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1 000 वोल्ट ए.सी. और 1 500 वोल्ट  
डी.सी. तक कम वोल्टेज वितरण प्रणालियों  
में विद्युत सुरक्षा — सुरक्षात्मक उपायों के  
परीक्षण, माप या निगरानी के लिए उपकरण  
भाग 9 आईटी सिस्टम में इन्सुलेशन दोष खोजने के  
लिए उपकरण

**Electrical Safety in Low Voltage  
Distribution Systems up to 1 000 V  
a.c. and 1 500 V d.c. — Equipment  
for Testing, Measuring or Monitoring  
of Protective Measures**

**Part 9 Equipment for Insulation Fault  
Location in IT Systems**

ICS 25.040.40

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भारतीय मानक ब्यूरो

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## NATIONAL FOREWORD

This Indian Standard (Part 9) which is identical with IEC 61557-9 : 2023 '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' issued by the International Electro technical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Measuring Equipment for Basic Electrical Quantities Sectional Committee and approval of the Electro technical Division Council.

This standard has been published in several parts. The other parts of the series are as follows:

Part 1	General requirements
Part 2	Insulation resistance
Part 3	Loop impedance
Part 4	Resistance of earth connection and equipotential bonding
Part 5	Resistance to earth
Part 6	Effectiveness of residual current devices (RCD) in TT, TN and IT systems
Part 7	Phase sequence
Part 8	Insulation monitoring devices for IT systems
Part 10	Combined measuring equipment for testing measuring or monitoring of protective measures
Part 11	Effectiveness of residual current monitors (RCM) In TT, TN and IT systems
Part 12	Power metering and monitoring devices (PWD)
Part 13	Hand- held and hand-manipulated current clamps and sensors for measurement of leakage currents in electrical distribution systems
Part 14	Equipment for testing the safety of electrical equipment for machinery
Part 15	Functional safety requirements for insulation monitoring devices in IT systems and equipment for insulation fault location in IT systems
Part 16	Equipment for testing the effectiveness of the protective measures of electrical equipment and/or medical electrical equipment
Part 17	Non-contact a.c. voltage indicators

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

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and
- b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standards for which Indian Standards also exist. The corresponding Indian Standards, and documents under print which are to be substituted in their places, are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60068-2-1 : 2007 Environmental testing — Part 2-1: Tests — Test A: cold	IS/IEC 60068-2-1 : 2007 Environmental testing: Part 2 Tests, Section 1 Test A: Cold	Identical
IEC 60068-2-2 : 2007 Environmental testing — Part 2-2: Tests — Test B: Dry heat	IS/IEC 60068-2-2 : 2007 Environmental testing: Part 2 Tests, Section 2: Test B — Dry heat	Identical
IEC 60068-2-6 Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)	IS/IEC 60068-2-6 : 2007 Environmental Testing Part 2 Tests Section 6 Test Fc: Vibration sinusoidal	Identical
IEC 60068-2-27 : 2008 Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock	IS 9000 (Part 7/Sec 1) : 2018/ IEC 60068-2-27 : 2008 Basic environmental testing procedures for electronic and electrical items: Part 7 Impact test, Section 1 Shock (Test Ea) ( <i>second revision</i> )	Identical
IEC 60364-7-710 : 2021 Low-voltage electrical installations — Part 7-710: Requirements for special installations or locations — Medical locations	IS 17512 : 2021 Requirements for electrical installations in medical locations	Modified
IEC 60529 Degree of protection provided by enclosures (IP code)	IS/IEC 60529 : 2001 Degrees of protection provided by enclosures (IP code)	Identical
IEC 60721-3-1 : 2018 Classification of environmental conditions — Part 3-1: Classification of groups of environmental parameters and their severities — Storage	IS/IEC 60721-3-1 : 2018 Classification of environmental conditions: Part 3 Classification of groups of environmental parameters and their severities, Section 1 Storage	Identical
IEC 60721-3-2 : 2018 Classification of environmental conditions — Part 3-2: Classification of groups of environmental parameters and their severities — Transportation and handling	IS/IEC 60721-3-2 : 2018 Classification of environmental conditions: Part 3 Classification of groups of environmental parameters and their severities, Section 2 Transportation and Handling	Identical
IEC 60721-3-3 : 2019 Classification of environmental conditions — Part 3-3: Classification of groups of environmental parameters and their severities — Stationary use at weather protected locations	IS/IEC 60721-3-3 : 2019 Classification of Environmental Conditions: Part 3 Classification of groups of environmental parameters and their severities, Section 3 Stationary use at weather protected locations	Identical

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
IEC 60947-5-1 : 2016 Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices	IS/IEC 60947-5-1 : 2016 Low-voltage switchgear and controlgear: Part 5 Control circuit devices and switching elements, Section 1 Electromechanical control circuit devices ( <i>second revision</i> )	Identical
IEC 61010-1 : 2010 Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements	IS 17724 (Part 1) : 2023 Safety requirements for electrical equipment for measurement, control, and laboratory use: Part 1 General requirements	Modified
IEC 61010-1 : 2010/AMD 1 : 2016		
IEC 61140 Protection against electric shock — Common aspects for installation and equipment	IS 9409 : 2023/IEC 61140 : 2016 Protection against electric shock — common aspects for installation and equipment ( <i>first revision</i> )	Identical
IEC 61326-1 : 2020 Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 1: General requirements	IS 17784 (Part 1) : 2023 Electrical equipment for measurement, control and laboratory use — EMC requirements: Part 1 General requirements	Modified
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	IS/IEC 61557-1 : 2019 Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing measuring or monitoring of protective measures: Part 1 General requirements	Identical
IEC 61810-2 : 2017 Electromechanical elementary relays — Part 2: Reliability	IS 17064 (Part 2) : 2019/IEC 61810-2 : 2017 Electromechanical elementary relays: Part 2 Reliability	Identical

The Committee has reviewed the provisions of the following international standards referred in this adopted standard and decided that they are acceptable for use in conjunction with this standard:

<i>International Standard</i>	<i>Title</i>
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 61010-2-030	Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-030: Particular requirements for testing and measuring circuits
IEC 61010-031	Safety requirements for electrical equipment for measurement, control and laboratory use — Part 031: Safety requirements for hand-held probe assemblies for measurement and test

<i>International Standard</i>	<i>Title</i>
IEC 61010-2-032	Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-032: Particular requirements for hand-held and hand-manipulated current sensors for electrical test and measurement
IEC 61326-2-2	Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 2-2: Particular requirements — Test configurations, operational conditions and performance criteria for portable test, measuring and monitoring equipment used in low voltage distribution systems
IEC 61326-2-4	Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 2-4: Particular requirements — Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9
IEC 61557-8: 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

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

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Indian Standard*

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

**IS/IEC 61557-9 : 2023**

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
$\mu F$	Microfarad The farad (symbol: F) is the SI derived unit of electrical capacitance. 1 $\mu F$ (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  $\mu\text{F}$  upstream of the locating current sensor ( $C_{Lu} = 1 \mu\text{F}$ ,  $C_{Ld} = 0 \mu\text{F}$  according to Figure C.2).

Information on the influence of the system leakage capacitances higher than 1  $\mu\text{F}$  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**

<b>Item</b>	<b>Reference conditions</b>
Mains frequency	Rated frequency $\pm 1 \%$
Operating temperature	$22 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$
External continuous magnetic field	$\leq 40 \text{ A/m DC}$ $\leq 3 \text{ A/m AC at 50/60 Hz}$
Auxiliary supply voltage	Nominal supply voltage specified by manufacturer $\pm 5 \%$

### **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  $> 100 \text{ M}\Omega$  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  $500 \text{ k}\Omega$ ,  $R_H$  can be set to  $9,9 \text{ M}\Omega$ ,  $R_T$  to  $100 \text{ k}\Omega$  and  $C_f$  to  $10 \text{ nF}$ .
  - 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  $f \geq 15 \text{ Hz}$ . 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  $250 \mu\text{s}$ .

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

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  $50 \text{ V AC RMS}$  and  $70 \text{ V peak}$  or  $120 \text{ V DC}$ :

- connect the voltage divider between the injection terminal and the earth terminal;
- set the voltage divider values,  $R_B$  to  $500 \Omega$  and  $R_S$  to  $1,5 \text{ k}\Omega$ ;

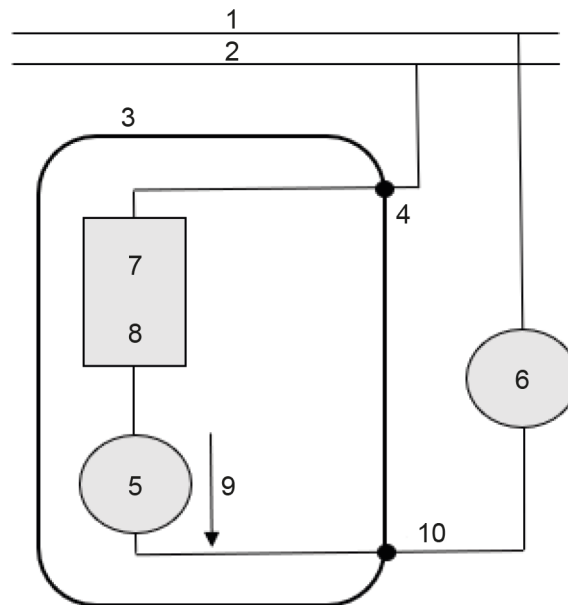
NOTE 2 The values for  $R_B$  and  $R_S$  represent the worst-case condition and can be found in IEC 60479-1.

- 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.



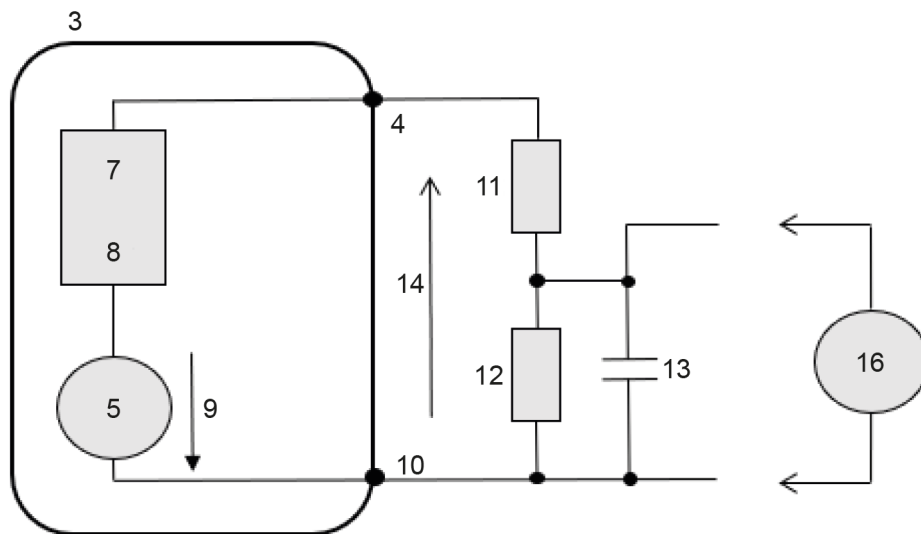
**Key** for Figure 1 to Figure 3

- 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



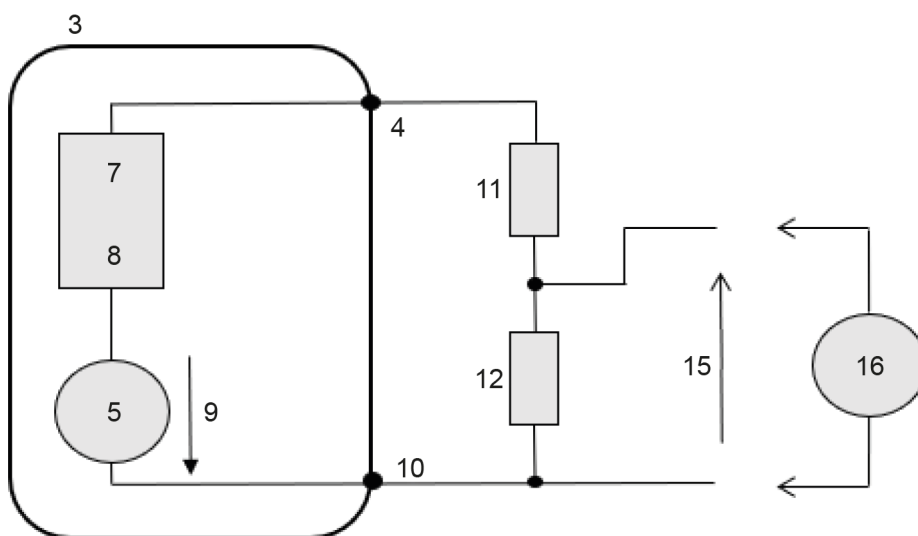
IEC

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



IEC

Figure 2 – Test configuration: Active locating source



IEC

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  $I_{limit\ AC} \times 500\ \Omega$  for  $f \geq 15\ Hz$ , 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  $\mu s$ .

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

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 $\pm 1$ mm 13,2 Hz to 100 Hz – acceleration $\pm 0,7$ g. For severe vibration conditions such as for example diesel engines, air compressors etc.: 2,0 Hz to 25,0 Hz – amplitude $\pm 1,6$ mm 25,0 Hz to 100 Hz – acceleration $\pm 4$ 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: <ul style="list-style-type: none"> <li>– malfunction and/or performance deterioration</li> <li>– mechanical resonances and/or other response effects occur, for example chatter.</li> </ul>
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	4.5.1	6.2.6	6.3.2
Insulation coordination			
Voltage test			
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  $50 \text{ k}\Omega$  or  $U_n / 50 \text{ k}\Omega$  at a total upstream system leakage capacitance (sum of the leakage capacitances of all phase conductors to earth) of  $0,5 \text{ }\mu\text{F}$ .

###### 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  $\mu\text{F}$  symmetrically distributed from all phase conductors upstream of the locating current sensor by suddenly reducing the insulation resistance from nearly infinity to 25  $\text{k}\Omega$  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**

<b>Test No.</b>	<b>Access</b>	<b>Test</b>	<b>Specification</b>	<b>Class</b>	<b>Comment</b>	<b>Basic Standard</b>
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.

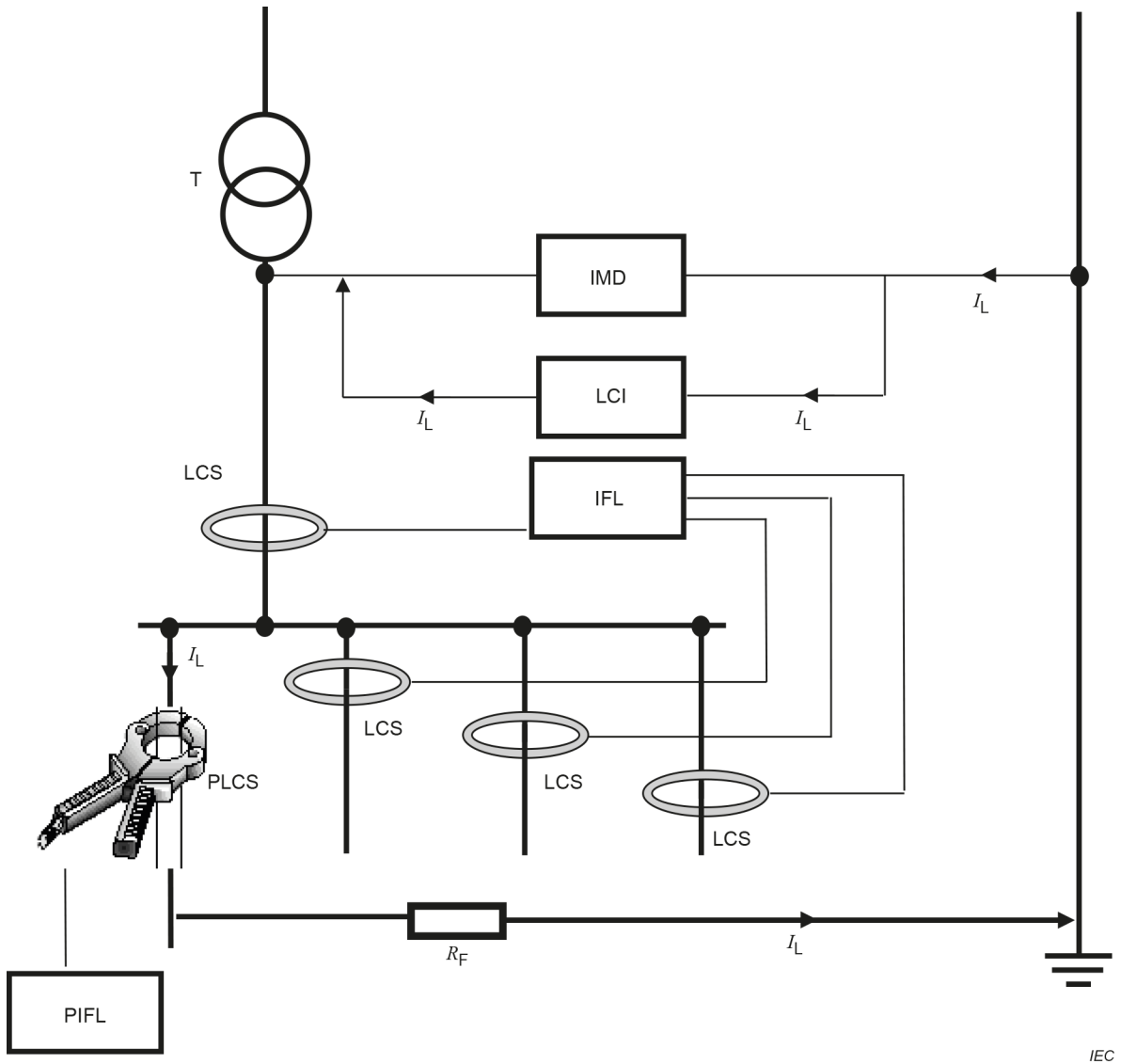
The PIFL may be used together with a fixed installed LCI or a portable LCI can be used.

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

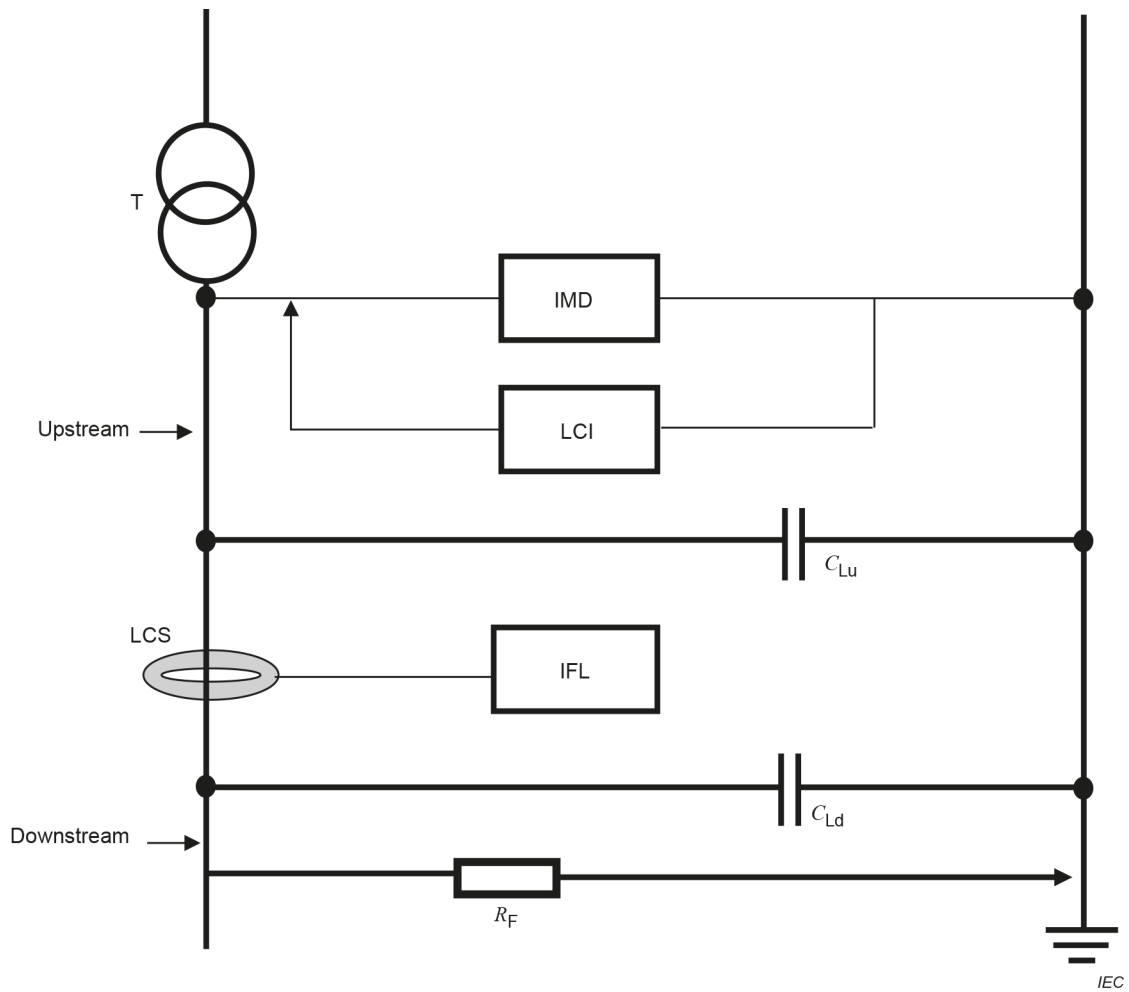


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Figure C.1 – Example of an IFLS

### C.2 Upstream and downstream system leakage capacitance

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



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

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