

BS EN 60255-27:2014

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BSI Standards Publication

Measuring relays and protection equipment

Part 27: Product safety requirements

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National foreword

This British Standard is the UK implementation of EN 60255-27:2014. It is identical to IEC 60255-27:2013. It supersedes BS EN 60255-5:2001 and BS EN 60255-27:2005 which are withdrawn.

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 secretary.

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

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Amendments/corrigenda issued since publication

Date	Text affected
30 June 2014	Implementation of CENELEC correction notice 16 April 2014: supersession information in national foreword and CENELEC foreword corrected

**Measuring relays and protection equipment -
Part 27: Product safety requirements
(IEC 60255-27:2013)**

Relais de mesure et dispositifs de
protection -
Partie 27: Exigences de sécurité
(CEI 60255-27:2013)

Messrelais und Schutzeinrichtungen -
Teil 27: Anforderungen an die
Produktsicherheit
(IEC 60255-27:2013)

This European Standard was approved by CENELEC on 2013-11-19. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 95/316/FDIS, future edition 2 of IEC 60255-27, prepared by IEC/TC 95 "Measuring relays and protection equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60255-27:2014.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2014-09-28
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-11-19

This document supersedes EN 60255-5:2001 and EN 60255-27:2005.

EN 60255-27:2014 includes the following significant technical changes with respect to EN 60255-27:2005:

- a) The removal of tables and diagrams which are from other standards and referring instead directly to the source standard.
- b) All aspects of EN 60255-5 have been covered and this standard can be withdrawn.
- c) Ambiguity within the standard has been removed.

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

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 60255-27:2013 was approved by CENELEC as a European Standard without any modification.

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

IEC 60068-3-4:2001	NOTE Harmonized in EN 60068-3-4:2001 (not modified)
IEC 60112:2003	NOTE Harmonized in EN 60112:2003 (not modified)
IEC 60127-1	NOTE Harmonized in EN 60127-1
IEC 60255-5:2000	NOTE Harmonized in EN 60255-5:2000 (not modified)
IEC 60384-14:2013	NOTE Harmonized in EN 60384-14:2013 (not modified)
IEC 60695-2-12	NOTE Harmonized in EN 60695-2-12
IEC 60695-2-13:2010	NOTE Harmonized in EN 60695-2-13:2010 (not modified)
IEC 61558 (series)	NOTE Harmonized in EN 61558 (series)
IEC 61810-1:2008	NOTE Harmonized in EN 61810-1:2008 (not modified)

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050 (series)		International Electrotechnical Vocabulary - Part 103: Mathematics - Functions	-	
IEC 60085		Electrical insulation - Thermal evaluation and designation	EN 60085	
IEC 60255-1		Measuring relays and protection equipment - Part 1: Common requirements	EN 60255-1	
IEC 60255-21-1		Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section 1: Vibration tests (sinusoidal)	EN 60255-21-1	
IEC 60255-21-2		Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section 2: Shock and bump tests	EN 60255-21-2	
IEC 60255-21-3		Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section 3: Seismic tests	EN 60255-21-3	
IEC 60255-26	2013	Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements	EN 60255-26 + AC:2013	2013
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 60352-2	
IEC 60417	Data-base	Graphical symbols for use on equipment		
IEC 60529 +A1	1989 1999	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May +A1	1991 1993 2000
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60664-3	2003	Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution	EN 60664-3	2003

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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	1999	Methods of measurement of touch current and protective conductor current	EN 60990	1999
IEC 61010-1	2010	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements	EN 61010-1	2010
IEC 61032		Protection of persons and equipment by enclosures - Probes for verification	EN 61032	
IEC 61140		Protection against electric shock - Common aspects for installation and equipment	EN 61140	
IEC 61180-1	1992	High-voltage test techniques for low-voltage equipment - Part 1: Definitions, test and procedure requirements	EN 61180-1	1994
IEC 61180-2		High-voltage test techniques for low-voltage equipment - Part 2: Test equipment	EN 61180-2	
IEC 62151		Safety of equipment electrically connected to a telecommunication network	-	-
ISO 7000		Graphical symbols for use on equipment - Registered symbols	-	-

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INTRODUCTION

In order to demonstrate that the equipment is safe, it was previously necessary to refer to general safety standards such as IEC 61010-1 in addition to IEC 60664-1.

These general safety standards specify requirements for general product types or product families in order to reduce the risk of fire, electric shock or injury to the user. The product types do not include measuring relays and protection equipment. These standards also take into account single-fault conditions.

Reference to all these various standards created confusion due to conflicting requirements, for example, different clearances, creepage distances and test voltages etc., for the same rated voltages.

The aim of this standard is:

- to remove confusion due to conflicting requirements between existing standards;
- to achieve a uniform approach throughout the international industry for measuring relays and protection equipment.

This product safety standard for measuring relays and protection equipment takes the general product safety standards and IEC 60664-1 as the base, defining those issues specific to measuring relays and protection equipment.

MEASURING RELAYS AND PROTECTION EQUIPMENT –

Part 27: Product safety requirements

1 Scope

This part of the IEC 60255 series describes the product safety requirements for measuring relays and protection equipment having a rated a.c. voltage up to 1 000 V with a rated frequency up to 65 Hz, or a rated d.c. 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 standard details essential safety requirements to minimize the risk of fire and hazards caused by electric shock or injury to the user.

This standard does not cover the safety requirements of installations. It does cover all the ways in which the equipment may be mounted and used in cubicles, racks and panels, and also retesting. This standard also applies to auxiliary devices such as shunts, series resistors, transformers, etc., that are used in conjunction with measuring relays and protection equipment and are tested together.

Ancillary equipment used in conjunction with measuring relays and protection equipment may need to comply with additional safety requirements.

This standard is intended to describe only product safety requirements; therefore, functional performance of the equipment is not covered.

Functional safety requirements, including EMC functional safety, are not covered by this standard. Functional safety risk analysis is not within the scope of this product safety standard.

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

The object of this standard is to have a comprehensive standard that covers all aspects of product safety and the related type and routine tests, for measuring relays and protection equipment.

This standard 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;
- external operating temperature range, in accordance with IEC 60255-1;
- maximum external relative humidity 95 %, non-condensing, in accordance with IEC 60255-1;
- supply fluctuations in accordance with IEC 60255-1;
- applicable supply overvoltage category;
- external pollution degree 1 and external pollution degree 2.

The equipment will normally be installed in a restricted access area within a power station, substation or industrial/retail environment. The environmental conditions specified for the equipment in IEC 60255-1 apply. This standard considers the normal environmental

conditions of corrosion caused by humidity but does not cover corrosion by atmospheric pollution.

It is assumed that access to the equipment during installation, maintenance, normal service and decommissioning is restricted to users aware of working procedures necessary to ensure safety.

This product safety standard takes precedence over general standards for matters of safety.

2 Normative references

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

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <<http://www.electropedia.org>>)

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

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

IEC 60255-21-1, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section One: Vibration tests (sinusoidal)*

IEC 60255-21-2, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section Two: Shock and bump tests*

IEC 60255-21-3, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section 3: Seismic tests*

IEC 60255-26:2013, *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)*
Amendment 1:1999¹

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3:2003, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*
Amendment 1:2010

¹ There exists a consolidated Edition 2.1 (2001) that includes Edition 2.0 and its Amendment 1.

IEC/TS 60695-2-20², *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*

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

IEC 60990:1999, *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 61032, *Protection of persons and equipment by enclosures – Probes for verification*

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

IEC 61180-1:1992, *High-voltage test techniques for low-voltage equipment – Part 1: Definitions, test and procedure requirements*

IEC 61180-2, *High-voltage test techniques for low-voltage equipment – Part 2: Test equipment*

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

ISO 7000, *Graphical symbols for use on equipment – Index and synopsis*. Available at: <http://www.graphical-symbols.info/equipment>

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60664-1 and IEC 60050-151-448 as well as the following apply.

3.1

accessible part

part which can be touched under normal conditions with a standard rigid or jointed test finger as specified in 3.5.1 of IEC 61010-1:2010

Note 1 to entry: A communication circuit/network, which may be connected and taken outside the cubicle housing the equipment, or on the front of the panel without the need to open a cover or flap to access it, should be considered to be accessible, i.e. should it be PEB, PELV, SELV or equivalent.

[SOURCE: IEC 60050:1998, 442.01.15, modified – More details about the test finger and the note to entry has been added.]

3.2

adjacent circuits

electric circuits which are separated from the considered circuit by the necessary basic or double/reinforced insulation

Note 1 to entry: Circuits which are separated by more than double or reinforced insulation are not considered to be adjacent.

² Edition 3.0 currently under preparation.

3.3

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 60050:2000, 441.11.13, modified – "switching device or fuse" has been replaced by "equipment" and a second note to entry has been added.]

3.4

barrier

electrically protective barrier

part providing protection against direct contact from any usual direction of access

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

[SOURCE: IEC 60050:2004, 826.12.23]

3.5

basic insulation

insulation of hazardous live parts to provide basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEC 60050:2004, 826.12.14, modified – the word "which" is replaced by "to".]

3.6

bounding surface

outer surface of the equipment case, considered as though metal foil were pressed into contact with accessible surfaces of insulating material

3.7

class I equipment

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

3.8

class II equipment

equipment with

- basic insulation as provision for basic protection against electric shock, and
- supplementary insulation as provision for fault protection; or
- in which basic protection and fault protection are provided by reinforced insulation

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 Class II equipment for functional (for example, EMC) purposes.

[SOURCE: IEC 60050:2008, 851.15.11, modified – The phrase "against electrical shock" and a note to entry have been added while the reference to IEC 61140:2001, 7.3 has been omitted.]

3.9

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

3.10

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

CTI

comparative tracking index

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 60050:2010, 212.11.59]

3.12

communication circuit/network

circuit/network for receiving and/or transmitting, digital or analogue signals

Note 1 to entry: It may communicate with other circuits via optical, magnetic or electromagnetic radiation means, or metallic connections.

3.13

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 60050:2001, 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.]

3.14

direct contact

electrical contact of persons with live parts

[SOURCE: IEC 60050:2004, 826.03.05, modified – The words "or animals" have been omitted.]

3.15

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 60050:1998, 195.06.08, modified – The note to entry has been added.]

3.16

ELV

extra low voltage

SEE: Table A.1

3.17

enclosure

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

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

[SOURCE: IEC 60050:1998, 195.02.35, modified – The note to entry has been added.]

3.18

accessible conductive part exposed conductive part

conductive part of electrical equipment, which can be touched and which is not normally live, but which can become live when basic insulation fails

Note 1 to entry: For equipment which is not enclosed, the frame, the fixing devices, etc., may form the accessible conductive parts.

Note 2 to entry: For equipment which is enclosed, the conductive parts which are accessible when the equipment is mounted in its normal position of use, including those of its fixing surface, form the accessible conductive parts.

[SOURCE: IEC 60050:1998, 422.01.21, modified – The notes to entry have been added.]

3.19

fire enclosure

part of the equipment intended to minimize the spread of fire or flames from within

3.20

functional earthing functional grounding, US

earthing a point or points in a system or in an installation or in equipment, for purposes other than electrical safety

[SOURCE: IEC 60050:2004, 826.13.10]

3.21

functional insulation

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

[SOURCE: IEC 60050:1998, 195.02.41]

3.22

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

3.23

hazardous live part

live part at a voltage exceeding 33 V a.c. or 70 V d.c.

3.24

HLV

hazardous live voltage

normal condition voltage which exceeds 33 V a.c. or 70 V d.c.

3.25

HB40 class material

material tested in the thinnest significant thickness used and classified HB40 according to IEC 60695-11-10

3.26

HB75 class material

material tested in the thinnest significant thickness used and classified HB75 according to IEC 60695-11-10

3.27

high-integrity part

high-integrity component

part or component that is considered not to become defective in such a manner as to cause a risk of hazard within the sense of this standard and not subject to failure when a single-fault condition is applied

3.28

limited-energy circuit

circuit that meets all the criteria given in 7.12 of this standard

3.29

live part

conductor or conductive part intended to be energized under normal conditions, including a neutral conductor

Note 1 to entry: This concept does not necessarily imply a risk of electric shock.

[SOURCE: IEC 60050:1998, 195.02.19, modified – The last part of the definition "but by convention not a PEN conductor or PEM conductor or PEL conductor" has been omitted.]

3.30

maintenance operative

operative having appropriate technical training and experience necessary to be aware of hazards to which that operative may be exposed in performing installation/maintenance and of measures to minimize the risks to that person or other persons

3.31

micro-environment

ambient conditions which immediately surround the clearance and creepage distance under consideration

Note 1 to entry: The micro-environment of the creepage distance or clearance and not the environment of the equipment determine the effect on the insulation.

[SOURCE: IEC 60050:1998, 442.01.29, modified – The latter part of the definition "excluding self produced pollution resulting from normal operation of the accessory" has been omitted.]

3.32

non-primary circuit

circuit electrically isolated from the a.c. or d.c. supply and from external VTs and CTs

3.33

normal conditions

equipment installed and operated under the normal operating conditions for the specified equipment as defined by the manufacturer (excluding maintenance)

3.34

overheating

operating at a level such that the equipment's thermal limit is exceeded

3.35

overvoltage category

number defining a transient overvoltage condition

Note 1 to entry: Overvoltage categories I, II, III are used.

Note 2 to entry: See Clause A.1 for overvoltage category details.

3.36

PEB-circuit

protective equipotential bonding circuit

SEE: Table A.1

3.37

PELV circuit

protective extra low voltage circuit

SEE: Table A.1

3.38

pollution

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

[SOURCE: IEC 60050:1998, 442.01.28, modified – The note to entry has been omitted.]

3.39

pollution degree

number characterizing the expected pollution of the micro-environment

3.40

pollution degree 1

normally no pollution or only dry, non-conductive pollution occurs.

Note 1 to entry: Pollution has no influence.

3.41

pollution degree 2

normally only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is to be expected

3.42

pollution degree 3

normally conductive pollution, or dry non-conductive pollution occurs, which becomes conductive, due to condensation which is to be expected

3.43

pollution degree 4

normally the pollution generates persistent conductivity caused by conductive dust or by rain or snow

3.44

primary circuit

circuit connected direct to the a.c. or d.c. supply input

Note 1 to entry: Equipment circuits connected to VTs (voltage transformers) or CTs (current transformers) are also classed as primary circuits.

Note 2 to entry: Measuring relay circuits supplied from an external a.c. or d.c. power supply, complying with ELV circuit requirements, as in Table A.1, may be treated as non-primary circuits, providing that any transients or impulse voltages on the supply output do not exceed the requirements of Figure 2 of IEC 61010-1:2010.

3.45

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

3.46**protective bonding resistance**

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

3.47**protective conductor**

conductor provided for purposes of safety, for example, protection against electric shock, by electrically connecting main earthing terminal, or accessible conductive parts, or earth electrode, or earthed point of the source or artificial neutral

[SOURCE: IEC 60050:1998, 195.02.09, modified – "by electrically connecting main earthing terminal, or accessible conductive parts, or earth electrode, or earthed point of the source or artificial neutral" has been added.]

3.48**protective earthing****protective grounding, US**

earthing of a point in equipment for protection against electric shock in case of a fault

3.49**protective impedance**

impedance connected between live parts and accessible conductive parts, of such value that the current, under normal conditions 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

Note 1 to entry: A protective impedance should withstand the dielectric voltage withstand test for double insulation, and its choice should take account of its predominated failure mode.

[SOURCE: IEC 60050:1998, 442.04.24, modified – The term "electronic switch" has been replaced by "equipment" and a note to entry has been added]

3.50**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 equipotential bonding system and intended to provide protection against electric shock

[SOURCE: IEC 60050:1998, 195.06.18]

3.51**protective separation**

separation of one electric circuit from another by means of double insulation, or basic insulation and electrically protective screening, or reinforced insulation

3.52**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

3.53**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.

Note 2 to entry: The rated insulation voltage refers to the insulation between electric circuits.

Note 3 to entry: For clearances and solid insulation the peak value of the voltage occurring across the insulation or clearance is the determining value for the rated insulation voltage. For creepage distances, the r.m.s. or d.c. value is the determining value.

3.54

rated voltage

value of voltage assigned by the manufacturer, for a specified 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.

3.55

reinforced insulation

insulation of hazardous live parts which provides a degree of protection against electric shock equivalent to double insulation

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

[SOURCE: IEC 60050:1998, 195.06.09]

3.56

restricted access area

area accessible only to electrically skilled persons and electrically instructed persons with the proper authorization and knowledge of any safety hazards

Note 1 to entry: These areas include closed switch plants, distribution plants, switchgear cells, transformer cells, distribution systems in metal-sheet enclosures or in other closed installations.

[SOURCE: IEC 60050:1998, 195.04.04, modified – "and knowledge of any safety hazards" and a note to entry have been added.]

3.57

routine test

conformity test made on each individual item during or after manufacture

[SOURCE: IEC 60050:2001, 151.16.17]

3.58

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 the risk of electric shock, injury, or fire hazard

3.59

screen

shield, US

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

3.60

SELV circuit

separated/safety extra low voltage circuit

SEE: Table A.1

3.61

single-fault conditions

conditions in which one fault is present which could cause a hazard

Note 1 to entry: If a single-fault condition results unavoidably in another fault condition, the two failures are considered as one single-fault.

3.62

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 60050:1998, 195.06.07, modified – "for fault protection" has been replaced by "in order to provide protection against electric shock in the event of a failure of basic insulation".]

3.63

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 60050:2010, 212.11.56]

3.64

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 60050:2008, 851.12.05]

3.65

user

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

Note 1 to entry: User can be classified as an operator accessing the equipment for routine purposes (considered to have access to the front of the unit only).

3.66

withstand

state of survival of the equipment to the related imposed environmental or test condition (for example, impulse voltage)

3.67

working voltage

highest r.m.s. value of the a.c. or d.c. 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.

4 General safety requirements

4.1 General

The equipment shall not jeopardize the safety of people and property.

Protection against electric shock for class I, II or III equipment is applicable to those parts accessible under normal conditions.

ELV, PEB, PELV and SELV circuits provide protection from electric shock by hazardous live voltages, and are not necessarily related to class I, II or III equipment class.

4.2 Earthing requirements

Earthing in equipment may be required not only to reduce the effects of interference, but also, and more importantly, for reasons of personnel safety. Where there is any conflict between these two requirements, personnel safety shall always take precedence.

5 Protection against electric shock

5.1 General

5.1.1 Introductory remark

Users shall be protected against electric shock hazards by use of good constructional and engineering practice.

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 10.

Protection against contact with accessible hazardous live parts shall be provided.

Any conductive part that is not separated from the hazardous live parts by at least basic insulation shall be considered to be a live part.

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.

A single-fault condition applied to the equipment shall not cause an electric shock hazard.

Unearthed accessible conductive parts which may become hazardous live under a single-fault condition shall be separated from hazardous live parts by double or reinforced insulation or be connected to the protective conductor or meet the requirements of 5.1 to 5.1.11.

Annex A covers equipment isolation class.

Annex C is for the determination of clearance and creepage distance and withstand type test voltages.

5.1.2 Protection from contact with hazardous live parts

5.1.2.1 General

Protection against direct contact with accessible hazardous live parts shall be provided by adequate insulation, the equipment case or a barrier.

5.1.2.2 Insulation

The insulation requirements shall be determined after consideration of the following influencing factors:

- rated insulation voltage of the circuit under consideration (see 6.7 of IEC 61010-1:2010);
- overvoltage category (see Annex B and Annex C);
- pollution degree (see Annex C);
- isolation level, for example, ELV, SELV, PELV, or PEB (see Annex A);

- insulation prescription (see Annex A and Annex C).

5.1.2.3 Equipment case and barriers

Hazardous live parts shall be located within the equipment case or behind barriers that meet at least the requirements of the protective type IP2X (finger protection) according to 5.1 of IEC 60529:1989, Amendment 1:1999 such that they are not accessible under normal conditions. If a cover is removed without the use of a tool then warning symbol 12 from Table 10 shall then be visible.

The top surfaces of barriers that are accessible in normal use shall meet at least the requirements of the protective type IP4X (protection against 1mm diameter wire) according to 5.1 of IEC 60529:1989, Amendment 1:1999. Any such barriers shall have sufficient mechanical strength, stability and durability to maintain the specified degree of protection and be firmly secured in place in such a way that it may only be removed by the use of a tool.

Hazardous live parts which may be accidentally touched by a maintenance operative when manually changing settings etc., shall meet at least the requirements of protective type IP2X according to 5.1 of IEC 60529:1989, Amendment 1:1999.

Compliance with 5.1.2.3 is checked using a test finger as specified in 6.2 of IEC 61010-1:2010.

5.1.2.4 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 nominal 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 10 marked on the equipment. The risk can be eliminated, for example, by the use of an insulated crimp terminal or a single-strand wire.

Compliance with 5.1.2.4 is checked by inspection.

5.1.3 Discharge of capacitors

After switching off the equipment, capacitors shall be discharged within 5 s to a residual charge of 50 μC or to a voltage of 20 V. In the case of installed equipment, where the voltage at the plug-and-socket devices can be touched and these devices may be pulled out when live, without the use of tools, the capacitors shall be discharged within 1 s to a charge of 50 μC , or to a voltage of 20 V.

With respect to the above two discharge cases, testing shall be by calculation of the energy, or measurement of the voltage, 5 s or 1 s after switching off the equipment. Where several

capacitors are interconnected throughout the circuit, this shall be allowed for, in such calculations.

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.

Compliance with 5.1.3 is checked by calculation or measurement.

5.1.4 Protective impedance

Protective impedance shall be one or more of the following so that unearthed accessible conductive parts cannot become hazardous live as a result of a single-fault condition.

- An appropriate high-integrity single component. Examples are high-voltage withstand capacitors and resistors rated at a minimum of 3 250 V r.m.s. for at least 1 min and shall meet the requirements of 5.1.5.3.2 under the normal conditions and 5.2.4.1.2 under a single-fault condition. The power rating, at maximum ambient temperature, of a high-integrity resistor, shall be at least twice that of the resistor dissipation, under normal use. If the predominant failure mode of the component is short circuit, then a single component shall not be used.
- 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 nominal capacitance value and a withstand voltage rating of at least 2 000 V r.m.s., 1 min. This provides basic protection against electric shock in the case of a single-fault condition.
- A combination of basic insulation and a current- or voltage-limiting device.

Compliance with protective impedance can be demonstrated by application of the appropriate voltage test for double/reinforced insulation in Table C.7 to Table C.10 for an altitude of 2 000 m. For test altitudes other than 2 000 m, the test voltage should be adjusted in accordance with Table C.11.

Components, wires and connections shall be rated according to the requirements for both normal conditions 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. Compliance of components with 5.1.4 and any associated basic insulation shall be checked after a single-fault condition assessment or test according to 10.6.5.5. Any associated basic insulation shall be checked by assessment, measurement or testing in accordance with Annex C of this standard and 6.7 of IEC 61010-1:2010.

5.1.5 Accessible parts

5.1.5.1 General

Unless obvious, determination of whether a part is accessible, under normal use, shall be made as specified below and in 5.1.5.2.

Circuits intended to be connected to an external accessible circuit shall be considered as accessible conductive parts, for example communication circuits.

Appropriate test fingers, as specified in 5.1.5.2.2, 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 5.1.4, the accessible parts or circuits shall comply with current limits in 5.1.5.3.2 for the normal

condition and 5.2.4.1.2 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 working voltage determined from IEC 60664-1 (see 5.1.6.4 below).

For equipment accepting plug-in modules, parts are considered to be accessible if they can be touched with the jointed test finger (see 5.1.5.2.2) 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, fibrous material, are also not considered to provide suitable insulation.

5.1.5.2 Determination of accessible parts

5.1.5.2.1 General

If the user is intended to perform any actions in normal use, with or without the aid of a tool (for example, a screwdriver, a coin, a key, etc.), which will increase the accessibility of parts, such actions shall be taken before performing the examinations of 5.1.5.2.2 to 5.1.5.2.4. Examples include:

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

5.1.5.2.2 General examination

The jointed test finger (see IEC 61032 and IEC 60529) 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,) 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.

5.1.5.2.3 Openings above parts, enclosed by the case, which are hazardous live

A metal test pin 100 mm long and 4 mm in diameter shall be inserted in all openings in the equipment case, above parts (the test pin shall be freely suspended) which are hazardous live. The test pin shall penetrate up to 100 mm. This test shall not be applied to terminals.

5.1.5.2.4 Openings for pre-set controls

A metal test pin 3 mm in diameter 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. Penetration shall not exceed three times the distance from the equipment case surface to the control shaft or 100 mm, whichever is smaller.

5.1.5.2.5 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 of symbols 14 and/or 12 in Table 10.

5.1.5.2.6 Wiring terminals

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, Amendment 1:1999 should be provided to prevent electric shock due to accidental contact.

If at least a protection of type IP1X, according to 5.1 of IEC 60529: 1989, Amendment 1:1999, is not provided then warning symbol 12 in Table 10, shall be used in the vicinity of accessible hazardous live wiring terminals.

Compliance with 5.1.5 to 5.1.5.2.6 shall be demonstrated by visual inspection or test.

5.1.5.3 Permissible limits for accessible parts

5.1.5.3.1 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 within a distance of 1,8 m (over a surface or through air), shall not exceed the values of 5.1.5.3.2 in normal condition, nor those of 5.2.4.1.2 in single-fault condition.

5.1.5.3.2 Values under normal conditions

Values under normal conditions are listed below. Values exceeding the levels/limits of items a) to c) below, in normal conditions, are deemed to be hazardous live. The limits of items b) and c) below apply only if the voltage exceeds the values of item a).

a) Voltage levels: 33 V a.c. or 70 V d.c.

For equipment rated for use in wet locations, the voltage levels are 25 V a.c. or 37,5 V d.c.

b) Current levels under normal conditions: indicated in Table 1.

Table 1 – Current levels under normal conditions

Installation location	Figure 3/Figure 4 of IEC 60990:1999 Measurement circuit to be used	Sinusoidal waveforms mA r.m.s.	Non-sinusoidal or mixed frequency waveforms mA peak	mA d.c.
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) Charge or energy of capacitance levels under normal conditions: indicated in Table 2.

Table 2 – Charge or energy of capacitance levels under normal conditions

Maximum level	For peak or d.c. 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.	

5.1.6 Bonding to the protective conductor

5.1.6.1 Insulation between live parts and accessible conductive parts

Accessible conductive parts shall be bonded to the protective conductor terminal if they could become hazardous live in the case of a single fault of the primary protective means specified in 5.1.2. Alternatively, such accessible parts shall be separated from parts which are hazardous live by a conductive protective screen or barrier bonded to the protective conductor terminal. For measuring and test equipment, indirect bonding is permitted as an alternative to direct bonding.

Unearthed accessible conductive parts such as equipment doors or flaps, handles, etc. shall meet one of the following criteria.

- Unearthed accessible conductive parts need not be bonded to the protective conductor if they are separated from all hazardous live parts by double insulation or reinforced insulation.
- Equipment of class I protection. A minimum of basic insulation between the unearthed accessible conductive part 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 of clearance shall be made by measurement, where there is any doubt of compliance.

5.1.6.2 Protective bonding

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

- When unearthed accessible conductive parts are exclusively related to electrical circuits with protection in case of direct contact according to 5.1.5, and the voltage does not exceed ELV limits (see Annex A).
- When magnetic cores are used, for example transformers, chokes and contactors.
- The unearthed accessible conductive parts are of small dimensions which in normal use are not intended to be grasped and which have a low probability of contact and are separated from hazardous live parts by at least basic insulation.

5.1.6.3 Bonding of parts connected to the protective conductor

See 10.6.4.5 for protective bonding test requirements.

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

5.1.6.4 Protection against corrosion

Conductive parts in contact at protective earthing terminals and connections shall not be subject to significant corrosion due to electrochemical action in any working, storage or transport environment conditions as specified in the instructions supplied with the equipment.

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

Compliance with 5.1.6.4 is checked by determination of the electrochemical potential difference between the dissimilar metals, also by inspection after the normally conducted damp heat type test.

5.1.6.5 Interruption of protective bonding

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

5.1.7 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/protection element rating, which may 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.

5.1.8 High leakage current

Where equipment has a continuous leakage current of more than 3,5 mA a.c. or 10 mA d.c. in normal use, the supply input shall be connected as for a 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 60990:1999. The equipment shall be isolated from earth and the measuring circuit connected between the protective conductor terminal and the protective conductor.

5.1.9 Solid insulation

5.1.9.1 General

Solid insulation shall be designed to resist the stresses which occur, especially mechanical, electrical, thermal and climatic stresses that are to be expected under normal conditions, and it shall have a sufficient resistance to ageing throughout the life of the equipment.

Solid insulation shall be designed to withstand mechanical vibration or shock which can be expected during transportation, storage, installation and use.

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.

5.1.9.2 Requirements

The maximum temperature of the solid insulation, under normal conditions at maximum ambient temperature, shall be less than the temperature given for the appropriate class in Table 7, 7.11.2.

Compliance of solid insulation shall be verified by performing dielectric voltage and impulse withstand type tests, according to the relevant rated working voltage and overvoltage category, determined from the appropriate Table C.1 to Table C.10, and Table C.11. The term solid insulation refers to material that provides electrical insulation between two opposite

surfaces, not along an outer surface. Its required properties are specified either as the actual minimum distance through the insulation, or by other requirements and tests in this standard instead of a minimum distance. Any test therefore only proves the minimum distance through the insulation, not the creepage distance across the surface of the insulation.

Compliance with 5.1.9 is checked by inspection, measurement and test.

5.1.10 Clearances and creepage distances

5.1.10.1 General

Clearance and creepage distances shall be determined from the appropriate Table C.1 to Table C.10.

NOTE The clearance and creepage distances in Table C.1 to Table C.10 can be interpolated for voltages above 300 V.

The minimum creepage distance shall not be less than the minimum clearance in air. These clearance and creepage distances are minimum values; manufacturing tolerances shall additionally be taken into account.

Examples for design and measurement of clearances and creepage distances are given in 6.2 of IEC 60664-1:2007.

Inhomogeneous fields generally apply to equipment.

For the functional insulation of pulsating voltage waveforms, the r.m.s. voltage of the waveform shall be calculated and used as the working voltage in the determination of the required clearances and creepage distances. The amplitude of repetitive peak voltages of short duration (defined as being less than 2 % of the waveform cycle duration) should not exceed 175 % of the rated r.m.s. working voltage used to determine the minimum creepage distance.

Where there is any doubt that the required clearance and creepage distances are compliant, measurements shall be made.

If appropriate, type tests and routine testing or sample testing of clearances shall be carried out to determine compliance with 5.1.10, in accordance with Clause 10.

5.1.10.2 Clearances

5.1.10.2.1 General

Clearances are specified to withstand the maximum transient overvoltage that can be present on the circuit, either as a result of an external event (such as a lightning strike, or a switching transient), or as the result of the operation of the equipment. Clearances shall be determined with reference to Annex A and Annex C. For clearances in primary circuits, Table B.1 should also be referred to.

The design of the clearance between any two circuits shall conform to the greater clearance of the two.

In order to maintain a fixed withstand test voltage, the clearances for equipment at altitudes greater than 2 000 m shall be multiplied by the factor given in Table 3 below.