. load current carrying conductor, because it is possible, that the locating current sensor may only be removed after switching-off the load current in the system.

B.4 Tests

The tests of Clause 6 and the following tests apply.

– unlike 6.2.9, tests of the electromagnetic compatibility on portable equipment for insulation fault location shall be performed in accordance with IEC 61326-2-2, but with the performance criteria of IEC 61326-2-4;

– 6.2.9 does not apply;

– the requirements of Clauses B.2 and B.3 shall be taken into consideration.

Annex C
(informative)

Example of an IFLS and explanation of upstream and downstream system leakage capacitances

C.1 Examples of an IFLS

An IFLS usually consists of several functions (see Figure C.1):

– an IMD according to IEC 61557-8;
– a LCI, portable or permanently installed;
– locating current sensor (e.g. differential current transformer or differential current clamp): these are used for the detection of the locating current and are connected to the IFL;
– IFL, portable or permanently installed: the locating current sensors are connected to the insulation fault evaluator to detect the locating current.

These functions can be performed either by a single device for each function; or all functions can be integrated into one device; or some or all functions can be integrated into an IMD according to IEC 61557-8; or into combined devices which fulfil additional monitoring functions.

The LCI can be a passive device or an active device. In case of a passive device, the locating current is driven by the voltage to earth of the system to be monitored and is limited by the LCI to the maximum locating current. In an active test device, the locating current is generated by an independent active voltage or current source inside the test device.

The IMD, LCI and IFL can either be single devices or all or some of these functions may be combined into one single device.

The PIFL can be used together with a fixed installed LCI or a portable LCI can be used.

NOTE For an explanation of the abbreviations used in Figure C.1, see Table 1 in 3.2.

Figure C.1 shows an example of an IFLS.

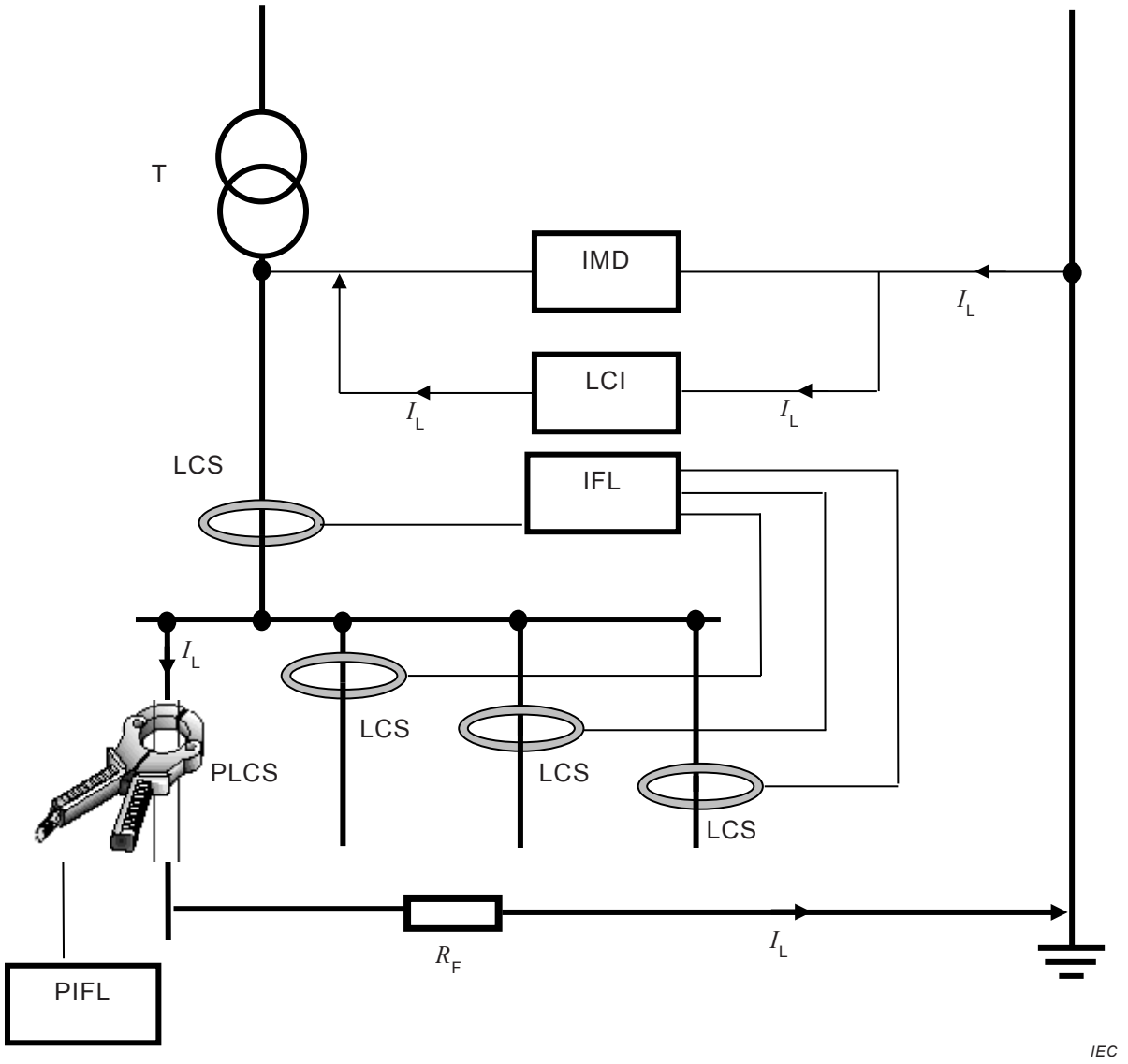

Figure C.1 – Example of an IFLS

C.2 Upstream and downstream system leakage capacitance

Figure C.2 shows the upstream and downstream system leakage capacitance.

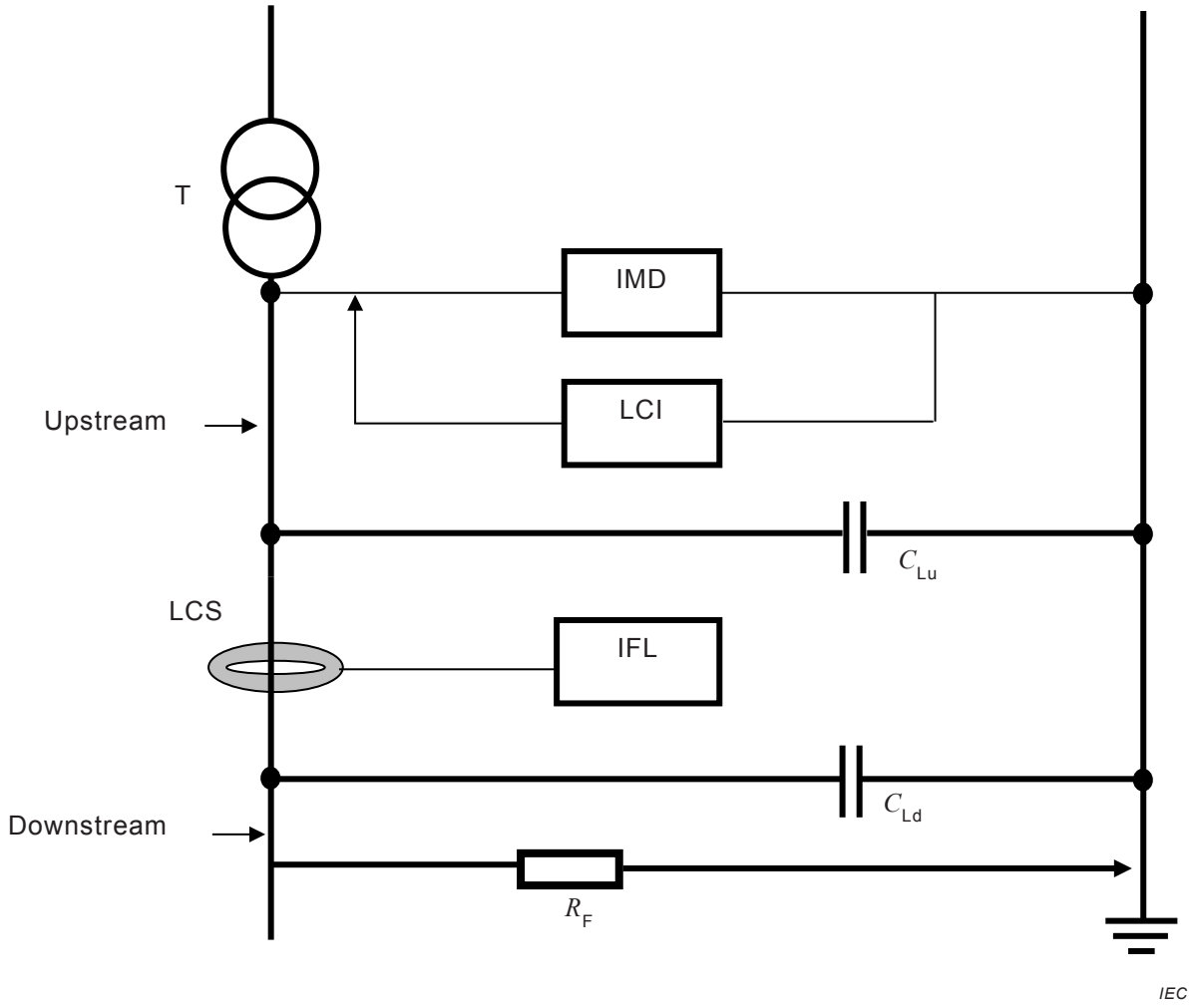

Figure C.2 – Explanation of upstream and downstream system leakage capacitance

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