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INTERNATIONAL STANDARD

colour inside

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

IEC 61557-9:2023-12 CMV(en)

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INTERNATIONAL
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CONTENTS

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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

FOREWORD

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This commented version (CMV) of the official standard IEC 61557-9:2023 edition 4.0 allows the user to identify the changes made to the previous IEC 61557-9:2014 edition 3.0. Furthermore, comments from IEC TC 85 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

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

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

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

a) new terms and definitions on maximum admissible locating AC and DC currents and voltages;
b) the requirements on locating current and locating voltage have been revised;
c) performance requirements have been added;
d) the test requirements for locating current and locating voltage have been revised;
e) the structure of this document has been adapted to that of IEC 61557-1:2019;
f) the limit values under Clause A.2 were adapted to fit the changed test methods in 6.2.3.

The text of this International Standard is based on the following documents:

Draft	Report on voting
85/896/FDIS	85/901/RVD

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

The language used for the development of this International Standard is English

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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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) that localizes insulation faults in any part of the system in unearthed IT AC systems and unearthed IT AC systems with galvanically connected DC circuits having nominal voltages up to 1 000 V AC, as well as in unearthed IT DC systems with voltages up to 1 500 V DC, 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.~~ 1 Further information on insulation fault location can be found in the following International standards: IEC 60364-4-41:2005, 411.6 and IEC 60364-4-41:2005/AMD1:2017, 411.6, and IEC 60364-5-53:~~2001~~2019/AMD1:2020, 2 531.3.

NOTE 2 This document covers both passive IFLS and active IFLS. Active IFLS can be used in de-energised systems. 3

NOTE 3 This document does not cover IMD complying with IEC 61557-8. 4

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *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 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60364-7-710:~~2002~~2021, *Low-voltage electrical installations ~~of buildings~~ – Part 7-710: Requirements for special installations or locations – Medical locations*

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

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

IEC 60721-3-1:2018, *Classification of environmental conditions – Part 3-1: Classification of groups of environmental parameters and their severities – Storage*

IEC 60721-3-2:2018, *Classification of environmental conditions – Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and handling*

IEC 60721-3-3:2019, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

IEC 60947-5-1:2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 60947-5-4:2002, *Low-voltage switchgear and controlgear – Part 5-4: Control circuit devices and switching elements – Method of assessing the performance of low-energy contacts – Special tests*
IEC 60947-5-4:2002/AMD1:2019

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016

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

IEC 61010-031, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 031: Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and 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 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61326-1:2020, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

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 testing, 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~~2019, *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 1: General requirements*

IEC 61557-8:2014, *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 8: Insulation monitoring devices for IT systems*

IEC 61810-2:2017, *Electromechanical elementary relays – Part 2: Reliability*

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

3 Terms, definitions and abbreviated terms

3.1 Terms, definitions, symbols and units

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
insulation fault location system
IFLS
device, equipment 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~~ **5**

Note 1 to entry: IFLS functionality can be used in addition to insulation monitoring functionality. It injects a locating current between the electrical system and earth and locates the insulation fault. **5**

3.1.2
locating current
I_L
~~r.m.s. value of the~~ **6** current that is injected by the locating current injector during the location process

Note 1 to entry: 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~~

– an active locating source with a sufficiently large internal impedance using an independent voltage source different from the system to be monitored, or

– a passive locating current source driven directly from the system to be monitored. **7**

3.1.3
locating voltage
U_L
~~r.m.s. value of the~~ **8** voltage present at the measuring terminals of the locating current injector during the measurement when the device has an ~~independent~~ active **9** 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~~ locating current or insulation resistance at which the ~~evaluator~~ insulation fault locator responds under specified conditions **10**

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

3.1.5
insulation fault locator
IFL
device or part of a device ~~for the location of~~, that has the function to locate **11** the insulation fault

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

3.1.7
locating current injector
LCI
device or part of a device, that has the function to inject the locating current into the IT system in order to locate the insulation fault

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

3.1.9
active locating current injector
ALCI
locating current injector that generates the locating current from a locating voltage source which is ~~independent~~ different **12** from the system to be monitored

3.1.10
~~**equipment for**~~ **insulation fault location system in medical location**
MED-IFLS
specific insulation fault location equipment dedicated to locating insulation faults in IT systems of group 2 medical locations ~~complying with Annex A~~

Note 1 to entry: The MED-IFLS is described in IEC 61557-9:2023, Annex A.

Note 2 to entry: Medical locations are defined in IEC 60364-7-710. **13**

3.1.11
response time
t_{al}
time required by insulation fault location equipment to respond under ~~the conditions of A.2.2.4~~ specified performance conditions

Note 1 to entry: The requirements for the condition can be found in IEC 61557-9:2023, A.2.2.4.

3.1.12
group 2 medical location
~~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]~~

medical location where ME equipment or ME systems are intended to be used intrusively, externally or invasively to any part of the patient and where discontinuity of the electrical supply, such as protection against electric shock, represents a risk to the safety of the patient

[SOURCE: IEC 60364-7-710:2021, 710.3.9, modified – "medical location" added to the source term "group 2".] **14** **15**

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

Note 1 to entry: The requirements for PIFL are defined in Annex B of this document.

3.1.14
system leakage capacitance for IFLS
C_{el}
maximum value of the total capacitance to earth of the system to be monitored including any connected appliances up to which the IFLS can work as specified

Note 1 to entry: The system leakage capacitance is the sum of the leakage capacitances of all phase conductors including the neutral conductor to earth. **16**

3.1.15
maximum admissible locating AC current
$I_{limit\ AC}$
maximum peak value of the locating current above a pre-set level of frequency

Note 1 to entry: The frequency and current levels are derived from IEC 61140. **17**

3.1.16
maximum admissible locating DC current
$I_{limit\ DC}$
maximum peak value of the locating current below a pre-set level of frequency

Note 1 to entry: The frequency and current levels are derived from IEC 61140. **17**

3.1.17
maximum admissible locating AC voltage
$U_{limit\ AC}$
maximum peak value of the locating voltage above a pre-set level of frequency

Note 1 to entry: The frequency and voltage levels are derived from IEC 61140. **18**

3.1.18
maximum admissible locating DC voltage
$U_{limit\ DC}$
maximum peak value of the locating voltage below a pre-set level of frequency

Note 1 to entry: The frequency and voltage levels are derived from IEC 61140. **18**

3.1.19
injection resistance
R_i
resistance of the locating current injector between the injection terminal and the earth terminal **19**

3.1.20
injection impedance
Z_i
total impedance of the locating current injector between the injection terminal and the earth terminal, measured at the nominal frequency **19**

3.1.21
symmetrical insulation fault
defect in the insulation of an electric installation or equipment creating a resistive path to earth having approximately the same resistance from all phase conductors to earth **20**

3.1.22
asymmetrical insulation fault
defect in the insulation of an electric installation or equipment creating a resistive path to earth having different resistances from all phase conductors to earth **20**

3.2 Abbreviated terms and symbols

The abbreviated terms and symbols listed in Table 1 apply to this document.

Table 1 – Abbreviated terms and symbols

Abbreviated term or symbol	~~Term~~ Explanation	~~Clause (in this part 9)~~	~~Other referenced standard~~
C_{Ld}	System leakage capacitance downstream of the ~~evaluating~~ locating current sensor	~~Figure C.2~~	
C_{Lu}	System leakage capacitance upstream of the ~~evaluating~~ locating current sensor	~~Figure C.2~~	
C_{el}	System leakage capacitance for IFLS		
EMC	Electromagnetic compatibility	~~4.5~~	~~IEC 60050-161:1990, 161-01-07~~
FE	Functional earth terminal	~~4.6.3~~	~~IEC 61010-1~~
g_n	Standard acceleration of free fall		
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 60050-426:2008, 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 conductor	~~4.6.3~~	~~IEC 60050-195:1998, 195-02-09~~
PIFL	Portable equipment for insulation fault location	~~Annex C~~	
PLCI	Passive locating current injector		
ALCI	Active locating current injector		
PLCS	Portable locating current sensor	~~B.2.2.1~~	
Q	Quality factor		
R_F	Insulation resistance	~~6.2.2, C.2~~	~~IEC 61557-8, 3.1.2~~
RLW	Remote location warning	~~4.2.3~~	
RMS	Root-mean-square value, effective value		
T	Transformer in an IT system	~~Annex C~~	

Abbreviated term or symbol	~~Term~~ Explanation	~~Clause (in this part 9)~~	~~Other referenced standard~~
$I_{limit\ AC}$	Maximum admissible locating AC current		
$I_{limit\ DC}$	Maximum admissible locating DC current		
$U_{limit\ AC}$	Maximum admissible locating AC voltage		
$U_{limit\ DC}$	Maximum admissible locating DC voltage		
MED-IFLS	Insulation fault location system in medical locations		
t_{al}	Response time		
RLW	Remote location warning		
µF	Microfarad The farad (symbol: F) is the SI derived unit of electrical capacitance. 1 µF (microfarad, one millionth (10−6) of a farad)		
U	Formula symbol for a voltage in the SI unit volt		
U_1	Calculated voltage for the locating voltage assessment		
U_B	Measured voltage for the locating current assessment		
U_L	Locating voltage		
U_{pa}	Permanently admissible nominal voltage		
U_n	Nominal system voltage		
U_s	Supply voltage		
MΩ	megaohm The ohm (symbol: Ω) is the SI derived unit of electrical resistance. 1 MΩ (megohm) corresponds to one million ohms		
Z_i	Injection impedance Total impedance of IFLS between the terminals to the system and earth, measured at the rated frequency f_N		
R_i	Injection resistance		
R_H	First resistance of the voltage divider		
R_T	Second resistance of the voltage divider		
R_S	First resistance of the voltage divider representing resistance of human skin		
R_B	Second resistance of the voltage divider representing resistance of a human body		
C_f	Capacitance of anti-aliasing filter		
µs	Microsecond The second (symbol: s) is the base unit of time in the International System of Units (SI).		
Fc	Test Fc: Vibration (sinusoidal)		
Ea	Test Ea and guidance: Shock		
nF	nanofarad The farad (symbol: F) is the SI derived unit of electrical capacitance.		

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.~~ **21**

Equipment for insulation fault location shall be capable of localizing symmetrical insulation faults 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.~~ **22**

~~NOTE 3 Warning indication can be done by a lamp, a buzzer or by any other kind of indication.~~ **22**

~~NOTE 4 An IFLS can have a self-test function. Checking the response sensitivity is not necessary.~~ **22**

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

For the requirements of an insulation fault location system in medical locations, see Annex A.

For the requirements of portable equipment for insulation fault location, see Annex B.

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~~. Alternatively, an IFLS shall allow for connection to such a visual warning device for the indication of an insulation fault. If externally connectable audible signalling devices are provided, they may be fitted with a resetting facility. In this case, after clearing an insulation fault or resetting the device, the audible signal shall sound if a new insulation 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 function aims at issuing a warning signal when the insulation resistance between the system and earth falls below the set response ~~sensitivity~~ value.

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 by additional 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 function 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~~ can 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~~ Alarm in case of the interruption of the loss 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.~~

When an IFLS includes a periodic verification of the connection to one or more LCSs, an indication in case of loss of connection shall be provided.

4.3.3 Self-test

An IFLS can have a self-test function. Checking the response sensitivity by the self-test is not mandatory.

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 of the ~~evaluating~~ locating 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.~~ For additional information about upstream and downstream capacitances, see Annex C.

~~4.4.2 Locating current I_L~~ 23

~~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.~~

~~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 kΩ.~~

~~If an active locating voltage U_L equal or below 50 V a.c. or 120 V d.c. is used, the locating current shall not exceed 500 mA r.m.s. through a shunt.~~

~~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.~~

4.4.2 Locating current I_L and locating voltage U_L

If a passive locating current source is used, the locating current I_L shall be limited to 500 mA RMS. The locating current shall not increase above 500 mA RMS, 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.

If an active locating source is used, then there are no additional requirements on the locating current I_L when the value of the locating voltage U_L does not exceed:

– The maximum admissible locating DC voltage U_{Limit_DC} of 120 V peak measured with the circuit, which has an equivalent resistance of at least 20 times the injection resistance if the signal frequency is less than 15 Hz or is DC.
– The maximum admissible locating AC voltage U_{Limit_AC} of 50 V RMS and 70 V peak measured with the circuit, which has an equivalent resistance of at least 20 times the injection resistance, if the signal frequency is greater than or equal to 15 Hz.

For signal frequencies less than 15 Hz or DC, the maximum locating DC current $I_{Limit\ DC}$ shall not exceed 10 mA peak, if the value of the locating voltage U_L exceeds:

– The maximum admissible locating DC voltage $U_{Limit\ DC}$ of 120 V peak measured with the circuit, which has an equivalent resistance of at least 20 times the injection resistance.

For signal frequencies greater than or equal to 15 Hz, the maximum locating AC current $I_{limit\ AC}$ shall not exceed 3,5 mA RMS and 5 mA peak if the value of the locating voltage U_L exceeds:

– The maximum admissible locating AC voltage $U_{Limit\ AC}$ of 50 V RMS and 70 V peak measured with the circuit, which has an equivalent resistance of at least at 20 times the injection resistance.

Under certain circumstances for the tests in accordance with 6.2.3, injection impedance shall be considered.

4.4.3 Permanently admissible nominal voltage U_{pa} 24

The permanently admissible nominal voltage U_{pa} shall be at least 105 % of the highest nominal system voltage U_n.

The permanently admissible nominal voltage U_{pa} applies between the system connections of the IFLS and between the system connections and earth.

If IFLS are applicable in IT systems with frequencies different from the mains nominal frequency, for example 50 Hz/60 Hz, the manufacturer shall provide information of the permanently admissible system voltages at the relevant frequency range in the operating instructions.

4.4.4 Supply voltage U_s 25

For IFLS without separate supply connections where the supply voltage U_s is taken out of the system voltage U_n, the working range of the supply voltage U_s shall be equal to the voltage range of the system voltage U_n.

For IFLS with separate connections for the supply voltage U_s, the manufacturer shall provide information about the admissible range of the supply voltage U_s.

4.5 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.~~ **26**

4.5.1 Clearance and creepage distances

An IFLS shall have minimum clearance 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.~~

Clearance and creepage shall comply with:

- overvoltage category III according to IEC 61010-1;
- measurement category III according to IEC 61010-2-030;
- pollution degree 2.

In special applications where transient overvoltage is limited, e.g. by the use of transformers with protective separation, measuring circuits may be designed for OVC II. For devices installed in OVCII environments, insulation shall be designed, and tests shall be carried out according to IEC 61010-1:2010, Clause 6 and IEC 61010-1:2010/AMD1:2016, Clause 6.

NOTE For circuit design features, see IEC 61140. **27**

4.5.2 Protection class and earth connection of the IFLS

~~Contrary to IEC 61557-1, the PE~~ The earth connection of the LCI component of an IFLS ~~(LCI)~~ is a measuring connection and shall be treated as a functional earth connection (FE). If the IFLS has accessible parts which are earthed for protective purposes, these connections shall be treated as protective ~~earth~~ conductor connections (PE). **28**

4.6 Electromagnetic compatibility

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

4.7 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.~~ **29**

4.7.1 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~~	

The mechanical tests according to 6.2.11 shall be passed without failure. **30**

4.7.2 IP protection class requirements

The manufacturer shall document equipment IP protection class in accordance with IEC 60529. The minimum requirements are given in Table 2, which specifies minimum IP requirements for the different kinds of IFLS housings.

Table 2 – 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~~ 0	IP 40

4.8 Climatic environmental conditions

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

– operation: class ~~3K5~~ 3K22 in accordance with IEC 60721-3-3:2019, −5 °C to +45 °C, ~~except condensation and formation of ice,~~
– transport: class ~~2K3~~ 2K11 in accordance with IEC 60721-3-2:2018, −25 °C to +70 °C,
– storage: class ~~1K4~~ 1K22 in accordance with IEC 60721-3-1:2018, −25 °C to +55 °C. **31**

5 Marking and operating instructions

5.1 Marking

In addition to the marking ~~in accordance with Clause 5 of IEC 61557-1:2007,~~ of IEC 61010-1 and IEC 61010-2-030 the following information shall be provided on the IFLS, if applicable: **32**

– 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~~ required on the outside and, if ~~necessary~~ this is not possible, on the inside of the IFLS.

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

5.2 Operating instructions

In addition to IEC 61010-1 and IEC 61010-2-030 the operating instructions shall state the following information ~~in addition to the requirements given in 5.2 of IEC 61557-1:2007~~: **33**

~~– 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;~~

– maximum RMS or peak values of the locating voltage U_L in cases where it is independent from the voltage in the system to be monitored;

– maximum RMS or peak values of the locating current I_L;

– 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~~ connection 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 4.4.2 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~~ can 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;

– an explanation in the operating instructions that if the IMD is deactivated during the fault ~~indication, it~~ location this 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;

– the maximum value of the system leakage capacitance C_{el}.

For an IFLS with an injection impedance where the injection current is not limited by any locating current resistance in series, information concerning the injection impedance Z_i of the locating current injector as a function of the injector frequency shall be provided.

Information for contact circuits, provided in the technical documentation, ~~should~~ shall be in accordance with IEC 61810-2 or with IEC 60947-5-1 and with IEC 60947-5-4. The choice of the standard to be taken into account is to be made by the manufacturer, depending on which scope of the standards mentioned is better suited to the intended field of application of the IFLS. The selection shall be documented.

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.~~ **34**

Compliance with requirements of Clause 4 shall be verified by all applicable tests specified in Clause 6 under the reference conditions according to Table 3.

Table 3 – Reference conditions for testing 35

Item	Reference conditions
Mains frequency	Rated frequency ± 1 %
Operating temperature	22 °C ± 3 °C
External continuous magnetic field	≤ 40 A/m DC ≤ 3 A/m AC at 50/60 Hz
Auxiliary supply voltage	Nominal supply voltage specified by manufacturer ±5 %

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.~~

6.2.1 Climatic tests 36

6.2.1.1 Climatic tests under operation

Normal operation of the IFLS under the conditions described in Table 4 shall be verified. At least 1 h before the end of each climatic test, the tests specified in 6.2.2, 6.2.3 and 6.2.4 shall be performed.

Table 4 – ~~Reference conditions for tests in operation~~ Climatic 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~~

6.2.1.2 Climatic tests for storage

Verification of resistance to environmental stresses during storage shall be verified in accordance with Table 5. This test is performed without voltage. One hour after the end of each climatic test, the tests specified in 6.2.2, 6.2.3 and 6.2.4 shall be performed.

Table 5 – ~~Reference conditions for storage tests~~ Climatic tests for storage

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 37

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~~ according to the 4 test conditions specified in Table 6:

– single pole resistor (from ~~one~~ each phase of U_n in turn to earth);

– symmetrically (same resistor from all phases of U_n to earth).

Table 6 – List of test conditions (TC)

Test conditions	Insulation resistance	U_n	Response sensitivity
TC1	single pole resistor	highest value of the nominal system voltage U_n	conditions of 4.4.1
TC2	symmetrically		
TC3	single pole resistor	lowest value of the nominal system voltage U_n	
TC4	symmetrically		

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~~ reference conditions of ~~4.7~~ 6.1.

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

6.2.3 Test of the locating current I_L and locating voltage U_L 38

~~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 locating current is driven directly from the system to be monitored:~~
  - ~~set the voltage of the IT system to the maximum nominal system voltage of the device;~~
  - ~~connect an amperemeter or an appropriate device between one phase conductor and the PE conductor and measure the r.m.s value of the locating current, as specified in Figure 1. 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 equal or below 50 V a.c or 120 V d.c.:~~
  - ~~connect a shunt in series with an amperemeter or an appropriate device between the interconnected system terminals and the earth terminal and measure the r.m.s. current of the locating current, as specified in Figure 2. 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 or an appropriate device between the interconnected system terminals and the earth terminal and measure the a.c. r.m.s. or the d.c. current of the locating current, as specified in Figure 3. The measured value shall not be higher than 3,5 mA a.c. r.m.s. or 10 mA d.c.~~

Requirements of 4.4.2 are tested in this subclause.

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 a passive locating current source is used:
  - set the voltage of the IT system to the maximum nominal system voltage of the device;
  - connect an amperemeter or an appropriate device between one phase conductor and the PE conductor and measure the RMS value of the locating current, as specified in Figure 1.
– If an active locating source is used:
  - connect the anti-aliasing filter between the injection terminal and the earth terminal;
  - set the voltage divider in Figure 2 to satisfy the equivalent resistance requirement from 4.4.2. For example, if the injection resistance is below 500 kΩ, R_H can be set to 9,9 MΩ, R_T to 100 kΩ and C_f to 10 nF.
  - connect a voltmeter with peak and RMS measurement capabilities to the output of the anti-aliasing filter and measure the peak and RMS values as shown in Figure 2.

U_1 shall be calculated from the voltmeter measurement and shall be less than $U_{\text{limit AC}}$ for $f \geq 15$ Hz. The voltmeter shall be in the peak mode for the peak measurement and in the true RMS mode for the RMS measurement. For the peak measurement, the voltmeter shall have a maximum response time of 250 µs.

U_1 shall be calculated from the voltmeter measurement and shall be less than $U_{\text{limit DC}}$ for $f < 15$ Hz, measured with a voltmeter in the peak mode. The voltmeter shall have a maximum response time of 250 µs.

NOTE 1 A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

If an active locating source is used with a locating voltage above 50 V AC RMS and 70 V peak or 120 V DC:

– connect the voltage divider between the injection terminal and the earth terminal;
– set the voltage divider values, R_B to 500 Ω and R_S to 1,5 kΩ;

NOTE 2 The values for R_B and R_S represent the worst-case condition and can be found in IEC 60479-1.

– connect a voltmeter with peak and RMS measurement capabilities to the output of the voltage divider and measure the peak and RMS values as shown in Figure 3.

Key for Figure 1 to Figure 3

1 phase
2 neutral
3 IFLS (operating)
4 injection terminal
5 injection system
6 amperemeter or appropriate device
7 injection impedance Z_i
8 injection resistance R_i

9 locating current I_L

10 earth terminal

11 R_H first resistance of the voltage divider

12 R_T second resistance of the voltage divider

13 C_f anti-aliasing filter

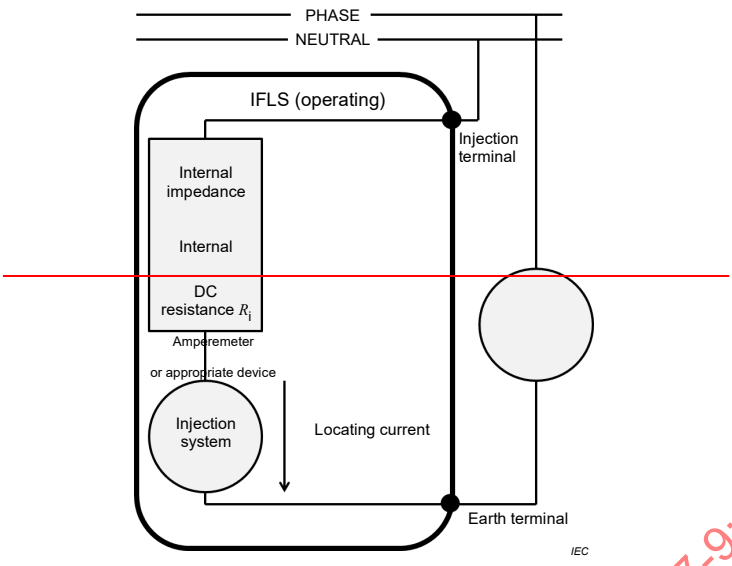
14 U_1 calculated voltage for the locating voltage assessment

15 U_B measured voltage for the locating current assessment

16 voltmeter with peak measurement capabilities for the peak measurement and a voltmeter with RMS measurement capabilities for the RMS measurement

17 R_S first resistance of the voltage divider representing resistance of human skin

18 R_B second resistance of the voltage divider representing resistance of a human body



NOTE The injection system contains the method of generating the locating current according to 4.4.2.

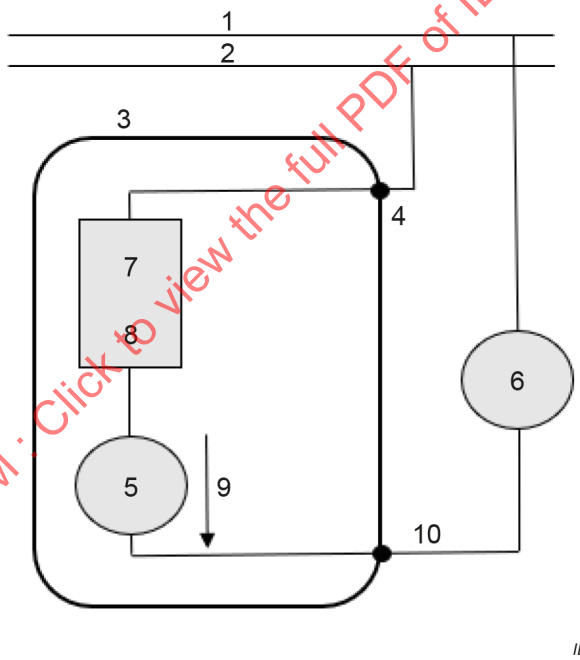
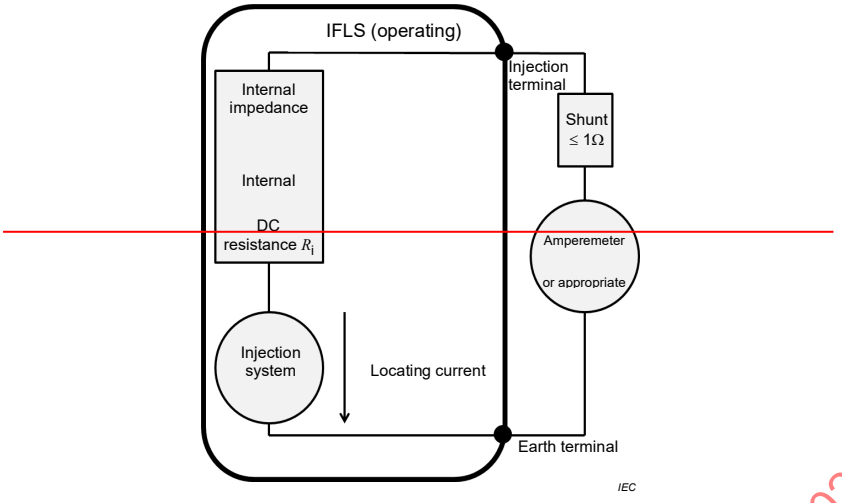


Figure 1 – Test configuration: I_L driven directly from the system to be monitored



~~NOTE The injection system contains the method of generating the locating current according to 4.4.2.~~

~~**Figure 2 – Test configuration: Independent locating voltage source with a locating voltage equal or below 50 V a.c. or 120 V d.c.**~~

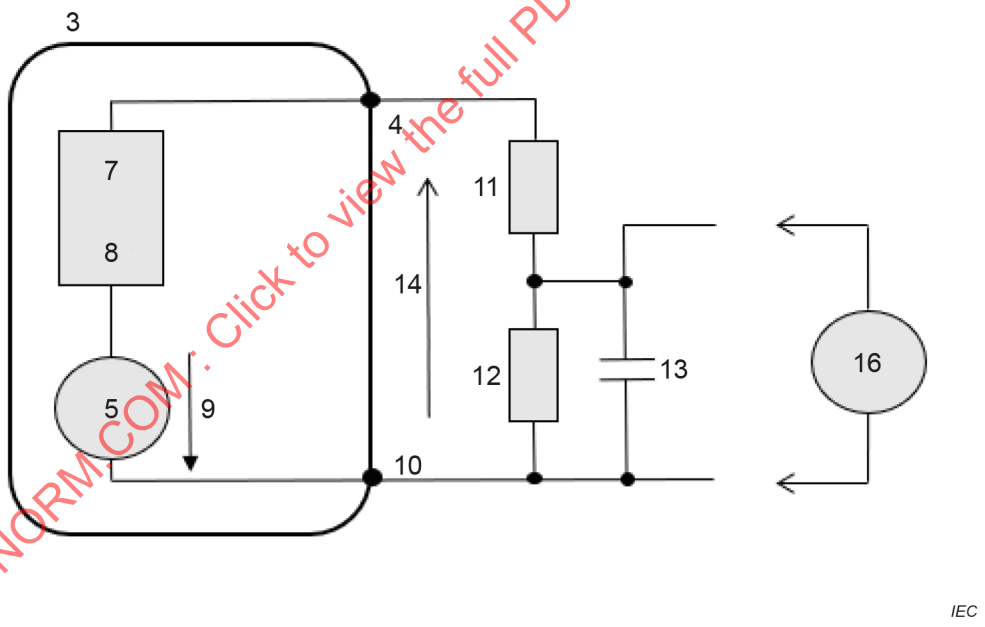
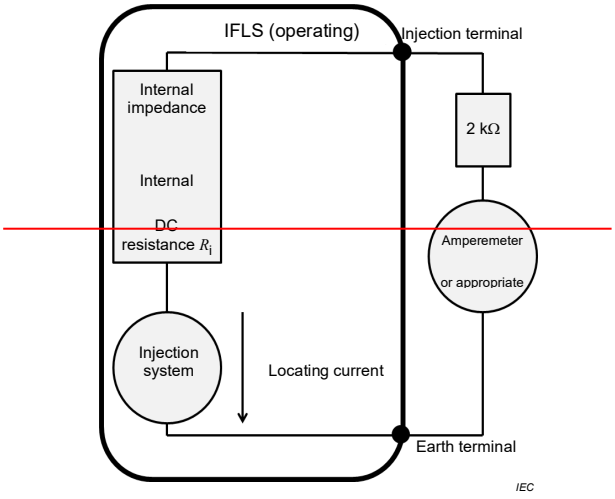


Figure 2 – Test configuration: Active locating source



~~NOTE The injection system contains the method of generating the locating current according to 4.4.2.~~

~~Figure 3 – Test configuration: Independent voltage source is used with a locating voltage above 50 V a.c. or 120 V d.c.~~

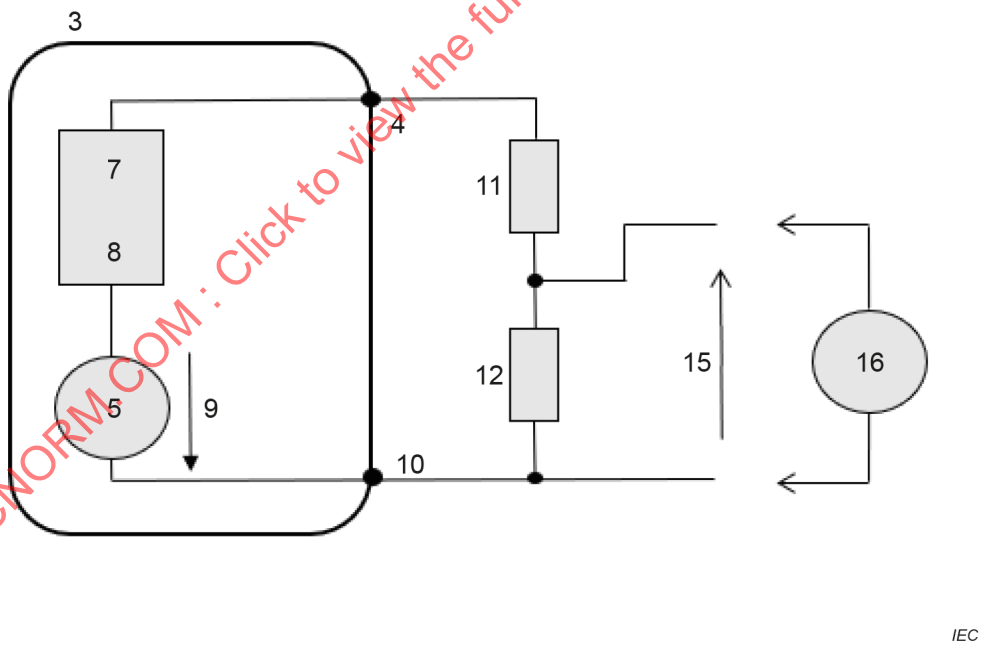


Figure 3 – Test configuration for current testing: Active locating source is used with a locating voltage above 50 V AC RMS and 70 V peak or 120 V DC

U_B shall be less than $I_{limit\ AC}$ × 500 Ω for f ≥ 15 Hz, measured with a voltmeter in peak mode for the peak measurement and in the RMS mode for the RMS measurement. For the peak measurement, the voltmeter shall have a maximum response time of 250 µs.

U_B shall be less than $I_{limit\ AC}$ × 500 Ω V for f < 15 Hz, measured with a voltmeter in a peak mode. The voltmeter shall have a maximum response time of 250 µs.

NOTE 3 A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

~~**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.~~

6.2.4 Test of the location warning

Compliance with the requirements given in 4.2.1 shall be verified in accordance with the test specification of the manufacturer which shall be documented.

6.2.5 Test of the indication of the insulation value

If an indication of the insulation value is provided, compliance with 4.3.1 shall be verified in accordance with the test specification of the manufacturer which shall be documented.

6.2.6 Verification of insulation coordination

Compliance with the requirements for the clearance and creepage distances and insulation in 4.5.1 shall be performed in accordance with IEC 61010-1.

~~**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.~~

6.2.7 Test of the electromagnetic compatibility (EMC)

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

6.2.8 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.~~

If a test of the loss of the connection of LCS function is implemented, the requirements of 4.3.2 shall be verified by the interruption of the connection. Compliance with the requirements shall be verified by visual or audible inspection.

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

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

Compliance with ~~4.6.3~~ IEC 61010-1 shall be verified if the earth connection of the IFLS is intended for protective earthing purposes. **39**

6.2.10 Inspection of the marking and operating instructions

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

6.2.11 Mechanical test

6.2.11.1 Shock and vibration test

Shock and vibration tests shall be performed according to ~~verify the requirements of 4.8.2~~ Table 7.

Table 7 – Product mechanical test 40

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 for example 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	Duration in case of no resonance condition 9 min at 30 Hz. Duration at each resonance frequency at which $Q \geq 2$ is recorded, 90 min. During the vibration test, functional tests are to be carried out. Tests are 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, the 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, for example chatter.
Behaviour to shocks	IEC 60068-2-27, Test Ea	10 g_n / 11 ms, 3 pulses	

6.2.11.2 Validation of the IP requirements

The requirements of 4.7.2 shall be verified by visual inspection.

6.2.12 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~~ **41**

~~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.~~

6.3.2 Voltage test

The ~~dielectric test~~ voltage tests of insulation fault location systems shall be performed in accordance with IEC 61010-1:2010, Annex F.

~~6.3.6 Compliance with the tests of Clause 6~~

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

6.3.3 Recording of routine tests

The compliance with the tests of 6.3 should be recorded.

7 Overview of requirements and tests for IFLS

Table 8 gives an overview of the requirements for IFLS and the tests that shall be performed for IFLS.

Table 8 – Requirements and tests on IFLSs

Characteristics	Requirements	Type tests	Routine tests
Local location warning	4.2.2	6.2.4	~~6.3.3~~ Not applicable
Remote location warning	4.2.3	6.2.4	~~6.3.3~~ Not applicable
Indication of the insulation value	4.3.1	6.2.5	Not applicable
~~Performance of the IFLS~~ Alarm in case of the interruption of the loss of the connection to the LCS	4.3.2	6.2.8	Not applicable
Self-test	4.3.3	---	Not applicable
Response sensitivity	4.4.1	6.2.2	~~6.3.2~~ Not applicable
Locating current	4.4.2	6.2.3	Not applicable
Locating voltage	4.4.2	6.2.3	Not applicable
EMC	4.6	6.2.7	Not applicable
Clearance and creepage distances Insulation coordination Voltage test	4.5.1	6.2.6	6.3.2
Protection class and earth connection	4.5.2	6.2.9	Not applicable
Climatic environmental conditions	4.8	6.2.1	Not applicable
Mechanical requirements	4.7	6.2.11	Not applicable
Marking and operating instructions	Clause 5	6.2.10	~~6.3.6~~ Not applicable

Annex A
(normative)

~~Equipment for~~ Insulation fault location system in medical locations (MED-IFLS)

A.1 ~~Scope~~ General

This annex gives additional requirements ~~for equipment~~ for the insulation fault location system that is used in unearthed AC IT systems of group 2 medical locations in accordance with IEC 60364-7-710. **42**

~~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 the requirements of Clause 4 ~~or modifications detailed in A.2.2 and A.2.3~~, the following requirements apply. These requirements and the relevant type and routine tests are given in Table A.1.

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 **43**

~~The locating current shall be limited to 1 mA r.m.s, 1,41 mA peak or 3 mA d.c.~~

The locating current I_L shall not exceed the maximum admissible locating AC current $I_{\text{limit AC}}$ of 1 mA peak and/or 1 mA RMS for frequencies greater than 15 Hz and it shall not exceed the maximum admissible locating DC current $I_{\text{limit DC}}$ of 1 mA peak for frequencies less than 15 Hz or DC.

A.2.2.3 Locating voltage U_L **43**

If an active locating voltage U_L or locating current I_L is used, the locating voltage U_L shall ~~be below 25 V a.c. r.m.s. or d.c~~ not exceed the maximum admissible locating AC voltage $U_{\text{limit AC}}$ of 35,5 V peak and 25 V RMS, and the maximum admissible locating DC voltage $U_{\text{limit DC}}$ of 35,5 V peak.

A.2.2.4 Response time t_{al}

The response time under the conditions of A.3.3 shall be stated by the manufacturer.

A.2.2.5 Indication of the fault ~~position~~ location

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

Information that indicates in which circuit the insulation fault has been detected shall be given. **44**

A.2.3 Electromagnetic compatibility

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

In addition to the requirements of 4.6, the following applies:

The MED-IFLS shall be in accordance with IEC 61326-1:2020, 7.2, Group 1, Class B equipment for emission and with the performance criteria in accordance with IEC 61326-2-4.

NOTE IEC 60364-7-710 provides the definitions for medical location groups. **45**

~~A.3 Marking and operating instructions~~

~~The requirements of Clause 5 apply.~~ **46**

~~A.4 Tests~~ **47**

~~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, but the r.m.s. value, the peak value and the d.c. value of the locating current of medical IFLS specified in A.2.2.2 shall be tested with an appropriate device~~	~~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~~

A.3 Additional tests

A.3.1 General

In addition to the tests of Clause 6, the tests of A.3.2 to A.3.4 shall apply.

A.3.2 Test of the performance requirements

A.3.2.1 Response sensitivity

The response sensitivity shall be tested according to 6.2.2, under consideration of the requirements of A.2.2.2.

A.3.2.2 Locating current

The compliance with the requirements in A.2.2.2 shall be verified according to 6.2.3.

NOTE A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

A.3.2.3 Locating voltage

The locating voltage shall be tested under consideration of the requirements of A.2.2.3 according to 6.2.3.

NOTE A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

A.3.3 Test of the response time

The response time 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 of the locating current sensor by suddenly reducing the insulation resistance from nearly infinity to 25 kΩ under consideration of the requirements of A.2.2.4 (type test).

A.3.4 Test of the electromagnetic compatibility (EMC)

Tests for the electromagnetic compatibility shall be performed according to 6.2.7 while also adhering to the requirements of A.2.3 and Table A.2 (type test).

Table A.1 – Additional requirements applicable to MED-IFLS

	Requirements for type tests	Requirements for routine tests
Response sensitivity	6.2.2 and A.2.2.1	Not applicable
Locating current I_L	6.2.3, A.2.2.2 and A.3.2.2	
Locating voltage U_L	6.2.3, A.2.2.3 and A.3.2.3	
Response time t_{al}	A.2.2.4 and A.3.3	

Table A.2 – Emission test for MED-IFLS

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	IEC 61326-1:2020, 7.2
2	Supply connections and main connections	Conducted disturbance emission	150 kHz to 30 MHz	B	At rated voltage	IEC 61326-1:2020, 7.2

Annex B
(normative)

Portable equipment for insulation fault location

B.1 ~~Scope~~ General

This annex gives additional requirements for portable equipment for insulation fault location (PIFL) that 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 Additional requirements

B.2.1 General

In addition to the requirements of Clause 4, the requirements of B.2.2 apply.

B.2.2 Performance requirements

B.2.2.1 Portable locating current sensor (PLCS)

If an PLCS is used as ~~evaluating~~ the locating current sensor, it shall ~~comply~~ be in accordance with IEC 61010-2-032. The PLCS shall be a current sensor type A in accordance with 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~~ be in accordance with IEC 61010-031.

The probe assemblies shall be of type A in accordance with IEC 61010-031.

B.3 Marking and operating instructions

In addition to the requirements regarding information in Clause 5, the following information ~~on~~ shall be included in the operating instructions ~~apply.~~:

– information on the influence of electro-magnetic 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 DC 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 Additional tests

In addition to the tests of Clause 6, the following tests shall be performed:

~~— 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;~~

– 6.2.7 does not apply, instead 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 in accordance with IEC 61326-2-4;

– the requirements of Clause B.2 and Clause B.3 shall be ~~taken into consideration~~ met.

Annex C
(informative)

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

C.1 Examples for the functions of an IFLS

An IFLS usually comprises several functions ~~(see Figure C.1)~~:

– an IMD in accordance with IEC 61557-8;

– an LCI, portable or permanently installed;

– an LCS, for example differential current transformer or differential current clamp, used for the detection of the locating current and is connected to the IFL;

– an IFL, portable or permanently installed: the locating current sensors are connected to the insulation fault ~~evaluator~~ locator (IFL) to detect the locating current.

These functions ~~can~~ may be performed either by single devices, one for each function; or all functions can be integrated into one single device~~; or~~. Likewise, some or all functions can be integrated into an IMD in accordance with IEC 61557-8; or into combined devices that fulfil additional monitoring functions.

The LCI can be a passive ~~device~~ locating current injector (PLCI) or an active ~~device~~ locating current injector (ALCI). In the 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~~ comprise single devices or all or some of these ~~se~~ functions of each device may be ~~combined~~ integrated into one single device.

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

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

Figure C.1 shows an example of an IFLS comprising several devices.

Key for Figure C.1 and Figure C.2

1	T	Transformer
2	IMD	Insulation monitoring device
3	LCI	Locating current injector
4	PIFL	Portable equipment for insulation fault location
5	IFL	Insulation fault locator
6	PLCS	Portable locating current sensor
7	LCS	Locating current sensor
8	I_L	Locating current
9	R_F	Insulation resistance
10	C_{Lu}	System leakage capacitance upstream of the locating current sensor
11	C_{Ld}	System leakage capacitance downstream of the locating current sensor

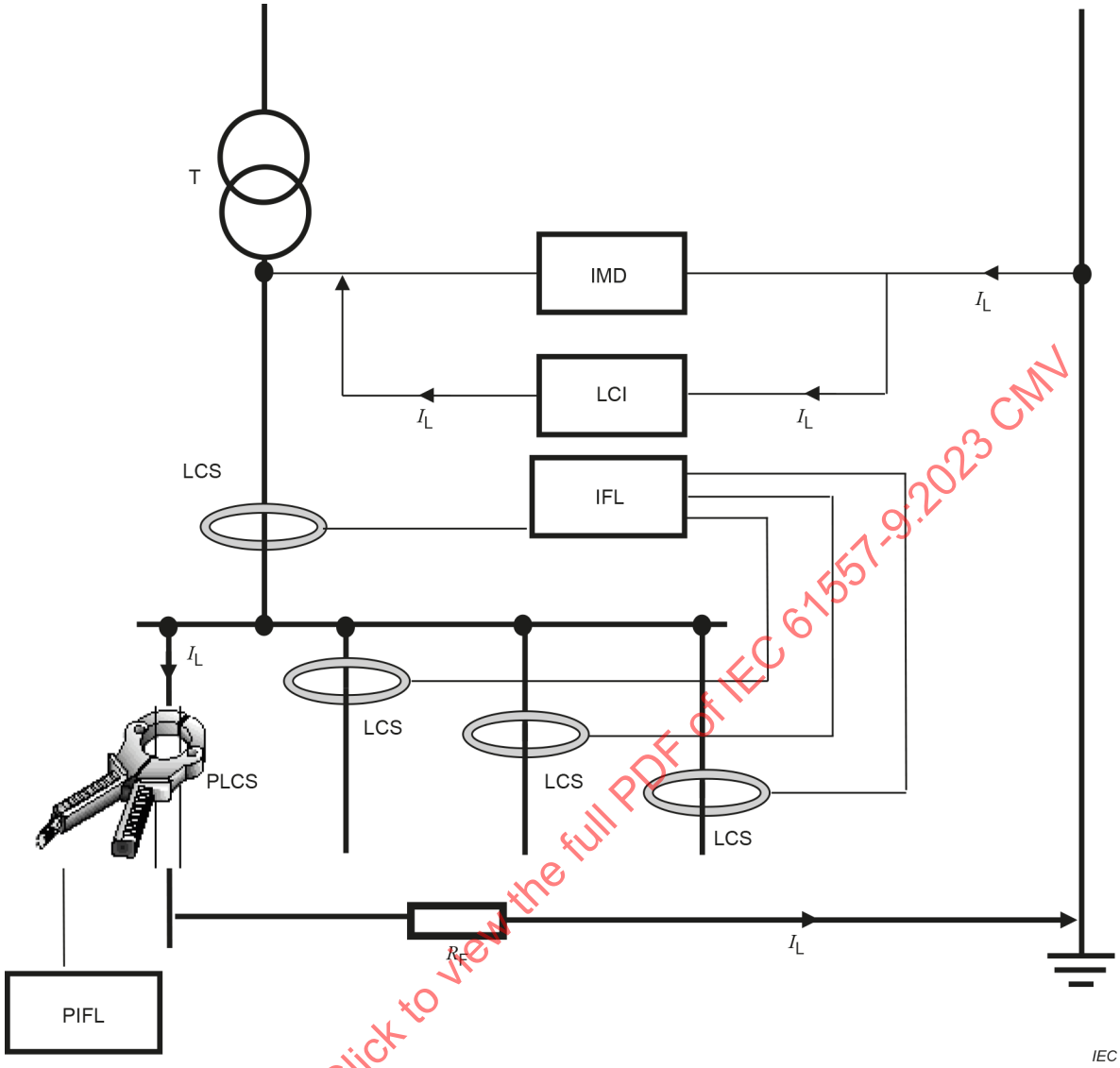


Figure C.1 – Example of an IFLS

C.2 Upstream and downstream system leakage capacitance

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

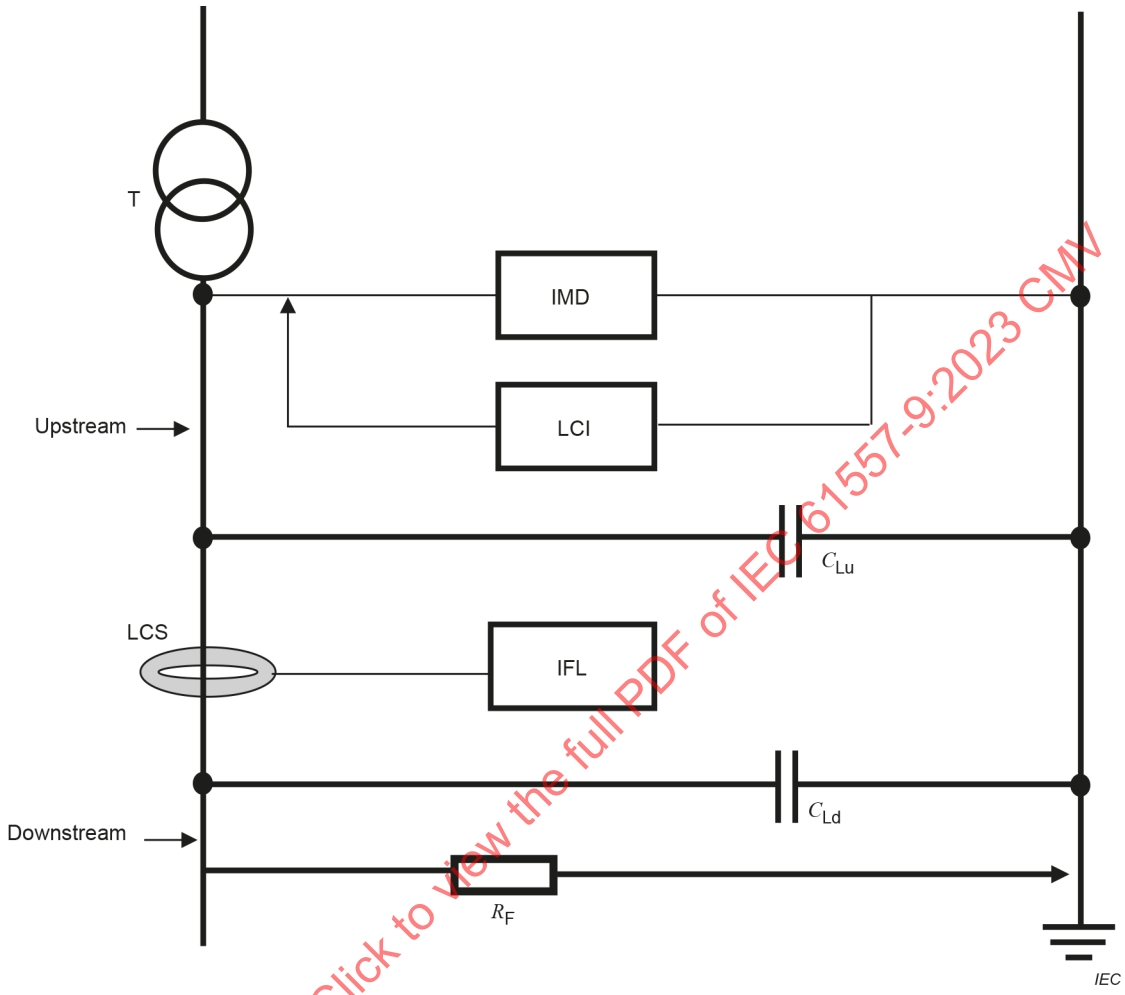


Figure C.2 – Explanation of upstream and downstream system leakage capacitance

Bibliography

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-53:~~2001~~2019, *Low-voltage electrical installations ~~of buildings~~ – Part 5-53: Selection and erection of electrical equipment – Devices for protection for safety, isolation, switching, control and monitoring*
IEC 60364-5-53:2019/AMD1:2020

IEC 60479-1:2018, *Effects of current on human beings and livestock – Part 1: General aspects*

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

IEC 60664-1, *Insulation coordination for equipment within low-voltage supply 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 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*~~

~~IEC 60947-5-4:2002, *Low-voltage switchgear and controlgear – Part 5-4: Control circuit devices and switching elements – Method of assessing the performance of low-energy contacts – Special tests*~~

~~IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*~~

IEC 61557-15, *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 15: Functional safety requirements for insulation monitoring devices in IT systems and equipment for insulation fault location in IT systems*

IEC 61810-2:~~2011~~2017, *Electromechanical elementary relays – Part 2: Reliability*

List of comments

1 This part of the note provides no added value for the reader.

2 Supplementation of relevant standards.

3 In this edition, some performance requirements have been completely revised to reduce the deviation of the test results during the testing. The test part is updated accordingly. A better distinction between the active and passive IFLS is also enabled.

4 In practice, insulation monitoring devices and insulation fault location system are often confused.

5 Increased understandability and better differentiation of the IFLS function from the IMD function.

6 In this edition, requirements for the locating current were not only based on the r.m.s. value.

7 There are different requirements for the locating current of active/passive insulation fault locating systems.

8 In this edition, requirements for the locating voltage were not only based on the r.m.s. value.

9 Every active locating source is independent of the voltage of the IT system being monitored.

10 More consistent use of the terms.

11 Improved wording to increase readability.

12 Improved wording for a more accurate description.

13 Better fitting references in Note 1 and Note 2.

14 Adapted to the amended definition in the source.

15 Updated reference.

16 The maximum system leakage capacitance influences the IFLS function and was therefore added.

17 Based on the different physiological effects of AC and DC body currents, different limits for the maximum locating current are defined.

18 Based on the different physiological effects of AC and DC voltages, different limits for the maximum locating voltage are defined.

19 These definitions are analogous to the internal resistance and the source impedance of the measuring voltage source in IEC 61557-8.

20 These definitions are comparable to the definition in IEC 61557-8. Since IMDs and IFLS are used in the IT system, the same definitions are used for the insulation faults to be distinguished.

21 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

22 These notes have been included in the normative text under Subclause 4.2.

23 This part has been completely revised in order to reduce the deviations of the test results in different third-party testing institutes.

24 These definitions are analogous to comparable requirements in IEC 61557-8.

25 These requirements have been supplemented in analogy to similar requirements in IEC 61557-8. However, a distinction was made here between actively and passively operating IFLS.

26 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

27 The optional use of IEC 60664-1 and parts of the IEC 61010 series for insulation coordination has been removed to simplify the harmonisation process at CENELEC level.

28 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

29 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

30 Requirements and test methods were mixed up here, so this part has been completely revised. See Table 7.

31 The climate classes have been updated. However, only the temperature requirements are taken into account as the other requirements are not applicable.

32 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

33 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

34 The reference to IEC 61557-1 has been deleted where possible to reduce the harmonisation effort in CENELEC.

35 The reference conditions have been completely revised and are more comparable to the reference conditions of other parts of the IEC 61557 series. Tests should thus be easier to understand and better reproducible.

36 The sections on climate testing have been revised to minimise misinterpretation.

37 The response sensitivity test was extended to 4 test cases to ensure the function of the IFLS under the defined operating conditions.

38 This part has been completely revised in order to reduce the deviations of the test results in different third-party testing institutes.

39 At least one functional earth is required for the function of IFLS. Whether a protective earth is required instead or in addition depends on the manufacturer's insulation coordination.

40 Previously Table 2. Updated and revised.

41 These tests are only required as a type test. The requirement for routine testing of these required properties dates back to a time when devices without microcontrollers and switching power supplies were predominantly on the market.

42 Reworded for better understanding.

43 Analogous to the changes in Subclause 4.4.2, the adjustment for medical locations is made here.

44 Rewording for better understanding.

45 Update and supplement.

46 No changes or additions, therefore this section has been deleted.

47 Complete revision of the structure and content analogous to the changes in Clause 6.

IEC 61557-9

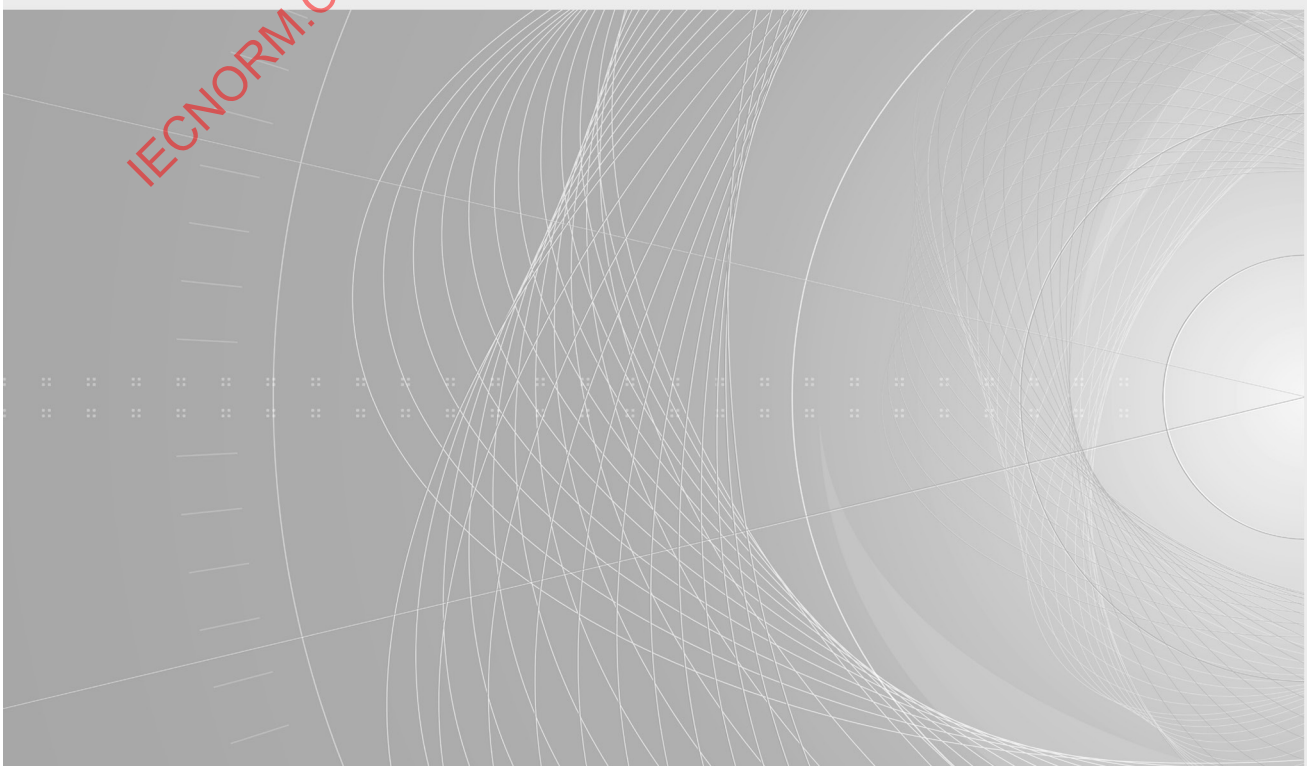
Edition 4.0 2023-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 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 61557-9:2023-12(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 61557-9 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

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

a) new terms and definitions on maximum admissible locating AC and DC currents and voltages;
b) the requirements on locating current and locating voltage have been revised;

c) performance requirements have been added;

d) the test requirements for locating current and locating voltage have been revised;

e) the structure of this document has been adapted to that of IEC 61557-1:2019;

f) the limit values under Clause A.2 were adapted to fit the changed test methods in 6.2.3.

The text of this International Standard is based on the following documents:

Draft	Report on voting
85/896/FDIS	85/901/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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) that localizes insulation faults in any part of the system in unearthed IT AC systems and unearthed IT AC systems with galvanically connected DC circuits having nominal voltages up to 1 000 V AC, as well as in unearthed IT DC systems with voltages up to 1 500 V DC, independent of the measuring principle.

NOTE 1 IT systems are described in IEC 60364-4-41. Further information on insulation fault location can be found in the following International Standards: IEC 60364-4-41:2005, 411.6 and IEC 60364-4-41:2005/AMD1:2017, 411.6, and IEC 60364-5-53:2019/AMD1:2020, 531.3.

NOTE 2 This document covers both passive IFLS and active IFLS. Active IFLS can be used in de-energised systems.

NOTE 3 This document does not cover IMD complying with IEC 61557-8.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *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 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60364-7-710:2021, *Low-voltage electrical installations – Part 7-710: Requirements for special installations or locations – Medical locations*

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

IEC 60721-3-1:2018, *Classification of environmental conditions – Part 3-1: Classification of groups of environmental parameters and their severities – Storage*

IEC 60721-3-2:2018, *Classification of environmental conditions – Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and handling*

IEC 60721-3-3:2019, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

IEC 60947-5-1:2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 60947-5-4:2002, *Low-voltage switchgear and controlgear – Part 5-4: Control circuit devices and switching elements – Method of assessing the performance of low-energy contacts – Special tests*
IEC 60947-5-4:2002/AMD1:2019

IEC 61010-1:2010, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-1:2010/AMD1:2016

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

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

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 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61326-1:2020, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

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 testing, 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 61557-1:2019, *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 1: General requirements*

IEC 61557-8:2014, *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 8: Insulation monitoring devices for IT systems*

IEC 61810-2:2017, *Electromechanical elementary relays – Part 2: Reliability*

3 Terms, definitions and abbreviated terms

3.1 Terms, definitions, symbols and units

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
insulation fault location system
IFLS
device, equipment or combination of devices used for insulation fault location in IT systems

Note 1 to entry: IFLS functionality can be used in addition to insulation monitoring functionality. It injects a locating current between the electrical system and earth and locates the insulation fault.

3.1.2
locating current
I_L
current that is injected by the locating current injector during the location process

Note 1 to entry: The locating current can be generated by:

– an active locating source with a sufficiently large internal impedance using an independent voltage source different from the system to be monitored, or

– a passive locating current source driven directly from the system to be monitored.

3.1.3
locating voltage
U_L
voltage present at the measuring terminals of the locating current injector during the measurement when the device has an active locating 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 locating current or insulation resistance at which the insulation fault locator responds under specified conditions

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

3.1.5
insulation fault locator
IFL
device or part of a device, that has the function to locate the insulation fault

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

3.1.7
locating current injector
LCI
device or part of a device, that has the function to inject the locating current into the IT system in order to locate the insulation fault

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

3.1.9
active locating current injector
ALCI
locating current injector that generates the locating current from a locating voltage source which is different from the system to be monitored

3.1.10
insulation fault location system in medical location
MED-IFLS
specific insulation fault location equipment dedicated to locating insulation faults in IT systems of group 2 medical locations

Note 1 to entry: The MED-IFLS is described in IEC 61557-9:2023, Annex A.

Note 2 to entry: Medical locations are defined in IEC 60364-7-710.

3.1.11
response time
t_{al}
time required by insulation fault location equipment to respond under specified performance conditions

Note 1 to entry: The requirements for the condition can be found in IEC 61557-9:2023, A.2.2.4.

3.1.12
group 2 medical location
medical location where ME equipment or ME systems are intended to be used intrusively, externally or invasively to any part of the patient and where discontinuity of the electrical supply, such as protection against electric shock, represents a risk to the safety of the patient

[SOURCE: IEC 60364-7-710:2021, 710.3.9, modified – "medical location" added to the source term "group 2".]

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

Note 1 to entry: The requirements for PIFL are defined in Annex B of this document.

3.1.14
system leakage capacitance for IFLS
C_{el}
maximum value of the total capacitance to earth of the system to be monitored including any connected appliances up to which the IFLS can work as specified

Note 1 to entry: The system leakage capacitance is the sum of the leakage capacitances of all phase conductors including the neutral conductor to earth.

3.1.15
maximum admissible locating AC current
$I_{limit\ AC}$
maximum peak value of the locating current above a pre-set level of frequency

Note 1 to entry: The frequency and current levels are derived from IEC 61140.

3.1.16
maximum admissible locating DC current
$I_{limit\ DC}$
maximum peak value of the locating current below a pre-set level of frequency

Note 1 to entry: The frequency and current levels are derived from IEC 61140.

3.1.17
maximum admissible locating AC voltage
$U_{limit\ AC}$
maximum peak value of the locating voltage above a pre-set level of frequency

Note 1 to entry: The frequency and voltage levels are derived from IEC 61140.

3.1.18
maximum admissible locating DC voltage
$U_{limit\ DC}$
maximum peak value of the locating voltage below a pre-set level of frequency

Note 1 to entry: The frequency and voltage levels are derived from IEC 61140.

3.1.19
injection resistance
R_i
resistance of the locating current injector between the injection terminal and the earth terminal

3.1.20
injection impedance
Z_i
total impedance of the locating current injector between the injection terminal and the earth terminal, measured at the nominal frequency

3.1.21
symmetrical insulation fault
defect in the insulation of an electric installation or equipment creating a resistive path to earth having approximately the same resistance from all phase conductors to earth

3.1.22
asymmetrical insulation fault
defect in the insulation of an electric installation or equipment creating a resistive path to earth having different resistances from all phase conductors to earth

3.2 Abbreviated terms and symbols

The abbreviated terms and symbols listed in Table 1 apply to this document.

Table 1 – Abbreviated terms and symbols

Abbreviated term or symbol	Explanation
C_{Ld}	System leakage capacitance downstream of the locating current sensor
C_{Lu}	System leakage capacitance upstream of the locating current sensor
C_{el}	System leakage capacitance for IFLS
EMC	Electromagnetic compatibility
FE	Functional earth terminal
g_n	Standard acceleration of free fall
IFL	Insulation fault locator
IFLS	Insulation fault location system
I_L	Locating current
IMD	Insulation monitoring device
IP	Degree of protection of enclosure
LCI	Locating current injector
LCS	Locating current sensor
LLW	Local location warning
PE	Protective earth conductor
PIFL	Portable equipment for insulation fault location
PLCI	Passive locating current injector
ALCI	Active locating current injector
PLCS	Portable locating current sensor
Q	Quality factor
R_F	Insulation resistance
RLW	Remote location warning
RMS	Root-mean-square value, effective value
T	Transformer in an IT system
$I_{limit\ AC}$	Maximum admissible locating AC current
$I_{limit\ DC}$	Maximum admissible locating DC current
$U_{limit\ AC}$	Maximum admissible locating AC voltage
$U_{limit\ DC}$	Maximum admissible locating DC voltage
MED-IFLS	Insulation fault location system in medical locations
t_{al}	Response time
RLW	Remote location warning
µF	Microfarad The farad (symbol: F) is the SI derived unit of electrical capacitance. 1 µF (microfarad, one millionth (10−6) of a farad)
U	Formula symbol for a voltage in the SI unit volt
U_1	Calculated voltage for the locating voltage assessment
U_B	Measured voltage for the locating current assessment

Abbreviated term or symbol	Explanation
U_L	Locating voltage
U_{pa}	Permanently admissible nominal voltage
U_n	Nominal system voltage
U_s	Supply voltage
MΩ	megaohm The ohm (symbol: Ω) is the SI derived unit of electrical resistance. 1 MΩ (megohm) corresponds to one million ohms
Z_i	Injection impedance Total impedance of IFLS between the terminals to the system and earth, measured at the rated frequency f_N
R_i	Injection resistance
R_H	First resistance of the voltage divider
R_T	Second resistance of the voltage divider
R_S	First resistance of the voltage divider representing resistance of human skin
R_B	Second resistance of the voltage divider representing resistance of a human body
C_f	Capacitance of anti-aliasing filter
µs	Microsecond The second (symbol: s) is the base unit of time in the International System of Units (SI).
Fc	Test Fc: Vibration (sinusoidal)
Ea	Test Ea and guidance: Shock
nF	nanofarad The farad (symbol: F) is the SI derived unit of electrical capacitance.

4 Requirements

4.1 General requirements

Equipment for insulation fault location shall be capable of localizing symmetrical insulation faults 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.

For the requirements of an insulation fault location system in medical locations, see Annex A.

For the requirements of portable equipment for insulation fault location, see Annex B.

4.2 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. Alternatively, an IFLS shall allow for connection to such a visual warning device for the indication of an insulation fault. If externally connectable audible signalling devices are provided, they may be fitted with a resetting facility. In this case, after clearing an insulation fault or resetting the device, the audible signal shall sound if a new insulation 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 function aims at issuing a warning signal when the insulation resistance between the system and earth falls below the set response value.

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 by additional 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 function 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 can 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 Alarm in case of the interruption of the loss of the connection to the locating current sensor (LCS)

When an IFLS includes a periodic verification of the connection to one or more LCSs, an indication in case of loss of connection shall be provided.

4.3.3 Self-test

An IFLS can have a self-test function. Checking the response sensitivity by the self-test is not mandatory.

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 of the locating 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 For additional information about upstream and downstream capacitances, see Annex C.

4.4.2 Locating current I_L and locating voltage U_L

If a passive locating current source is used, the locating current I_L shall be limited to 500 mA RMS. The locating current shall not increase above 500 mA RMS, 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.

If an active locating source is used, then there are no additional requirements on the locating current I_L when the value of the locating voltage U_L does not exceed:

– The maximum admissible locating DC voltage U_{Limit_DC} of 120 V peak measured with the circuit, which has an equivalent resistance of at least 20 times the injection resistance if the signal frequency is less than 15 Hz or is DC.
– The maximum admissible locating AC voltage U_{Limit_AC} of 50 V RMS and 70 V peak measured with the circuit, which has an equivalent resistance of at least 20 times the injection resistance, if the signal frequency is greater than or equal to 15 Hz.

For signal frequencies less than 15 Hz or DC, the maximum locating DC current $I_{Limit\ DC}$ shall not exceed 10 mA peak, if the value of the locating voltage U_L exceeds:

– The maximum admissible locating DC voltage $U_{Limit\ DC}$ of 120 V peak measured with the circuit, which has an equivalent resistance of at least 20 times the injection resistance.

For signal frequencies greater than or equal to 15 Hz, the maximum locating AC current $I_{limit\ AC}$ shall not exceed 3,5 mA RMS and 5 mA peak if the value of the locating voltage U_L exceeds:

– The maximum admissible locating AC voltage $U_{Limit\ AC}$ of 50 V RMS and 70 V peak measured with the circuit, which has an equivalent resistance of at least at 20 times the injection resistance.

Under certain circumstances for the tests in accordance with 6.2.3, injection impedance shall be considered.

4.4.3 Permanently admissible nominal voltage U_{pa}

The permanently admissible nominal voltage U_{pa} shall be at least 105 % of the highest nominal system voltage U_n.

The permanently admissible nominal voltage U_{pa} applies between the system connections of the IFLS and between the system connections and earth.

If IFLS are applicable in IT systems with frequencies different from the mains nominal frequency, for example 50 Hz/60 Hz, the manufacturer shall provide information of the permanently admissible system voltages at the relevant frequency range in the operating instructions.

4.4.4 Supply voltage U_s

For IFLS without separate supply connections where the supply voltage U_s is taken out of the system voltage U_n, the working range of the supply voltage U_s shall be equal to the voltage range of the system voltage U_n.

For IFLS with separate connections for the supply voltage U_s, the manufacturer shall provide information about the admissible range of the supply voltage U_s.

4.5 Safety requirements

4.5.1 Clearance and creepage distances

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

Clearance and creepage shall comply with:

– overvoltage category III according to IEC 61010-1;
– measurement category III according to IEC 61010-2-030;
– pollution degree 2.

In special applications where transient overvoltage is limited, e.g. by the use of transformers with protective separation, measuring circuits may be designed for OVC II. For devices installed in OVCII environments, insulation shall be designed, and tests shall be carried out according to IEC 61010-1:2010, Clause 6 and IEC 61010-1:2010/AMD1:2016, Clause 6.

NOTE For circuit design features, see IEC 61140.

4.5.2 Protection class and earth connection of the IFLS

The earth connection of the LCI component of an IFLS is a measuring connection and shall be treated as a functional earth connection (FE). If the IFLS has accessible parts which are earthed for protective purposes, these connections shall be treated as protective conductor connections (PE).

4.6 Electromagnetic compatibility

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

4.7 Mechanical requirements

4.7.1 Product mechanical robustness

The mechanical tests according to 6.2.11 shall be passed without failure.

4.7.2 IP protection class requirements

The manufacturer shall document equipment IP protection class in accordance with IEC 60529. The minimum requirements are given in Table 2, which specifies minimum IP requirements for the different kinds of IFLS housings.

Table 2 – 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 0	IP 40

4.8 Climatic environmental conditions

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

– operation: class 3K22 in accordance with IEC 60721-3-3:2019, −5 °C to +45 °C,
– transport: class 2K11 in accordance with IEC 60721-3-2:2018, −25 °C to +70 °C,
– storage: class 1K22 in accordance with IEC 60721-3-1:2018, −25 °C to +55 °C.

5 Marking and operating instructions

5.1 Marking

In addition to the marking of IEC 61010-1 and IEC 61010-2-030 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 required on the outside and, if this is not possible, on the inside of the IFLS.

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

5.2 Operating instructions

In addition to IEC 61010-1 and IEC 61010-2-030 the operating instructions shall state the following information:

– maximum RMS or peak values of the locating voltage U_L in cases where it is independent from the voltage in the system to be monitored;
– maximum RMS or peak values of the locating current I_L;
– 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;
– connection 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 4.4.2 and conformity to the relevant EMC standards;
- functional description of the IFLS;
- an indication that the system to be monitored including any connected appliances can 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;
- an explanation in the operating instructions that if the IMD is deactivated during the fault location this 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;
- the maximum value of the system leakage capacitance C_{el}.

For an IFLS with an injection impedance where the injection current is not limited by any locating current resistance in series, information concerning the injection impedance Z_i of the locating current injector as a function of the injector frequency shall be provided.

Information for contact circuits, provided in the technical documentation, shall be in accordance with IEC 61810-2 or with IEC 60947-5-1 and with IEC 60947-5-4. The choice of the standard to be taken into account is to be made by the manufacturer, depending on which scope of the standards mentioned is better suited to the intended field of application of the IFLS. The selection shall be documented.

6 Tests

6.1 General

Compliance with requirements of Clause 4 shall be verified by all applicable tests specified in Clause 6 under the reference conditions according to Table 3.

Table 3 – Reference conditions for testing

Item	Reference conditions
Mains frequency	Rated frequency ± 1 %
Operating temperature	22 °C ± 3 °C
External continuous magnetic field	≤ 40 A/m DC ≤ 3 A/m AC at 50/60 Hz
Auxiliary supply voltage	Nominal supply voltage specified by manufacturer ±5 %

6.2 Type tests

6.2.1 Climatic tests

6.2.1.1 Climatic tests under operation

Normal operation of the IFLS under the conditions described in Table 4 shall be verified. At least 1 h before the end of each climatic test, the tests specified in 6.2.2, 6.2.3 and 6.2.4 shall be performed.

Table 4 – Climatic tests in operation

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

6.2.1.2 Climatic tests for storage

Verification of resistance to environmental stresses during storage shall be verified in accordance with Table 5. This test is performed without voltage. One hour after the end of each climatic test, the tests specified in 6.2.2, 6.2.3 and 6.2.4 shall be performed.

Table 5 – Climatic tests for storage

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 under the conditions of 4.4.1.

For this test, the insulation resistance shall be simulated according to the 4 test conditions specified in Table 6:

– single pole resistor (from each phase of U_n in turn to earth);

– symmetrically (same resistor from all phases of U_n to earth).

Table 6 – List of test conditions (TC)

Test conditions	Insulation resistance	U_n	Response sensitivity
TC1	single pole resistor	highest value of the nominal system voltage U_n	conditions of 4.4.1
TC2	symmetrically		
TC3	single pole resistor	lowest value of the nominal system voltage U_n	
TC4	symmetrically		

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 reference conditions of 6.1.

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

6.2.3 Test of the locating current I_L and locating voltage U_L

Requirements of 4.4.2 are tested in this subclause.

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 a passive locating current source is used:
  - set the voltage of the IT system to the maximum nominal system voltage of the device;
  - connect an amperemeter or an appropriate device between one phase conductor and the PE conductor and measure the RMS value of the locating current, as specified in Figure 1.
– If an active locating source is used:
  - connect the anti-aliasing filter between the injection terminal and the earth terminal;
  - set the voltage divider in Figure 2 to satisfy the equivalent resistance requirement from 4.4.2. For example, if the injection resistance is below 500 kΩ, R_H can be set to 9,9 MΩ, R_T to 100 kΩ and C_f to 10 nF.
  - connect a voltmeter with peak and RMS measurement capabilities to the output of the anti-aliasing filter and measure the peak and RMS values as shown in Figure 2.

U_1 shall be calculated from the voltmeter measurement and shall be less than $U_{\text{limit AC}}$ for $f \geq 15$ Hz. The voltmeter shall be in the peak mode for the peak measurement and in the true RMS mode for the RMS measurement. For the peak measurement, the voltmeter shall have a maximum response time of 250 µs.

U_1 shall be calculated from the voltmeter measurement and shall be less than $U_{\text{limit DC}}$ for $f < 15$ Hz, measured with a voltmeter in the peak mode. The voltmeter shall have a maximum response time of 250 µs.

NOTE 1 A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

If an active locating source is used with a locating voltage above 50 V AC RMS and 70 V peak or 120 V DC:

– connect the voltage divider between the injection terminal and the earth terminal;
– set the voltage divider values, R_B to 500 Ω and R_S to 1,5 kΩ;

NOTE 2 The values for R_B and R_S represent the worst-case condition and can be found in IEC 60479-1.

– connect a voltmeter with peak and RMS measurement capabilities to the output of the voltage divider and measure the peak and RMS values as shown in Figure 3.

Key for Figure 1 to Figure 3

1 phase

2 neutral

3 IFLS (operating)

4 injection terminal

5 injection system

6 amperemeter or appropriate device

7 injection impedance Z_i

8 injection resistance R_i

9 locating current I_L

10 earth terminal

11 R_H first resistance of the voltage divider

12 R_T second resistance of the voltage divider

13 C_f anti-aliasing filter

14 U_1 calculated voltage for the locating voltage assessment

15 U_B measured voltage for the locating current assessment

16 voltmeter with peak measurement capabilities for the peak measurement and a voltmeter with RMS measurement capabilities for the RMS measurement

17 R_S first resistance of the voltage divider representing resistance of human skin

18 R_B second resistance of the voltage divider representing resistance of a human body

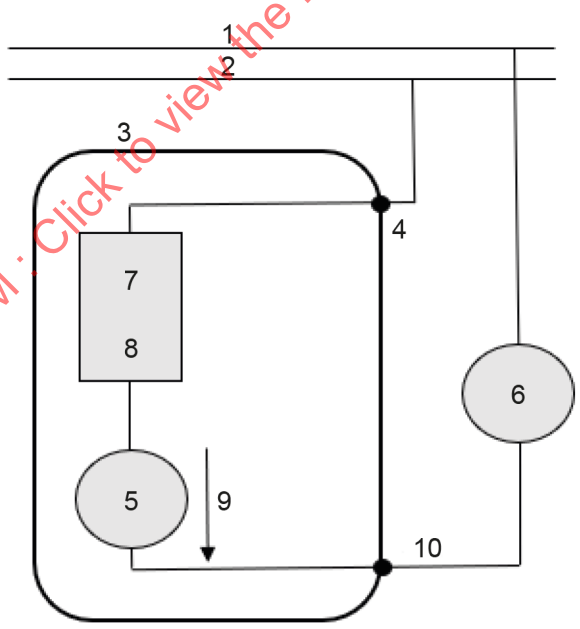

Figure 1 – Test configuration: I_L driven directly from the system to be monitored

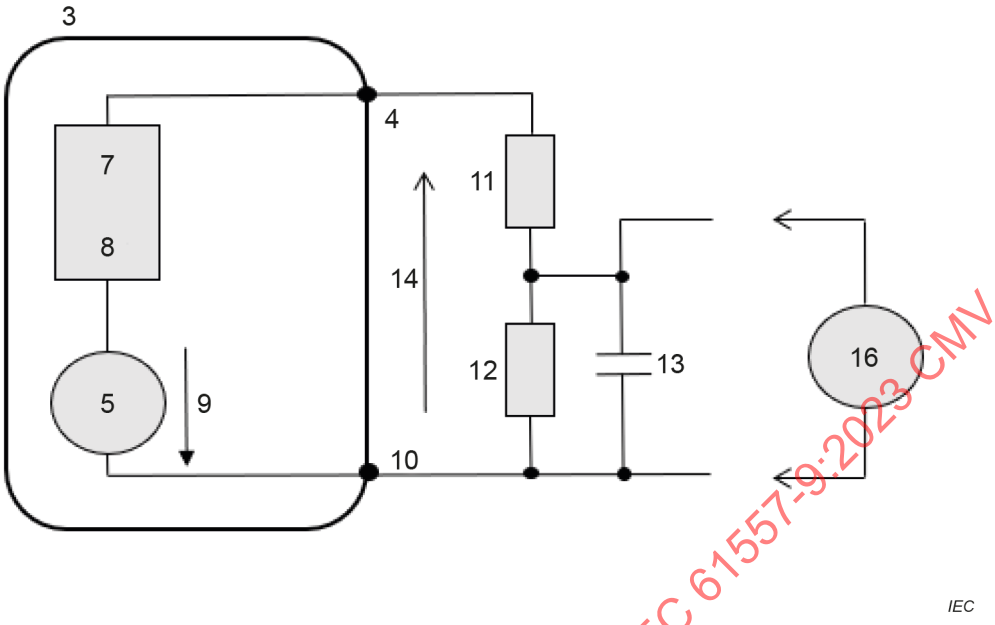

Figure 2 – Test configuration: Active locating source

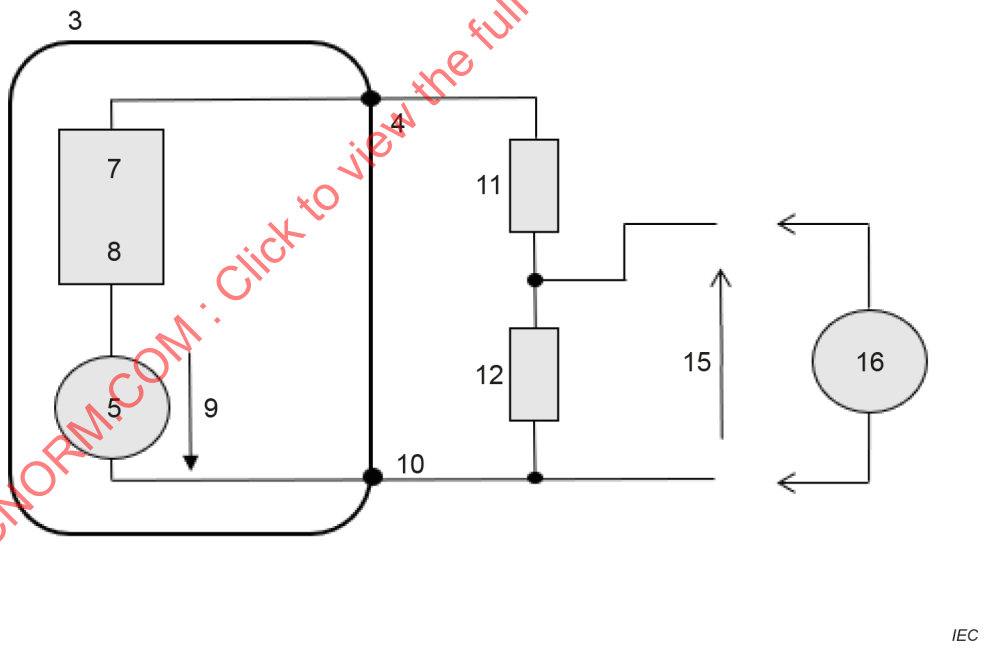

Figure 3 – Test configuration for current testing: Active locating source is used with a locating voltage above 50 V AC RMS and 70 V peak or 120 V DC

U_B shall be less than $I_{limit\ AC}$ × 500 Ω for f ≥ 15 Hz, measured with a voltmeter in peak mode for the peak measurement and in the RMS mode for the RMS measurement. For the peak measurement, the voltmeter shall have a maximum response time of 250 µs.

U_B shall be less than $I_{limit\ AC}$ × 500 Ω V for f < 15 Hz, measured with a voltmeter in a peak mode. The voltmeter shall have a maximum response time of 250 µs.

NOTE 3 A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

6.2.4 Test of the location warning

Compliance with the requirements given in 4.2.1 shall be verified in accordance with the test specification of the manufacturer which shall be documented.

6.2.5 Test of the indication of the insulation value

If an indication of the insulation value is provided, compliance with 4.3.1 shall be verified in accordance with the test specification of the manufacturer which shall be documented.

6.2.6 Verification of insulation coordination

Compliance with the requirements for the clearance and creepage distances and insulation in 4.5.1 shall be performed in accordance with IEC 61010-1.

6.2.7 Test of the electromagnetic compatibility (EMC)

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

6.2.8 Test of the loss of LCS connection

If a test of the loss of the connection of LCS function is implemented, the requirements of 4.3.2 shall be verified by the interruption of the connection. Compliance with the requirements shall be verified by visual or audible inspection.

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

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

Compliance with IEC 61010-1 shall be verified if the earth connection of the IFLS is intended for protective earthing purposes.

6.2.10 Inspection of the marking and operating instructions

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

6.2.11 Mechanical test

6.2.11.1 Shock and vibration test

Shock and vibration tests shall be performed according to Table 7.

Table 7 – Product mechanical test

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 for example 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	Duration in case of no resonance condition 9 min at 30 Hz. Duration at each resonance frequency at which $Q \geq 2$ is recorded: 90 min. During the vibration test, functional tests are to be carried out. Tests are 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, the 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, for example chatter.
Behaviour to shocks	IEC 60068-2-27, Test Ea	10 g_n / 11 ms, 3 pulses	

6.2.11.2 Validation of the IP requirements

The requirements of 4.7.2 shall be verified by visual inspection.

6.2.12 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.

6.3.2 Voltage test

The voltage tests of insulation fault location systems shall be performed in accordance with IEC 61010-1:2010, Annex F.

6.3.3 Recording of routine tests

The compliance with the tests of 6.3 should be recorded.

7 Overview of requirements and tests for IFLS

Table 8 gives an overview of the requirements for IFLS and the tests that shall be performed for IFLS.

Table 8 – Requirements and tests on IFLSs

Characteristics	Requirements	Type tests	Routine tests
Local location warning	4.2.2	6.2.4	Not applicable
Remote location warning	4.2.3	6.2.4	Not applicable
Indication of the insulation value	4.3.1	6.2.5	Not applicable
Alarm in case of the interruption of the loss of the connection to the LCS	4.3.2	6.2.8	Not applicable
Self-test	4.3.3	---	Not applicable
Response sensitivity	4.4.1	6.2.2	Not applicable
Locating current	4.4.2	6.2.3	Not applicable
Locating voltage	4.4.2	6.2.3	Not applicable
EMC	4.6	6.2.7	Not applicable
Clearance and creepage distances Insulation coordination Voltage test	4.5.1	6.2.6	 6.3.2
Protection class and earth connection	4.5.2	6.2.9	Not applicable
Climatic environmental conditions	4.8	6.2.1	Not applicable
Mechanical requirements	4.7	6.2.11	Not applicable
Marking and operating instructions	Clause 5	6.2.10	Not applicable

Annex A
(normative)

Insulation fault location system in medical locations (MED-IFLS)

A.1 General

This annex gives additional requirements for the insulation fault location system that is used in unearthed AC IT systems of group 2 medical locations in accordance with IEC 60364-7-710.

A.2 Requirements

A.2.1 General

In addition to the requirements of Clause 4, the following requirements apply. These requirements and the relevant type and routine tests are given in Table A.1.

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 I_L shall not exceed the maximum admissible locating AC current $I_{\text{limit AC}}$ of 1 mA peak and/or 1 mA RMS for frequencies greater than 15 Hz and it shall not exceed the maximum admissible locating DC current $I_{\text{limit DC}}$ of 1 mA peak for frequencies less than 15 Hz or DC.

A.2.2.3 Locating voltage U_L

If an active locating voltage U_L or locating current I_L is used, the locating voltage U_L shall not exceed the maximum admissible locating AC voltage $U_{\text{limit AC}}$ of 35,5 V peak and 25 V RMS, and the maximum admissible locating DC voltage $U_{\text{limit DC}}$ of 35,5 V peak.

A.2.2.4 Response time t_{al}

The response time under the conditions of A.3.3 shall be stated by the manufacturer.

A.2.2.5 Indication of the fault location

Information that indicates in which circuit the insulation fault has been detected shall be given.

A.2.3 Electromagnetic compatibility

In addition to the requirements of 4.6, the following applies:

The MED-IFLS shall be in accordance with IEC 61326-1:2020, 7.2, Group 1, Class B equipment for emission and with the performance criteria in accordance with IEC 61326-2-4.

NOTE IEC 60364-7-710 provides the definitions for medical location groups.

A.3 Additional tests

A.3.1 General

In addition to the tests of Clause 6, the tests of A.3.2 to A.3.4 shall apply.

A.3.2 Test of the performance requirements

A.3.2.1 Response sensitivity

The response sensitivity shall be tested according to 6.2.2, under consideration of the requirements of A.2.2.2.

A.3.2.2 Locating current

The compliance with the requirements in A.2.2.2 shall be verified according to 6.2.3.

NOTE A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

A.3.2.3 Locating voltage

The locating voltage shall be tested under consideration of the requirements of A.2.2.3 according to 6.2.3.

NOTE A conformity assessment can be used to consider both the device and its related user documentation. A third-party body can use the above test configuration or any other relevant test configuration.

A.3.3 Test of the response time

The response time 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 of the locating current sensor by suddenly reducing the insulation resistance from nearly infinity to 25 kΩ under consideration of the requirements of A.2.2.4 (type test).

A.3.4 Test of the electromagnetic compatibility (EMC)

Tests for the electromagnetic compatibility shall be performed according to 6.2.7 while also adhering to the requirements of A.2.3 and Table A.2 (type test).

Table A.1 – Additional requirements applicable to MED-IFLS

	Requirements for type tests	Requirements for routine tests
Response sensitivity	6.2.2 and A.2.2.1	Not applicable
Locating current I_L	6.2.3, A.2.2.2 and A.3.2.2	
Locating voltage U_L	6.2.3, A.2.2.3 and A.3.2.3	
Response time t_{al}	A.2.2.4 and A.3.3	

Table A.2 – Emission test for MED-IFLS

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	IEC 61326-1:2020, 7.2
2	Supply connections and main connections	Conducted disturbance emission	150 kHz to 30 MHz	B	At rated voltage	IEC 61326-1:2020, 7.2

Annex B
(normative)

Portable equipment for insulation fault location

B.1 General

This annex gives additional requirements for portable equipment for insulation fault location (PIFL) that is used in unearthed IT systems. This portable equipment can be used instead of, or in combination with, fixed equipment for insulation fault location.

B.2 Additional requirements

B.2.1 General

In addition to the requirements of Clause 4, the requirements of B.2.2 apply.

B.2.2 Performance requirements

B.2.2.1 Portable locating current sensor (PLCS)

If an PLCS is used as the locating current sensor, it shall be in accordance with IEC 61010-2-032. The PLCS shall be a current sensor type A in accordance with 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 be in accordance with IEC 61010-031.

The probe assemblies shall be of type A in accordance with IEC 61010-031.

B.3 Marking and operating instructions

In addition to the requirements regarding information in Clause 5, the following information shall be included in the operating instructions:

– information on the influence of electro-magnetic fields in the vicinity of the locating current sensor;
– 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;
– information shall be added where the locating current sensor for example is erroneously applied to one single DC 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 Additional tests

In addition to the tests of Clause 6, the following tests shall be performed:

– 6.2.7 does not apply, instead 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 in accordance with IEC 61326-2-4;
– the requirements of Clause B.2 and Clause B.3 shall be met.

Annex C
(informative)

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

C.1 Examples for the functions of an IFLS

An IFLS usually comprises several functions:

– an IMD in accordance with IEC 61557-8;
– an LCI, portable or permanently installed;
– an LCS, for example differential current transformer or differential current clamp, used for the detection of the locating current and is connected to the IFL;
– an IFL, portable or permanently installed: the locating current sensors are connected to the insulation fault locator (IFL) to detect the locating current.

These functions may be performed either by single devices, one for each function; or all functions can be integrated into one single device. Likewise, some or all functions can be integrated into an IMD in accordance with IEC 61557-8; or into combined devices that fulfil additional monitoring functions.

The LCI can be a passive locating current injector (PLCI) or an active locating current injector (ALCI). In the 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 comprise single devices or all or some of the functions of each device may be integrated into one single device.

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

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

Figure C.1 shows an example of an IFLS comprising several devices.

Key for Figure C.1 and Figure C.2

1	T	Transformer
2	IMD	Insulation monitoring device
3	LCI	Locating current injector
4	PIFL	Portable equipment for insulation fault location
5	IFL	Insulation fault locator
6	PLCS	Portable locating current sensor
7	LCS	Locating current sensor
8	I_L	Locating current
9	R_F	Insulation resistance
10	C_{Lu}	System leakage capacitance upstream of the locating current sensor
11	C_{Ld}	System leakage capacitance downstream of the locating current sensor

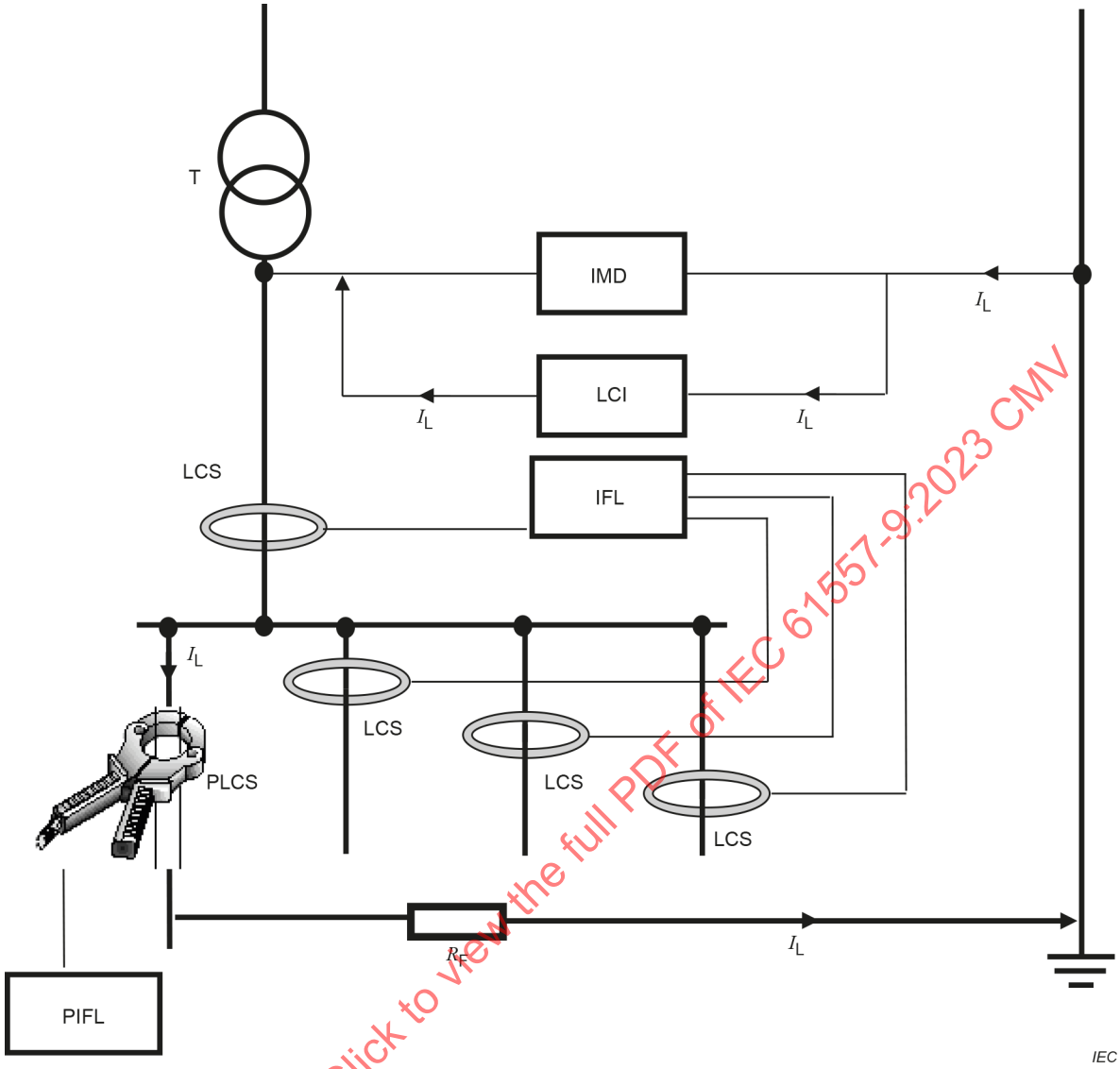

Figure C.1 – Example of an IFLS

C.2 Upstream and downstream system leakage capacitance

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

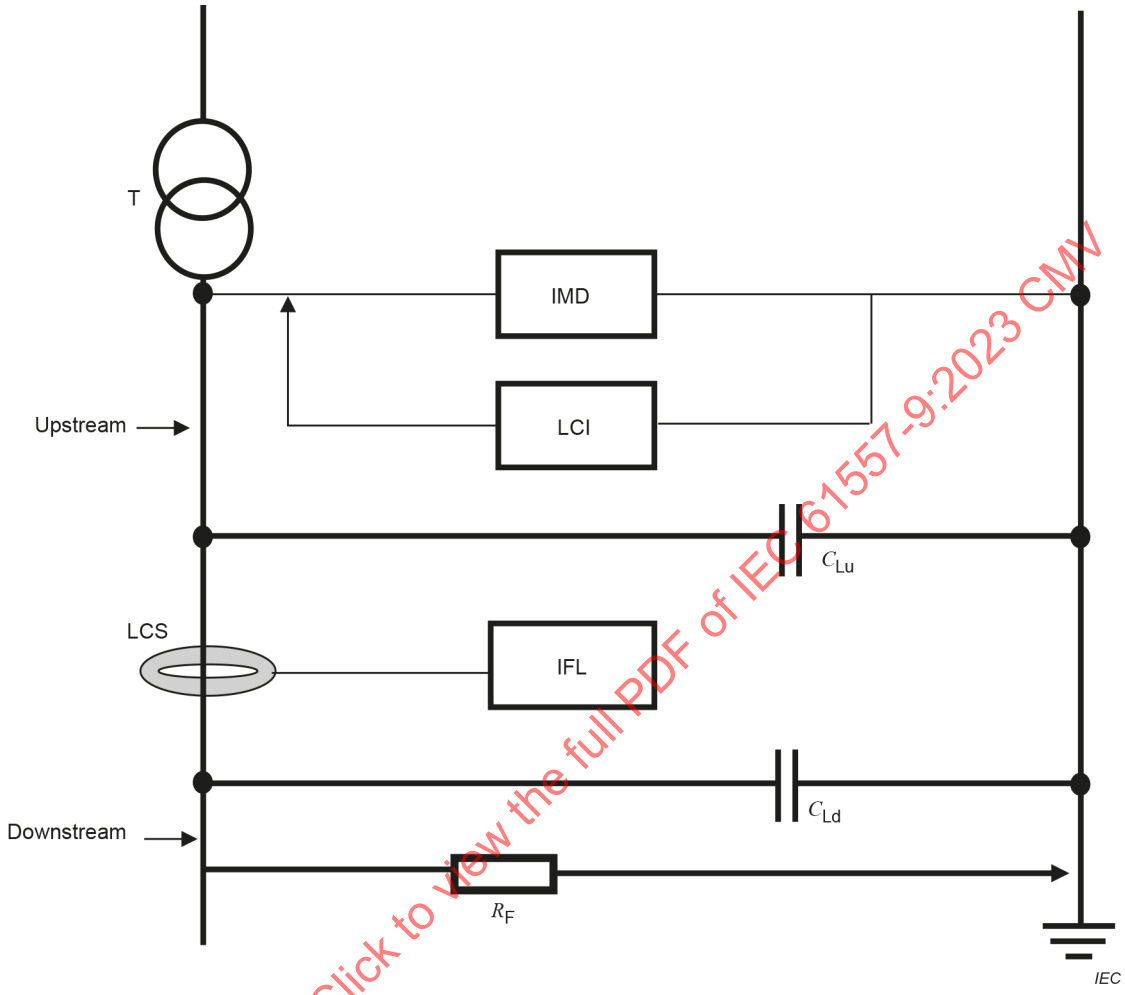

Figure C.2 – Explanation of upstream and downstream system leakage capacitance

Bibliography

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-53:2019, *Low-voltage electrical installations – Part 5-53: Selection and erection of electrical equipment – Devices for protection for safety, isolation, switching, control and monitoring*
IEC 60364-5-53:2019/AMD1:2020

IEC 60479-1:2018, *Effects of current on human beings and livestock – Part 1: General aspects*

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

IEC 60664-1, *Insulation coordination for equipment within low-voltage supply 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 61557-15, *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 15: Functional safety requirements for insulation monitoring devices in IT systems and equipment for insulation fault location in IT systems*

IEC 61810-2:2017, *Electromechanical elementary relays – Part 2: Reliability*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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SÉCURITÉ ÉLECTRIQUE DANS LES RÉSEAUX DE DISTRIBUTION BASSE TENSION AU PLUS ÉGALE À 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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L'IEC 61557-9 a été établie par le comité d'études 85 de l'IEC: Équipement de mesure des grandeurs électriques et électromagnétiques. Il s'agit d'une Norme internationale.

Cette quatrième édition annule et remplace la troisième édition parue en 2014. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) ajout de nouveaux termes et de nouvelles définitions sur les courants et tensions, alternatifs et continus, de localisation maximaux admissibles;
b) révision des exigences relatives au courant de localisation et à la tension de localisation;
c) ajout d'exigences de performance;
d) révision des exigences d'essai pour le courant de localisation et la tension de localisation;
e) modification de la structure du présent document pour s'adapter à l'IEC 61557-1:2019;
f) modification des valeurs limites de l'Article A.2 pour s'adapter aux méthodes d'essai modifiées en 6.2.3.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
85/896/FDIS	85/901/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 61557, publiées sous le titre général *Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection*, peut être consultée sur le site Web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site Web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera:

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SÉCURITÉ ÉLECTRIQUE DANS LES RÉSEAUX DE DISTRIBUTION BASSE TENSION AU PLUS ÉGALE À 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

1 Domaine d'application

La présente partie de l'IEC 61557 spécifie les exigences applicables aux dispositifs de localisation de défauts d'isolement (DLD) qui, indépendamment du principe de mesure, peuvent localiser les défauts d'isolement des parties de réseaux IT à courant alternatif non mis à la terre et des réseaux IT à courant alternatif non mis à la terre comprenant des circuits à courant continu reliés galvaniquement dont les tensions nominales sont au plus égales à 1 000 V en courant alternatif, et de réseaux IT à courant continu non mis à la terre dont les tensions sont au plus égales à 1 500 V en courant continu.

NOTE 1 Les réseaux IT sont décrits dans l'IEC 60364-4-41. D'autres informations sur la localisation de défauts d'isolement peuvent être consultées dans les Normes internationales suivantes: IEC 60364-4-41:2005, 411.6, IEC 60364-4-41:2005/A1:2017, 411.6, et IEC 60364-5-53:2019/A1:2020, 531.3.

NOTE 2 Le présent document couvre aussi bien les DLD passifs que les DLD actifs. Les DLD actifs peuvent être utilisés dans les réseaux hors tension.

NOTE 3 Le présent document ne vise pas les CPI conformes à l'IEC 61557-8.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-2-1:2007, *Essais d'environnement – Partie 2-1: Essais – Essai A: froid*

IEC 60068-2-2:2007, *Essais d'environnement – Partie 2-2: Essais – Essai B: chaleur sèche*

IEC 60068-2-6, *Essais d'environnement – Partie 2-6: Essais – Essai Fc: vibrations (sinusoïdales)*

IEC 60068-2-27:2008, *Essais d'environnement – Partie 2-27: Essais – Essai Ea et guide: chocs*

IEC 60364-7-710:2021, *Installations électriques à basse tension – Partie 7-710: Exigences pour les installations ou emplacements spéciaux – Locaux à usages médicaux*

IEC 60529, *Degrés de protection procurés par les enveloppes (code IP)*

IEC 60721-3-1:2018, *Classification des conditions d'environnement – Partie 3-1: Classification des groupements des agents d'environnement et de leurs sévérités – Stockage*

IEC 60721-3-2:2018, *Classification des conditions d'environnement – Partie 3-2: Classification des groupements des agents d'environnement et de leurs sévérités – Transport et manutention*

IEC 60721-3-3:2019, *Classification des conditions d'environnement – Partie 3-3: Classification des groupements des agents d'environnement et de leurs sévérités – Utilisation à poste fixe, protégé contre les intempéries*

IEC 60947-5-1:2016, *Appareillage à basse tension – Partie 5-1: Appareils et éléments de commutation pour circuits de commande – Appareils électromécaniques pour circuits de commande*

IEC 60947-5-4:2002, *Appareillage à basse tension – Partie 5-4: Appareils et éléments de commutation pour circuits de commande – Méthode d'évaluation des performances des contacts à basse énergie – Essais spéciaux*
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IEC 61010-1:2010, *Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 1: Exigences générales*
IEC 61010-1:2010/A1:2016

IEC 61010-2-030, *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-030: Exigences particulières pour les appareils équipés de circuits d'essai ou de mesure*

IEC 61010-031, *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 031: Exigences de sécurité pour sondes équipées tenues à la main et manipulées pour mesurage et essais électriques*

IEC 61010-2-032, *Exigences de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire – Partie 2-032: Exigences particulières pour les capteurs de courant, portatifs et manipulés manuellement, pour essai électrique et mesurage*

IEC 61140, *Protection contre les chocs électriques – Aspects communs aux installations et aux matériels*

IEC 61326-1:2020, *Matériel électrique de mesure, de commande et de laboratoire – Exigences relatives à la CEM – Partie 1: Exigences générales*

IEC 61326-2-2, *Matériel électrique de mesure, de commande et de laboratoire – Exigences relatives à la CEM – Partie 2-2: Exigences particulières – Configurations d'essai, conditions de fonctionnement et critères de performance des matériels portables d'essai, de mesure et de surveillance utilisés dans des réseaux de distribution à basse tension*

IEC 61326-2-4, *Matériel électrique de mesure, de commande et de laboratoire – Exigences relatives à la CEM – Partie 2-4: Exigences particulières – Configurations d'essai, conditions de fonctionnement et critères de performance pour les contrôleurs d'isolement conformes à l'IEC 61557-8 et pour les dispositifs de localisation de défaut d'isolement conformes à l'IEC 61557-9*

IEC 61557-1:2019, *Sécurité électrique dans les réseaux de distribution basse tension au plus égale à 1 000 V c.a. et 1 500 V c.c. – Dispositifs de contrôle, de mesure ou de surveillance de mesures de protection – Partie 1: Exigences générales*

IEC 61557-8:2014, *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 8: Contrôleurs d'isolement pour réseaux IT*

IEC 61810-2:2017, *Relais électromécaniques élémentaires – Partie 2: Fiabilité*

3 Termes, définitions et abréviations

3.1 Termes, définitions, symboles et unités

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC 61557-1, l'IEC 61557-8, ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1.1
dispositif de localisation de défauts d'isolement
DLD
dispositif, appareil ou combinaison de dispositifs utilisés pour la localisation de défauts d'isolement dans les réseaux IT

Note 1 à l'article: La fonctionnalité d'un DLD peut être utilisée en complément de la fonctionnalité de contrôle d'isolement. Elle injecte un courant de localisation entre le réseau électrique et la terre et localise le défaut d'isolement.

3.1.2
courant de localisation
I_L
courant qui est injecté par l'injecteur du courant de localisation pendant la phase de localisation

Note 1 à l'article: Le courant de localisation peut être généré par:

– une source de localisation active avec une impédance interne suffisamment grande utilisant une source de tension indépendante différente du réseau à surveiller; ou

– une source de courant de localisation passive fourni directement à partir du réseau à surveiller.

3.1.3
tension de localisation
U_L
tension présente sur les bornes de mesure de l'injecteur du courant de localisation pendant le mesurage lorsque le dispositif dispose d'une source de localisation active

Note 1 à l'article: Dans un réseau de distribution hors tension et sans défaut, il s'agit de la tension qui se trouve entre les bornes du dispositif de localisation du réseau à surveiller et les bornes pour la connexion au conducteur PE.

3.1.4
sensibilité de déclenchement
valeur du courant de localisation ou de la résistance d'isolement à laquelle le localisateur de défaut d'isolement réagit dans des conditions données

Note 1 à l'article: La sensibilité de déclenchement peut être soit un seuil fixe, soit une courbe de réponse.

3.1.5
localisateur de défaut d'isolement
LDI
dispositif ou partie d'un dispositif dont la fonction est de localiser le défaut d'isolement

3.1.6
capteur de courant de localisation
CCL
capteur pour la détection du courant de localisation utilisé pour la localisation du défaut d'isolement

3.1.7
injecteur de courant de localisation
ICL
dispositif ou partie d'un dispositif dont la fonction est d'injecter le courant de localisation dans le réseau IT afin de localiser le défaut d'isolement

3.1.8
injecteur de courant de localisation passif
ICLP
injecteur de courant de localisation qui génère le courant de localisation directement à partir du réseau à surveiller

3.1.9
injecteur de courant de localisation actif
ICLA
injecteur de courant de localisation qui génère le courant de localisation à partir d'une source de tension de localisation qui est différente du réseau à surveiller

3.1.10
dispositif de localisation de défauts d'isolement dans les locaux à usages médicaux
DLD-MED
dispositif spécifique de localisation de défauts d'isolement destiné à situer les défauts d'isolement dans les réseaux IT des locaux à usages médicaux de groupe 2

Note 1 à l'article: Le DLD-MED est décrit dans l'IEC 61557-9:2023, Annexe A.

Note 2 à l'article: Les locaux à usages médicaux sont définis dans l'IEC 60364-7-710.

3.1.11
temps de réponse
t_{al}
temps nécessaire à un dispositif de localisation de défauts d'isolement pour réagir dans des conditions de performance spécifiées

Note 1 à l'article: Les exigences de conditions peuvent être consultées dans l'IEC 61557-9:2023, A.2.2.4.

3.1.12
locaux à usages médicaux de groupe 2
locaux à usages médicaux dans lesquels les appareils EM ou les systèmes EM sont destinés à être utilisés de manière intrusive, externe ou invasive sur n'importe quelle partie du patient et dans lesquels la discontinuité de l'alimentation électrique (par exemple pour la protection contre les chocs électriques) constitue un risque pour la sécurité du patient

[SOURCE: IEC 60364-7-710:2021, 710.3.9, modifié – ajout de "locaux à usages médicaux de" au terme source "groupe 2"]

3.1.13
localisateur portable de défauts d'isolement
LPDI
dispositif utilisé pour la localisation de défauts d'isolement de manière temporaire dans les réseaux IT à la place ou en complément des dispositifs de localisation de défauts d'isolement à installation fixe

Note 1 à l'article: Les exigences relatives aux LPDI sont définies à l'Annexe B du présent document.

3.1.14
capacité de fuite du réseau pour un DLD
C_{el}
valeur maximale de la capacité totale à la terre du réseau à surveiller, y compris tous les appareils connectés, jusqu'à laquelle le DLD peut fonctionner comme spécifié

Note 1 à l'article: La capacité de fuite du réseau est la somme des capacités de fuite de tous les conducteurs de phase, y compris le conducteur de neutre à la terre.

3.1.15
courant alternatif de localisation maximal admissible
$I_{\text{limite c.a.}}$
valeur de crête maximale du courant de localisation au-dessus d'un niveau de fréquence prédéfini

Note 1 à l'article: Les niveaux de fréquence et de courant sont issus de l'IEC 61140.

3.1.16
courant continu de localisation maximal admissible
$I_{\text{limite c.c.}}$
valeur de crête maximale du courant de localisation en dessous d'un niveau de fréquence prédéfini

Note 1 à l'article: Les niveaux de fréquence et de courant sont issus de l'IEC 61140.

3.1.17
tension alternative de localisation maximale admissible
$U_{\text{limite c.a.}}$
valeur de crête maximale de la tension de localisation au-dessus d'un niveau de fréquence prédéfini

Note 1 à l'article: Les niveaux de fréquence et de tension sont issus de l'IEC 61140.

3.1.18
tension continue de localisation maximale admissible
$U_{\text{limite c.c.}}$
valeur de crête maximale de la tension de localisation en dessous d'un niveau de fréquence prédéfini

Note 1 à l'article: Les niveaux de fréquence et de tension sont issus de l'IEC 61140.

3.1.19
résistance d'injection
R_i
résistance de l'injecteur de courant de localisation entre la borne d'injection et la borne de terre

3.1.20
impédance d'injection
Z_i
impédance totale de l'injecteur de courant de localisation entre la borne d'injection et la borne de terre, mesurée à la fréquence nominale

3.1.21
défaut d'isolement symétrique
défaut dans l'isolation d'une installation ou d'un dispositif électriques qui crée un chemin résistif à la terre ayant approximativement la même résistance entre tous les conducteurs de phase et la terre

3.1.22
défaut d'isolement asymétrique
défaut dans l'isolation d'une installation ou d'un dispositif électriques qui crée un chemin résistif à la terre ayant différentes résistances entre tous les conducteurs de phase et la terre

3.2 Abréviations et symboles

Les abréviations et symboles répertoriés dans le Tableau 1 s'appliquent au présent document.

Tableau 1 – Abréviations et symboles

Abréviation ou symbole	Explication
C_{Ld}	Capacité de fuite du réseau en aval du capteur de courant de localisation
C_{Lu}	Capacité de fuite du réseau en amont du capteur de courant de localisation
C_{el}	Capacité de fuite du réseau pour un DLD
CEM	Compatibilité électromagnétique
FE	Terre fonctionnelle
g_n	Accélération normale de la pesanteur
LDI	Localisateur de défaut d'isolement
DLD	Dispositif de localisation de défauts d'isolement
I_L	Courant de localisation
CPI	Contrôleur permanent d'isolement
IP	Degré de protection procuré par une enveloppe
ICL	Injecteur de courant de localisation
CCL	Capteur de courant de localisation
ALLD	Alarme locale de localisation de défaut
PE	Conducteur de protection à la terre
LPDI	Localisateur portable de défauts d'isolement
ICLP	Injecteur de courant de localisation passif
ICLA	Injecteur de courant de localisation actif
CCLM	Capteur de courant de localisation mobile
Q	Facteur de qualité
R_F	Résistance d'isolement
ADLD	Alarme distante de localisation de défaut
RMS	Valeur efficace (*Root-mean-square value*)
T	Transformateur dans un réseau IT
$I_{limite\ c.a.}$	Courant alternatif de localisation maximal admissible
$I_{limite\ c.c.}$	Courant continu de localisation maximal admissible
$U_{limite\ c.a.}$	Tension alternative de localisation maximale admissible
$U_{limite\ c.c.}$	Tension continue de localisation maximale admissible
DLD-MED	Dispositif de localisation de défauts d'isolement dans les locaux à usages médicaux
t_{al}	Temps de réponse
ADLD	Alarme distante de localisation de défaut

Abréviation ou symbole	Explication
µF	Microfarad Le farad (symbole: F) est l'unité de capacité électrique issue du Système international d'unités (SI). 1 µF (microfarad, un millionième [10^{-6}] d'un farad)
U	Symbole de formule pour une tension dans l'unité SI "volt"
U_1	Tension calculée pour l'évaluation de la tension de localisation
U_B	Tension mesurée pour l'évaluation du courant de localisation
U_L	Tension de localisation
U_{pa}	Tension nominale admissible en permanence
U_n	Tension nominale du réseau
U_s	Tension d'alimentation
MΩ	Mégaohm L'ohm (symbole: Ω) est l'unité de résistance électrique issue du SI. 1 MΩ (mégohm) correspond à un million d'ohms
Z_i	Impédance d'injection Impédance totale du DLD entre les bornes du réseau et la terre, mesurée à la fréquence assignée, f_N
R_i	Résistance d'injection
R_H	Première résistance du diviseur de tension
R_T	Deuxième résistance du diviseur de tension
R_S	Première résistance du diviseur de tension représentant la résistance d'une peau humaine
R_B	Deuxième résistance du diviseur de tension représentant la résistance d'un corps humain
C_f	Capacité du filtre antirepliement
µs	Microseconde La seconde (symbole: s) est l'unité de base du temps dans le SI.
Fc	Essai Fc: vibrations (sinusoïdales)
Ea	Essai Ea et guide: chocs
nF	nanofarad Le farad (symbole: F) est l'unité de capacité électrique issue du SI.

4 Exigences

4.1 Exigences générales

Les dispositifs de localisation de défauts d'isolement doivent être en mesure de localiser, dans un réseau IT, les défauts d'isolement tant symétriques qu'asymétriques et de donner une alarme de localisation si la résistance d'isolement dans une partie de l'installation chute en dessous de la sensibilité de déclenchement.

Si le dispositif de localisation de défauts d'isolement possède une fonction d'autotest, celle-ci ne doit pas produire de défaut d'isolement à la terre.

Pour les exigences d'un dispositif de localisation de défauts d'isolement dans les locaux à usages médicaux, voir Annexe A.