



BSI Standards Publication

Measuring relays and protection equipment

Part 27: Product safety requirements

National foreword

This British Standard is the UK implementation of EN IEC 60255-27:2025. It is identical to IEC 60255-27:2023. It supersedes BS EN 60255-27:2014, which will be withdrawn on 30 April 2028.

The UK participation in its preparation was entrusted to Technical Committee PEL/95, Measuring relays and protection systems.

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

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(IEC 60255-27:2023)

Relais de mesure et dispositifs de protection - Partie 27:
Exigences de sécurité des produits
(IEC 60255-27:2023)

Messrelais und Schutzeinrichtungen - Teil 27:
Anforderungen an die Produktsicherheit
(IEC 60255-27:2023)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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European foreword

The text of document 95/516/FDIS, future edition 3 of IEC 60255-27, prepared by TC 95 "Measuring relays and protection equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60255-27:2025.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2026-04-30 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2028-04-30 document have to be withdrawn

This document supersedes EN 60255-27:2014 and all of its amendments and corrigenda (if any).

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The text of the International Standard IEC 60255-27:2023 was approved by CENELEC as a European Standard without any modification.

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

IEC 60332 series	NOTE	Approved as EN IEC 60332 series
IEC 60384-14:2013/A1:2016	NOTE	Approved as EN 60384-14:2013/A1:2016 (not modified)
IEC 60695-2-12	NOTE	Approved as EN IEC 60695-2-12
IEC 60695-11-5	NOTE	Approved as EN 60695-11-5
IEC 61508 series	NOTE	Approved as EN 61508 series
IEC 61558 series	NOTE	Approved as EN IEC 61558 series
IEC 61810-1	NOTE	Approved as EN 61810-1
IEC 61869-1	NOTE	Approved as EN IEC 61869-1
IEC 62368-1	NOTE	Approved as EN IEC 62368-1
IEC 62477-1:2022	NOTE	Approved as EN IEC 62477-1:2023 (not modified)
IEC 62479	NOTE	Approved as EN 62479

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

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

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60085	-	Electrical insulation - Thermal evaluation and designation	EN 60085	-
IEC 60127-1	-	Miniature fuses - Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links	EN IEC 60127-1	-
IEC 60255-1	-	Measuring relays and protection equipment - Part 1: Common requirements	EN IEC 60255-1	-
IEC 60255-26	-	Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements	EN IEC 60255-26	-
IEC 60352-1	-	Solderless connections - Part 1: Wrapped connections - General requirements, test methods and practical guidance	EN 60352-1	-
IEC 60352-2	-	Solderless connections - Part 2: Crimped connections - General requirements, test methods and practical guidance	EN IEC 60352-2	-
IEC 60417	-	Graphical symbols for use on equipment. Index, survey and compilation of the single sheets.	-	-
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529	1991
-	-		+ AC	1993
+ A1	1999		+ A1	2000
+ A2	2013		+ A2	2013
-	-		+ AC	2016
IEC 60664-1	2020	Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests	EN IEC 60664-1	2020
-	-		+ AC	2020

EN IEC 60255-27:2025 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60664-3	-	Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution	EN 60664-3	-
IEC/TS 60695-2-20	-	Fire hazard testing -- Part 2-20: Glowing/hot wire based test methods - Hot-wire coil ignitability - Apparatus, test method and guidance	-	-
IEC 60695-11-10	-	Fire hazard testing - Part 11-10: Test flames - 50 W horizontal and vertical flame test methods	EN 60695-11-10	-
IEC 60825-1	-	Safety of laser products - Part 1: Equipment classification and requirements	EN 60825-1	-
IEC 60990	2016	Methods of measurement of touch current and protective conductor current	EN 60990	2016
IEC 61010-1	2010	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements	EN 61010-1	2010
+ A1 (mod)	2016		+ A1	2019
-	-		+ AC	2019
IEC 61032	-	Protection of persons and equipment by enclosures - Probes for verification	EN 61032	-
IEC 61051-2	2021	Varistors for use in electronic equipment - Part 2: Sectional specification for surge suppression varistors	EN IEC 61051-2	2021
IEC 61180	-	High-voltage test techniques for low-voltage equipment - Definitions, test and procedure requirements, test equipment	EN 61180	-
IEC 61869-6	-	Instrument transformers - Part 6: Additional general requirements for low-power instrument transformers	EN 61869-6	-
IEC 61869-10	-	Instrument transformers - Part 10: Additional requirements for low-power passive current transformers	EN IEC 61869-10	-
IEC 61869-11	-	Instrument transformers - Part 11: Additional requirements for low-power passive voltage transformers	EN IEC 61869-11	-
IEC 62151	-	Safety of equipment electrically connected to a telecommunication network	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MEASURING RELAYS AND PROTECTION EQUIPMENT –**Part 27: Product safety requirements**

FOREWORD

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IEC 60255-27 has been prepared by IEC technical committee 95: Measuring relays and protection equipment. It is an International Standard.

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

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

- a) conflicting statements removed;
- b) scope clarified and statement added that all clauses of the standard are required not just type tests;
- c) terminology, definitions and documentation requirements aligned with IEC 60255-1;
- d) alignment with IEC 61010-1, e.g. HLV definitions;
- e) ingress protection clarified;
- f) dielectric and impulse tests added to mechanical and environmental test requirements;

- g) insulation resistance requirements updated for alignment with other product safety standards;
- h) sample testing removed;
- i) short time limiting thermal overload added;
- j) resistance to mechanical stress added;
- k) low-power voltage and current transformer ports added;
- l) Annex C tables updated to align with base standards;
- m) Annex D voltage dependent resistors and radio transmitters added;
- n) Annex G for risk assessment added.

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

Draft	Report on voting
95/516/FDIS	95/526/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 60255 series, published under the general title *Measuring relays and protection equipment*, 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,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document specifies the safety requirements that are generally applicable to all equipment within its scope. These requirements may be supplemented by general product safety standards and IEC 60664-1.

MEASURING RELAYS AND PROTECTION EQUIPMENT –

Part 27: Product safety requirements

1 Scope

This part of IEC 60255 specifies the product safety requirements for measuring relays and protection equipment having a rated AC voltage up to 1 000 V, or a rated DC voltage up to 1 500 V. Above these limits, IEC 60664-1 is applicable for the determination of clearance, creepage distance and withstand test voltage.

This document specifies essential safety requirements to minimize the risk of fire and hazards caused by electric shock or injury to the user and property. This document specifies only product safety requirements; functional performance of the equipment is not covered.

This document covers all the ways in which the equipment can be mounted and used in cabinets, racks and panels. This document also applies to auxiliary devices such as shunts, series resistors, transformers, auxiliary control panels, display devices, etc., that are used in conjunction with measuring relays and protection equipment and are tested together.

It is possible that ancillary equipment such as network switches used in conjunction with measuring relays and protection equipment needs to comply with additional safety requirements.

This document does not specify the implementation of individual equipment, circuits and components.

This document applies to equipment designed to be safe at least under the following environmental conditions:

- indoor use;
- altitude up to 2 000 m, in accordance with IEC 60255-1;
- rated ambient temperature range, in accordance with IEC 60255-1;
- maximum external relative humidity, in accordance with IEC 60255-1;
- operating range of auxiliary energizing voltage in accordance with IEC 60255-1;
- applicable overvoltage category;
- applicable pollution degree of the intended environment (pollution degree 2 in most cases).

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 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60127-1, *Miniature fuses – Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links*

IEC 60255-1, *Measuring relays and protection equipment – Part 1: Common requirements*

IEC 60255-26, *Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements*

IEC 60352-1, *Solderless connections – Part 1: Wrapped connections – General requirements, test methods and practical guidance*

IEC 60352-2, *Solderless connections – Part 2: Crimped connections – General requirements, test methods and practical guidance*

IEC 60417, *Graphical symbols for use on equipment*. Available at: <http://www.graphical-symbols.info/equipment>

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

IEC 60664-1:2020, *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 TS 60695-2-20, *Fire hazard testing – Part 2-20: Glowing/hot-wire based test methods – Hot-wire coil test method – Apparatus, test method and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*

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 61032, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61051-2:2021, *Varistors for use in electronic equipment – Part 2: Sectional specification for surge suppression varistors*

IEC 61180, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

IEC 61869-6, *Instrument transformers – Part 6: Additional general requirements for low-power instrument transformers*

IEC 61869-10, *Instrument transformers – Part 10: Additional requirements for low-power passive current transformers*

IEC 61869-11, *Instrument transformers – Part 11: Additional requirements for low-power passive voltage transformers*

IEC 62151, *Safety of equipment electrically connected to a telecommunication network*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

accessible conductive part

conductive part of electrical equipment touchable under normal use

3.2

accessible part

part which can be touched under normal use with a standard rigid or jointed test finger as specified in 6.2 of IEC 61010-1:2010 and IEC 61010-1:2010/AMD1:2016

Note 1 to entry: Circuits intended to be connected to an external accessible circuit are considered as accessible conductive parts, for example wired network ports.

3.3

adjacent circuit

independent circuit

electric circuit which is separated from the considered circuit by applicable insulation

3.4

ambient temperature

ambient air temperature

temperature, determined under prescribed conditions, of the air surrounding the complete equipment

Note 1 to entry: For equipment installed inside an enclosure, it is the temperature of the air outside the enclosure.

Note 2 to entry: The ambient temperature is measured at half the distance from any neighbouring equipment, but not more than 300 mm distance from the equipment case, at middle height of the equipment, protected from direct heat radiation from the equipment.

[SOURCE: IEC 60050-441:1984, 441-11-13, modified – The preferred term "ambient temperature" has been added. In the definition and Note 1 to entry, "switching device or fuse" has been replaced by "equipment". Note 2 to entry has been added.]

3.5

barrier

electrically protective barrier

part providing protection against direct contact from any usual direction of access that is firmly secured in place in such a way that it can only be removed by the use of a tool

[SOURCE: IEC 60050-826:2004, 826-12-23, modified – The preferred term "barrier" has been added. At the end of the definition, "that is firmly secured in place in such a way that it can only be removed by the use of a tool" has been added.]

3.6

basic insulation

insulation of hazardous-live-parts to provide basic protection

[SOURCE: IEC 60050-826:2004, 826-12-14, modified – In the definition, "which provides" has been replaced by "to provide" and the Note has been removed.]

3.7**basic protection**

protection against electric shock under normal conditions

[SOURCE: IEC 60050-195:2021, 195-06-01]

3.8**bounding surface**

outer surface of the equipment case

3.9**cabinet**

free-standing and self-supporting enclosure for housing electrical and/or electronic equipment

Note 1 to entry: A cabinet is usually fitted with doors and/or side panels, which may or may not be removable.

[SOURCE: IEC 60050-581:2008, 581-25-02]

3.10**clearance**

shortest distance, measured in air, between two conductive parts, or between a conductive part and the outer bounding surface of the equipment, whether conductive or not

3.11**comparative tracking index****CTI**

numerical value of the maximum voltage in volts which a material can withstand without tracking and without a persistent flame occurring under specified test conditions

[SOURCE: IEC 60050-212:2010, 212-11-59]

3.12**creepage distance**

shortest distance along the surface of a solid insulating material between two conductive parts, or between a conductive part and the bounding surface (accessible part) of the equipment, measured along the surface of insulation

[SOURCE: IEC 60050-151:2001, 151-15-50, modified – The phrase ", or between a conductive part and the bounding surface (accessible part) of the equipment, measured along the surface of insulation" has been added.]

3.13**direct contact**

electric contact of persons with live parts

[SOURCE: IEC 60050-826:2004, 826-12-03, modified – In the definition, the words "or animals" have been omitted.]

3.14**double insulation**

insulation comprising both basic insulation and supplementary insulation

Note 1 to entry: Basic and supplementary insulation are separate, each designed for basic protection against electric shock.

[SOURCE: IEC 60050-195:2021, 195-06-08, modified – The note to entry has been added.]

3.15

enclosure

housing affording the type and degree of protection suitable for the intended application

Note 1 to entry: Enclosures can provide protection against the spread of fire (see Clause 7).

[SOURCE: IEC 60050-151:2001, 151-13-08, modified – Note 1 to entry has been added.]

3.16

extra low voltage

ELV

voltage not exceeding the maximum value of the prospective touch voltage that is acceptable to be maintained indefinitely under specified conditions of external influences

Note 1 to entry: For the purposes of this document, the ELV values are specified in 4.3.3.2.

SEE: Table A.1

[SOURCE: IEC 60050-195:2021, 195-05-24, modified – The note to entry has been added.]

3.17

fire enclosure

enclosure intended as a safeguard against the spread of fire from within the enclosure to outside the enclosure

[SOURCE: IEC 60050-903:2014, 903-04-10, modified – In the definition, the word "protection" has been replaced by "as safeguard", and Note 1 to entry has been deleted.]

3.18

functional earthed circuit

functional grounded circuit, US

circuit that can include PCB tracks, wiring, components and equipotential bonds that is connected to earth for purposes other than electrical safety

Note 1 to entry: Purposes other than electrical safety include screening and reference point for measurements.

3.19

functional insulation

insulation between conductive parts, necessary for the proper functioning of the equipment

[SOURCE: IEC 60050-195:2021, 195-02-41]

3.20

hazardous energy level

available power level of 240 VA or more, having a duration of 60 s or more, or a stored energy level of 20 J or more (for example, from one or more capacitors), at a potential of 2 V or more

3.21

hazardous-live-part

live part which, under certain conditions, can give a harmful electric shock

[SOURCE: IEC 60050-826:2004, 826-12-13]

3.22

hazardous live voltage

HLV

normal use voltage which exceeds ELV levels

Note 1 to entry: For the purposes of this document the ELV values are specified in 4.3.3.2.

3.23**high-integrity part****high-integrity component**

part or component whose specification or qualification is well in excess of the application such that the risk of failure is minimal

3.24**live part**

conductive part intended to be energized under normal operating conditions, including the neutral conductor

[SOURCE: IEC 60050-195:2021, 195-02-19, modified – The last part of the definition " and mid-point conductor, but excluding the PEN conductor, PEM conductor and PEL conductor" has been omitted.]

3.25**low-power instrument transformer****LPIT**

arrangement, consisting of one or more current or voltage transformer(s) which may be connected to transmitting systems and secondary converters, all intended to transmit a low-power analogue or digital output signal to measuring instruments, meters and protective or control devices or similar apparatus

EXAMPLE An arrangement consisting of three current sensors, three voltage sensors connected to one merging unit delivering one digital output is considered an LPIT.

Note 1 to entry: LPITs are commonly called non-conventional instrument transformers (NCIT).

Note 2 to entry: The output power produced by these devices is typically lower than or equal to 1 VA.

[SOURCE: IEC 61869-6:2016, 3.1.601]

3.26**low-power current transformer****LPCT**

low-power instrument transformer for current measurement

[SOURCE: IEC 61869-6:2016, 3.1.602]

3.27**low-power voltage transformer****LPVT**

low-power instrument transformer for voltage measurement

[SOURCE: IEC 61869-6:2016, 3.1.603]

3.28**maintenance use**

state of the equipment when being serviced by trained personnel with any tool removable covers and protective measures removed

3.29**non-primary circuit**

circuit electrically isolated from the AC or DC supply and from external voltage transformers and current transformers

3.30

normal use

state of the equipment when installed and operated for its intended purpose, with any tool removable covers and protective measures in place

3.31

overheating

operating at a level such that the thermal limit is exceeded

3.32

overvoltage category

numeral defining a transient overvoltage condition

Note 1 to entry: Overvoltage categories I, II, III and IV are used, see IEC 60664-1.

[SOURCE: IEC 60050-426:2020, 426-04-48]

3.33

protective class I equipment

equipment with basic insulation and protective bonding for protection against electric shock, such that conductive parts on the outside of the equipment case cannot become live (in the event of a failure of the basic insulation)

3.34

protective class II equipment

equipment with

- basic insulation as provision for basic protection against electric shock, and supplementary insulation as provision for fault protection; or
- double- or reinforced-insulation basic and fault protection

Note 1 to entry: There should be no provision for a protective conductor or reliance upon installation conditions for safety purposes. It is, however, possible to connect an earth conductor to protective Class II equipment for functional (for example, EMC) purposes.

3.35

protective class III equipment

equipment, or parts of equipment, in which protection against electric shock relies upon supply from SELV or PELV circuits and in which hazardous voltages are not generated

3.36

pollution

addition of foreign matter, solid, liquid or gaseous that can produce a reduction of dielectric strength or surface resistivity of the insulation

[SOURCE: IEC 60050-442:1998, 442-01-28, modified – In the definition, the word "permanent" has been deleted, and the note has been omitted.]

3.37

pollution degree

number characterizing the expected pollution of the ambient conditions which immediately surround the clearance and creepage distance under consideration as detailed in IEC 60664-1

3.38

primary circuit

circuit electrically connected to the AC or DC supply input and external voltage transformers and current transformers

3.39**protective bonding**

electrical connection of accessible conductive parts or of protective screening to provide electrical continuity by means of connection to an external protective conductor which is securely returned to earth

3.40**protective bonding resistance**

resistance between the protective conductor terminal and a conductive part required to be connected to the protective conductor

3.41**protective conductor**

conductor provided for purposes of electrical safety

[SOURCE: IEC 60050-195:2021 195-02-09]

3.42**protective earthing****protective grounding, US**

earthing for purposes of protection against electric shock

[SOURCE: IEC 60050-195:2021, 195-01-11, modified – The term "electrical safety" has been replaced by "protection against electric shock".]

3.43**protective equipotential bonding circuit****PEB circuit**

circuit with a low impedance path from exposed-conductive-parts to extraneous-conductive-parts, to ensure equal potential throughout thus preventing a hazardous potential difference occurring between such parts in the event of a fault

Note 1 to entry: See Table A.1.

3.44**protective extra low voltage circuit****PELV circuit**

circuit in which the voltage cannot exceed the value of extra low voltage under normal conditions and under single fault conditions (except earth faults in other electric circuits)

Note 1 to entry: See Table A.1.

3.45**protective impedance**

impedance connected between live parts and accessible conductive parts, of such value that the current, under normal use and under likely fault conditions in the equipment, is limited to a safe value, and which is so constructed that the reliability is maintained throughout the life of the equipment

[SOURCE: IEC 60050-442:1998, 442-04-24, modified – In the definition, the term "exposed" has been replaced by "accessible", "in normal use" has been replaced by "under normal use", "electronic switch" has been replaced by "equipment".]

3.46**protective screening****protective shielding, US**

separation of electric circuits and/or conductors from hazardous-live-parts by an electrically protective screen connected to the protective earth

[SOURCE: IEC 60050-195:2021, 195-06-18, modified – In the definition, the words "equipotential bonding system and intended to provide protection against electric shock" have been replaced by "earth".]

3.47

protective separation

separation of one electric circuit from another by means of basic protection and fault protection

[SOURCE: IEC 60050-195:2021, 195-06-19]

3.48

rated impulse voltage

impulse voltage value assigned by the manufacturer to the equipment or to a part of it, characterizing the specified withstand capability of its insulation against transient overvoltages and to which clearances are referred

3.49

rated insulation voltage

RIV

voltage value assigned by the manufacturer to the equipment, or to a part of it, characterizing the specified (long-term) withstand capability of its insulation and to which dielectric voltage tests and creepage distances are referred

Note 1 to entry: The rated insulation voltage is not necessarily equal to the rated voltage of equipment which is primarily related to functional performance.

3.50

rated voltage

value of voltage assigned by the manufacturer, over the normal operating condition of a component, device or equipment

Note 1 to entry: Equipment may have more than one rated voltage value or may have a rated voltage range.

[SOURCE: IEC 60050-442:2014, 442-09-10, modified – In the definition, the term "rated value" has been replaced by "value", the term "to" has been replaced by "over the normal operating condition of", and at the end of the definition the words "and to which operation and performance characteristics are referred" and Note 2 to entry have been omitted.]

3.51

reinforced insulation

insulation that provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation can comprise several layers that cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60050-195:2021, 195-06-09]

3.52

restricted access area

area accessible only to users with the proper authorization and knowledge of any safety hazards

[SOURCE: IEC 60050-195:2021, 195-04-04, modified – In the definition, the words "electrically skilled persons and electrically instructed persons" have been replaced by "users" and the words "and knowledge of any safety hazards" have been added.]

3.53

routine test

conformity test made on each individual equipment during or after manufacture

Note 1 to entry: Individual equipment includes complete products and spare parts.

[SOURCE: IEC 60050-151:2001, 151-16-17, modified – In the definition, the word "item" has been replaced by the word "equipment", and Note 1 to entry has been added.]

3.54

safety critical component

component which is relied upon for the integrity of its electrical insulation, mechanical strength, thermal, or flame-retardant properties during normal operation and single fault conditions, to prevent a safety hazard

3.55

safety extra low voltage circuit

separated extra low voltage circuit

SELV circuit

circuit in which the voltage cannot exceed the value of extra low voltage under normal conditions and under single fault conditions (including earth faults in other electric circuits)

3.56

screen

shield, US

conductive part that encloses or separates electric circuits and/or conductors

Note 1 to entry: See Table A.1.

3.57

single fault condition

condition in which there is a fault of a single protection (but not a reinforced protection) or of a single component or a device

Note 1 to entry: If a single fault condition results in one or more other fault conditions, all are considered as one single fault condition.

[SOURCE: IEC 60050-903:2013, 903-01-15]

3.58

solid insulation

material that provides electrical insulation between two opposite surfaces, not along an outer surface

3.59

supplementary insulation

independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation

[SOURCE: IEC 60050-195:2021, 195-06-07, modified – ", that provides fault protection" has been replaced by "in order to provide protection against electric shock in the event of a failure of basic insulation".]

3.60

tracking

progressive formation of conductive paths, which are produced on the surface or within a solid insulating material, due to the combined effects of electric stress and electrolytic contamination

Note 1 to entry: Tracking usually occurs due to surface contamination.

[SOURCE: IEC 60050-212:2010, 212-11-56]

3.61**type test**

test of one or more devices made to a given design, to check if these devices comply with the requirements of the standard concerned

[SOURCE: IEC 60050-851:2008, 851-12-05]

3.62**user**

person with the appropriate training and experience necessary to be aware of hazards to which they are exposed when accessing the equipment in a restricted access area and aware of measures to minimize a hazardous situation to themselves and other persons

3.63**wired network port**

port for the connection of voice, data and signalling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network

Note 1 to entry: Examples of these include CATV, PSTN, ISDN, xDSL, LAN and similar networks.

Note 2 to entry: These ports may support screened or unscreened cables and may also carry AC or DC power (e.g. PoE) where this is an integral part of the telecommunication specification.

Note 3 to entry: A port generally intended for interconnection of components of a system under test (e.g. EIA-232, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 ("Fire Wire"), etc.) and used in accordance with its functional specifications (e.g. for the maximum length of cable connected to it), is not considered to be a wired network port.

Note 4 to entry: Optical fibre interfaces are considered as a wired network port. To achieve maximum power dissipation, it is important that the optical fibre ports are active when required during the safety assessment (during temperature rise testing, etc.)

3.64**withstand**

ability of the equipment not to be damaged when imposed environmental or test conditions are applied (for example, impulse voltage)

3.65**working voltage**

highest RMS value of the AC or DC voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

Note 1 to entry: Transients are disregarded.

Note 2 to entry: Both open-circuit conditions and normal operating conditions are taken into account.

[SOURCE: IEC 60050-581:2008, 581-21-19, modified – Notes 1 and 2 to entry have been added.]

4 Protection against electric shock**4.1 Protection from contact with hazardous-live-parts****4.1.1 General**

Protection against direct contact with hazardous-live-parts shall be provided by adequate insulation, the equipment case or a barrier. Access to the equipment during installation, maintenance use, normal use and decommissioning shall be restricted to users aware of working procedures necessary to ensure safety.

The testing of components and equipment with regard to protection against electric shock shall be conducted as type tests and routine tests as defined in Clause 9.

Unearthed accessible conductive parts which can become hazardous live under a single fault condition shall meet the requirements of 4.1 to 4.10.

4.1.2 Insulation

Any conductive part that is not separated from the hazardous-live-parts by at least basic insulation shall be considered a live part. The insulation requirements shall be determined after consideration of the following influencing factors:

- rated insulation voltage of the circuit under consideration (see C.1.3);
- overvoltage category (see Annex B and Annex C);
- pollution degree (see Annex C);
- isolation class, for example, ELV, SELV, PELV, or PEB (see Annex A).

4.1.3 Equipment enclosure and barriers

The enclosure protection required by the product depends upon face and access level; minimum equipment enclosure requirements are detailed in Table 1.

Table 1 – Equipment enclosure requirements for protection against electric shock

Face	IP Code (IEC 60529:1989, IEC 60529:1989/AMD1:1999, IEC 60529:1989/AMD2:2013)	Requirements
Front panel, sides	IP2X or IPXXB	Hazardous-live-parts shall be located within the equipment enclosure or behind barriers such that they are not accessible under normal use. If a cover can be removed without the use of a tool, warning symbol 12 from Table 12 shall be visible.
Front panel connection(s)	IP2X	The front panel connections and terminal wiring, which are ELV, shall be accessible under normal use.
Top	IP4X	The top surfaces of barriers that are accessible in normal use shall provide ingress protection against falling objects, loose wires, washers, etc. Any such barriers shall have sufficient mechanical strength, stability and durability to maintain the specified degree of protection.
Bottom	IP4X	The bottom surfaces of barriers that are accessible in normal use shall provide ingress protection against loose wires, etc. Any such barriers shall have sufficient mechanical strength, stability and durability to maintain the specified degree of protection.
Rear	IP2X	Hazardous-live-parts shall be located within the equipment enclosure or behind barriers such that they are not accessible under normal use.
Rear panel connection(s)	IP1X	The rear connection panel, terminal wiring, under normal use shall be in a restricted access area and shall be IP1X or greater.
Corners	-	The corner shall have the highest IP taken from the adjacent sides.

Further requirements for accessible parts are detailed in 4.3.2.

Conformity with 4.1.3 is checked by applying the safety ingress requirements of IEC 60529:1989, IEC 60529:1989/AMD1:1999, and IEC 60529:1989/AMD2:2013.

4.1.4 Hazardous live terminations using stranded wire

The end of a stranded wire shall not be consolidated by soft soldering at places where the wire is subject to contact pressure, unless the method of clamping is designed so as to reduce the likelihood of a bad contact due to cold flow of the solder. Spring terminals that compensate for the cold flow are deemed to satisfy this requirement. Preventing the clamping screws from rotating is not considered to be adequate.

Terminals shall be located, guarded or insulated so that, should a strand of a flexible wire escape when the wire is fitted, there is no likelihood of accidental contact between such a strand and:

- accessible conductive parts; or
- unearthed conductive parts separated from accessible conductive parts by supplementary insulation only.

A loose strand of 8 mm length is normally considered for assessing this risk.

If the manufacturer determines that there is a risk, a recommendation shall be given in the documentation and a warning symbol 14 from Table 12 marked on the equipment. The risk can be eliminated, for example, by the use of an insulated crimp terminal or a single-strand wire.

Conformity with 4.1.4 is checked by inspection.

4.2 Protective impedance

A protective impedance shall limit the current or voltage to the levels of 4.3.3.2 in normal use and 4.10.4.1.2 in single fault condition.

Insulation between the terminations of the protective impedance shall meet the requirements of double insulation or reinforced insulation.

A protective impedance shall be one or more of the following:

- a) an appropriate single component which shall be constructed, selected and tested so that safety and reliability for protection against electric shock are assured. In particular, the component shall be:
 - 1) rated for twice the maximum working voltage;
 - 2) if a resistor, rated for twice the power dissipation for the maximum working voltage;
- b) a combination of components, for example, two Y rated capacitors in series, each rated for the total working voltage across the pair. Each capacitor shall have the same rated capacitance value and a withstand voltage rating of at least 2 000 V RMS, 1 min. This provides basic protection against electric shock in the case of a single fault condition.

Conformity with protective impedance can be demonstrated by application of the appropriate voltage test for double or reinforced insulation in Table C.8 to Table C.11 for a test site altitude of up to 2 000 m. For test site altitudes over 2 000 m, the test voltage should be adjusted in accordance with Table C.12.

Components, wires and connections shall be rated in accordance with the requirements for both normal use and appropriate single fault conditions. It is permissible for double insulation or reinforced insulation to be bridged by components meeting the requirement for protective impedance. Conformity of components with 4.2 and any associated basic insulation shall be checked after a single fault condition assessment or test according to 9.6.5.5. Any associated basic insulation shall be checked by assessment, measurement or testing in accordance with Annex C.

4.3 Accessible parts

4.3.1 General

Unless obvious, determination of whether a part is accessible, under normal use, shall be made as specified below and in 4.3.2.

Circuits intended to be connected to an external accessible circuit shall be considered as accessible conductive parts, for example wired network port.

Appropriate test fingers, as specified in 4.3.2.2, shall be applied without force unless a force is specified. Parts are considered to be accessible if they can be touched with a finger or pin, or if the covering does not provide suitable protection when touched under normal use (see below).

Where accessible conductive parts or circuits are separated from other parts by double insulation or reinforced insulation that is bridged by components in accordance with 4.2, the accessible parts or circuits shall comply with current limits in 4.3.3.2 for the normal use and 4.10.4.1.2 for a single fault condition. These requirements shall apply after dielectric voltage testing.

For hazardous-live-parts, a part is considered to be accessible if the test finger or pin reaches a point nearer to the hazardous-live-part than the applicable clearance for basic insulation at the rated impulse voltage determined from IEC 60664-1.

For equipment accepting plug-in modules, parts are considered to be accessible if they can be touched with the jointed test finger (see 4.3.2.2) up to a depth of 180 mm from the opening in the equipment.

Materials which can easily be damaged are not considered to provide suitable insulation (for example, lacquer, enamel, oxides and anodic films). Non-impregnated hygroscopic materials, such as paper, fibres and fibrous material, are also not considered to provide suitable insulation.

A metallic accessible part is considered to be conductive if its surface is bare or is covered by an insulating layer which does not comply with the requirements of basic insulation.

4.3.2 Determination of accessible parts

4.3.2.1 General

If the user is intended to perform any actions in normal use, with or without the aid of a tool (a screwdriver, a coin, a key, etc.), which will increase the accessibility of parts, such actions shall be taken before performing the examinations of 4.3.2.2 to 4.3.2.3. Examples include:

- removing covers;
- adjusting controls;
- replacing consumable material;
- removing parts.

4.3.2.2 General examination

The jointed test finger (see IEC 61032 and IEC 60529:1989) shall be applied in every possible position. Where a part could become accessible by applying a force, the rigid test finger (see 6.2 of IEC 61010-1:2010 and of IEC 61010-1:2010/AMD1:2016) shall be applied with a force of 10 N. The force shall be exerted by the tip of the test finger so as to avoid wedge and lever action. The test shall be applied to all outer surfaces, including the bottom.

4.3.2.3 Openings for pre-set controls

A metal test pin 3 mm in diameter (force applied 10 N) shall be inserted through holes, in the equipment case, intended to give access to pre-set controls which require the use of a screwdriver or other tool. The test pin shall be applied in every possible direction through the hole; additional information can be found in IEC 61010-1. Penetration shall not exceed three times the distance from the equipment case surface to the control shaft or 100 mm, whichever is smaller.

4.3.2.4 ELV rated or live parts accessible when cover removed

If ELV rated or live parts, such as replaceable batteries or electromechanical relay contacts, are accessible when the cover is removed without the aid of a tool, then a warning label is required, visible when the cover is removed. This warning shall comprise symbol 14 and/or symbol 12 in Table 12.

4.3.2.5 Wiring terminals

Wiring terminals which are accessible under normal use, for example terminals on the front of a product, shall meet the requirement of Table 1.

Wiring terminals which are behind a panel, or in a restricted access area, and cannot be touched in normal use shall be deemed non-accessible. However, a protection of at least type IP1X according to 5.1 of IEC 60529:1989 shall be provided to prevent electric shock due to accidental contact.

If the protection is of type IP0X or IP1X, according to 5.1 of IEC 60529:1989, then the warning symbol 12 in Table 12 shall be used in the vicinity of accessible hazardous live wiring terminals.

Conformity with 4.3.1 to 4.3.2.5 shall be demonstrated by test.

4.3.3 Permissible limits for accessible parts

4.3.3.1 General

The voltage, current, charge or energy between an accessible part and reference test earth, or between any two accessible parts on the same piece of equipment (over a surface or through air), shall not exceed the values of 4.3.3.2 in normal use, nor those of 4.10.4.1.2 in single fault condition.

4.3.3.2 Values under normal use

Values under normal use are listed below. Voltages above the levels of a) are deemed to be hazardous live if any of the levels of b) or c) are exceeded at the same time.

a) Voltage levels: 30 V AC RMS or 60 V DC

For equipment rated for use in wet locations (either device or operator or both in wet locations due to rain, condensation, etc.), the voltage levels are 16 V AC RMS or 35 V DC.

b) Current levels under normal use: indicated in Table 2.

Table 2 – Current levels under normal use

Installation location	Figure 3 or Figure 4 of IEC 60990:2016 Measurement circuit to be used	Sinusoidal waveforms	Non-sinusoidal or mixed frequency waveforms	
		mA RMS	mA peak	mA DC
Dry	Figure 4	0,5	0,7	2
Wet	Figure 3 with $R_S = 375 \Omega$ (instead of 1 500 Ω)	0,5	0,7	2
Dry	Figure 3 with $R_B = 75 \Omega$ Relates to possible burns in the frequency range 30 kHz to 500 kHz	70	-----	-----

- c) After switching off the equipment, capacitors shall be discharged within 5 s to a residual charge in Table 3 or to a voltage of 20 V or less. In the case of installed equipment, where the voltage at the plug-and-socket devices can be touched and these devices can be pulled out when live, without the use of tools, the capacitors shall be discharged within 1 s.

With respect to the above two discharge cases, verification shall be by calculation of the energy in the total in-circuit capacitance, or measurement of the voltage, 5 s or 1 s after switching off the equipment.

If the above parameters cannot be complied with, due to design constraints, there shall be an easily observable warning on the equipment that such capacitors should be safely discharged during decommissioning (symbol 14 from Table 12).

Table 3 – Charge or energy of capacitance levels under normal use

Maximum level	For peak or DC voltages
45 μC	Up to 15 kV
350 mJ	$\geq 15 \text{ kV}$
NOTE Figure 3 of IEC 61010-1:2010 shows the maximum acceptable voltage for the capacitance value for both normal use and single fault condition.	

4.4 Earthing and protective bonding requirements

4.4.1 General

Earthing in equipment may be required for reasons of personnel safety or to reduce the effects of electromagnetic interference. Where there is any conflict between these two requirements, personnel safety shall always take precedence. The acceptable arrangement of protective means against electric shock is illustrated in Figure 4 of IEC 61010-1:2010.

4.4.2 Insulation between live parts and accessible conductive parts

Accessible conductive parts shall be bonded to the protective earth conductor terminal if they could become hazardous live in the case of a single fault of the primary protective means specified in 4.1. Alternatively, such accessible parts shall be separated from parts which are hazardous live by a conductive protective screen or barrier bonded to the protective earth conductor terminal. For measuring and protection equipment, indirect bonding is permitted as an alternative to direct bonding.

Unearthed accessible conductive parts such as equipment doors or flaps, handles, etc. need not be bonded to the protective earth conductor if they are separated from all hazardous-live-parts by double insulation or reinforced insulation.

Equipment of protective class I shall have a minimum of basic insulation between the accessible conductive parts bonded to protective earth conductor and live parts, provided that the insulation cannot be reduced to less than basic insulation by any single fault including

mechanical impact, loose wires and terminals, etc. Mechanical retention can be used to ensure maintenance of basic insulation under a single fault condition. Screws or nuts with lock washers are not regarded as liable to become loose, nor are wires which are mechanically secured by more than soldering alone.

Verification shall be made by measurement, where there is any doubt of conformity.

4.4.3 Protective bonding

4.4.3.1 General

Accessible conductive parts shall be bonded to the protective conductor; it is not, however, essential when one of the following applies.

- Unearthed accessible conductive parts are exclusively related to electrical circuits with automatic disconnection of supply, or with current or voltage limiting in case of direct contact according to 4.3, and the voltage does not exceed ELV limits (see Annex A).
- The unearthed accessible conductive parts are of small dimensions, in normal use are not intended to be grasped, have a low probability of contact, and are separated from hazardous-live-parts by at least basic insulation.

Additional information for the acceptable arrangement of protective bonding against electric shock can be found in IEC 61010-1:2010, Figure 4.

4.4.3.2 Bonding of parts connected to the protective conductor

The equipment design shall ensure that any painting or coating of surfaces within the protective earth bonding circuit does not affect the protective bonding resistance of that circuit.

See 9.6.4.5 for protective bonding test requirements.

4.4.3.3 Protection against corrosion

Conductive parts in contact at protective earthing terminals and connections shall be chosen to minimize electro-chemical corrosion between materials in any working, storage or transport environment conditions as specified in the instructions supplied with the equipment.

Corrosion resistance can be achieved by a suitable plating or coating process.

Conformity with 4.4.3.3 is tested by applying the conducted damp-heat, steady state type test (including protective bonding test requirements given in 9.6.4.5).

4.4.3.4 Interruption of protective bonding

Where the protective bonding to a subassembly of equipment is made by a plug-and-socket device when it is live or conducting, the protective bonding shall not be broken before the live conductors. On re-connection, the protective bonding shall re-connect before the live conductors or, at the latest, together with the live conductors.

Conformity is checked by inspection and/or test.

4.5 Functional earthed circuits

If functional earthing of accessible parts is necessary, the following apply.

- It is permitted to connect the functional earthed circuit to a protective conductor terminal or to a protective bonding conductor.
- The functional earthed circuit shall be separated from ELV circuits by at least basic insulation.

- The functional earthed circuit shall be separated from PEB and PELV circuits by at least functional insulation.
- The functional earthed circuit shall be separated from parts at hazardous voltage in the equipment by either:
 - double insulation or reinforced insulation; or
 - a protectively earthed screen or another protectively earthed conductive part, separated from parts at hazardous voltages by at least basic insulation.

Conformity is checked by inspection, measurement and test.

4.6 Protective conductor connection

Equipment with internal protective bonding shall have means of connection for the external protective conductor, preferably near to the terminals for the respective live conductors.

The protective conductor terminal shall be corrosion-resistant. It shall be capable of accommodating cables of at least the same cross-sectional area as the equipment circuit with the highest current or protection element rating which can cause an earth fault.

The means of connection for the protective conductor shall not be used as a part of the mechanical assembly of the equipment.

Conformity is checked by inspection.

4.7 High leakage current

Where equipment has a continuous leakage current of more than 3,5 mA AC RMS or 10 mA DC in normal use, the protective conductor shall be connected as for permanently connected equipment (see Clause E.2); this shall be stated in the equipment documentation.

Any current measurements shall be performed using the measuring circuit in Figure 4 of IEC 60990:2016. The equipment shall be isolated from earth and from the measuring circuit connected between the protective conductor terminal and the protective conductor.

Conformity is checked by measurement.

4.8 Solid insulation

4.8.1 General

Solid insulation shall be designed to resist the mechanical, electrical, thermal, climatic, and other stresses that are to be expected under normal use throughout the life of the equipment.

Solid insulation shall be designed to withstand mechanical vibration or shock which can be expected during transportation, storage and installation. Conformity with the requirements in 4.8.2 shall be checked after the mechanical tests in 9.6.2.1 and 9.6.2.2.

Wire insulation shall be considered as solid insulation.

Thin, easily damageable materials, such as coating with lacquer or oxides and anode coatings, are considered insufficient to satisfy these requirements.

Conformity with 4.8 is checked by inspection, measurement and test.