Draft for Public Comment

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Responsible committee: PEL/95 Measuring relays and protection systems

Interested committees:

Title: Draft BS EN 60255-27 Measuring relays and protection equipment. Part 27: Product safety requirements.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex **(e.g. 3.1)**	Paragraph/Figure/ Table/Note	**Type of comment**	**Commend (justification for change) by the MB**	**Proposed change by the MB**	**Secretariat observations on each comment submitted**
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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COMMITTEE DRAFT (CD)

PROJECT NUMBER: **IEC 60255-27 ED3**	
DATE OF CIRCULATION: **2018-06-22**	CLOSING DATE FOR COMMENTS: **2018-09-14**
SUPERSEDES DOCUMENTS: **95/389/RR**	

IEC TC 95 : MEASURING RELAYS AND PROTECTION EQUIPMENT	
SECRETARIAT: France	SECRETARY: Mr Thierry BARDOU
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 14, TC 17, TC 38, TC 57, TC 77	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY

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TITLE:

Measuring relays and protection equipment – Part 27: Product safety requirements

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MEASURING RELAYS AND PROTECTION EQUIPMENT –

Part 27: Product safety requirements

FOREWORD

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

This third edition cancels and replaces the second edition published in 2113. This edition constitutes a technical revision.

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

a) ...;

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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
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INTRODUCTION

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 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 consider 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.

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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 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 standard specifies essential safety requirements to minimize the risk of fire and hazards caused by electric shock or injury to the user, this standard is intended to describe only product safety requirements, functional performance of the equipment is not covered.

This standard covers all the ways in which the equipment may be mounted and used in cubicles, racks and panels. 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 such as network switches used in conjunction with measuring relays and protection equipment may need to comply with additional safety requirements.

This standard does not specify the implementation of individual equipment, circuits and components. Equipment shall be designed to meet the requirements of all relevant clauses of the standard and tested to prove compliance where necessary. Type testing alone (as section 10 type tests) does not form a complete safety assessment and does not guarantee that the correct components / materials have been used.

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.

Access to the equipment during installation, maintenance, normal service and decommissioning shall be restricted to users aware of working procedures necessary to ensure safety.

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

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 60255-21-1, *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, *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 60384-14, *Fixed capacitors for use in electronic equipment - Part 14: Sectional specification - Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

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

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

IEC 60664-1, *Insulation coordination for equipment within low-voltage 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 60695-2-12, *Fire hazard testing - Part 2-12: Glowing/hot-wire based test methods- Glow-wire flammability index (GWFI) test method for materials*

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

IEC 60695-11-5, *Fire hazard testing - Part 11-5: Test flames - Needle-flame test method - Apparatus, confirmatory test arrangement 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, *Methods of measurement of touch current and protective conductor current*

IEC 61010-1, *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 61051-2, *Varistors for use in electronic equipment - Part 2: Sectional specification for surge suppression varistors*

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

IEC 61180-1, *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 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61558, *Safety of transformers, reactors, power supply units and combinations thereof*

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, IEC 60050-151-448 and IEC60255-1 as well as the following apply.

[1] Edition 3.0 currently under preparation.

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

[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
independent circuits
electric circuits which are separated from the considered circuit

3.3
ambient temperature
ambient air temperature
temperature, determined under prescribed conditions, of the air surrounding the complete 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 and be firmly secured in place in such a way that it may only be removed by the use of a tool

[SOURCE: IEC 60050:2004, 826.12.23]

3.5
basic insulation
insulation of hazardous live parts to provide protection single level of protection

[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 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)

3.8
class II equipment
equipment with

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

[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, voice or data

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.

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[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 – Circuit isolation class for product circuits/groups ***(1 of 2)***

3.17
enclosure
housing affording the type and degree of protection suitable for the intended application

[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 under normal use

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

3.19
fire enclosure
enclosure intended as a safeguard against the spread of fire from within the enclosure to outside the enclosure

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
part at a voltage exceeding HLV

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3.24
HLV
hazardous live voltage
normal condition voltage which exceeds 30 V AC or 60 V DC

3.25
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

3.26
live part
conductor or conductive part intended to be energized under normal conditions, including a neutral conductor

[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.]

3.27
non-primary circuit
circuit electrically isolated from the AC or DC supply and from external VTs and CTs

3.28
normal conditions
equipment installed and operated under the manufacturer claimed parameters

3.29
overheating
operating at a level such that the thermal limit is exceeded

3.30
overvoltage category
number defining a transient overvoltage condition as defined by IEC 60664-1

3.31
PEB-circuit
protective equipotential bonding circuit
SEE: Table A.1 – Circuit isolation class for product circuits/groups ***(1 of 2)***

3.32
PELV circuit
protective extra low voltage circuit
SEE: Table A.1 – Circuit isolation class for product circuits/groups ***(1 of 2)***

3.33
pollution
any addition of foreign matter, solid, liquid or gaseous that can produce a reduction of dielectric strength or surface resistivity of the insulation

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

3.34
pollution degree
number characterizing the expected pollution of the ambient conditions which immediately surround the clearance and creepage distance under consideration as detailed in IEC60664-1

3.35
primary circuit
circuit electrically connected to the AC or DC supply input and external CTs and VTs

3.36
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

3.37
protective bonding resistance
resistance between the protective conductor terminal and a conductive part required to be connected to the protective conductor

3.38
protective conductor
conductor provided for purposes of safety, for example, protection against electric shock

[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.]

3.39
protective earthing
protective grounding, US
earthing of a point in equipment for protection against electric shock in case of a fault

3.40
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

[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]

3.41
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 60050:1998, 195.06.18]

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3.42
protective separation
separation of one electric circuit from another by means of:

- double insulation; or
- basic insulation and electrically protective screening;
- or reinforced insulation
  -

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

3.43
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: The rated insulation voltage is not necessarily equal to the rated voltage of equipment which is primarily related to functional performance.

3.44
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.

3.45
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]

3.46
restricted access area
area accessible only to users with the proper authorization and knowledge of any safety hazards

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

3.47
routine test
conformity test made on each individual item during or after manufacture

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[SOURCE: IEC 60050:2001, 151.16.17]

3.48
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

3.49
screen
shield, US
conductive part that encloses or separates electric circuits and/or conductors

3.50
SELV circuit
separated/safety extra low voltage circuit
SEE: Table A.1 – Circuit isolation class for product circuits/groups ***(1 of 2)***

3.51
single-fault conditions
conditions in which one fault is present

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

3.52
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".]

3.53
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]

3.54
type test
test of one or more devices made to a given design, to confirm if these devices conform with the requirements of the standard concerned

[SOURCE: IEC 60050:2008, 851.12.05]

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3.55
user
personnel 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 of measures to minimize the danger to themselves and other persons

3.56
withstand
ability of the equipment not to be damaged when imposed environmental or test condition are applied (for example, impulse voltage)

3.57
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.

4 General safety requirements

4.1 General

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

Protection against electric shock shall be maintained under normal condition and single fault condition, accessible parts shall not be hazardous live.

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.

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

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

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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 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).

5.1.2.3 Equipment enclosure and barriers

Hazardous live parts shall be located within the equipment enclosure or behind barriers that meet at least the requirements of the protective type IP2X or IPXXB (finger protection) according to IEC 60529 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 (to provide ingress protection against falling objects loose wires, washers, etc.) according to IEC 60529. Any such barriers shall have sufficient mechanical strength, stability and durability to maintain the specified degree of protection.

Hazardous live parts which may be accidentally touched by a user when manually changing settings etc., shall meet at least the requirements of the protective type IP2X or IPXXB (finger protection) according to IEC 60529 such that they are not accessible under normal .

Compliance with 5.1.2.3 is checked by applying the requirements of IEC 60529.

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.

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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 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.

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 during normal conditions and in single-fault condition.

- RATED conditions at which the TERMINAL has been designed to operate while maintaining safety (maximum RATED input/output voltage, specific type of connector, designated use, etc.);
- RATING of the insulation required for the external circuit to conform to the requirements for protection against electric shock, arising from the connection to the TERMINAL, in NORMAL CONDITION and SINGLE FAULT CONDITION.
-
- 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.

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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 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 10.6.2.5) 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.

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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).

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

For equipment rated for use in wet locations, the voltage levels are 25 V AC or 37,5 V DC

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 60990:2016 Measurement circuit to be used	Sinusoidal waveforms mA RMS	Non-sinusoidal or mixed frequency waveforms mA peak	mA DC
Dry	Figure 4	0,5	0,7	2
Wet	Figure 3 with R_S = 375 Ω (instead of 1 500 Ω)	0,5	0,7	2
Dry	Figure 3 with R_B = 75 Ω 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 DC voltages
45 μC	Up to 15 kV
350 mJ	≥ 15 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 Earthing and protective bonding requirements

5.1.6.1 General

Earthing in equipment may be required for reasons of personnel safety or to reduce the effects of interference. Where there is any conflict between these two requirements, personnel safety shall always take precedence.

5.1.6.2 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.

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- 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.

5.1.6.3 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).
- 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.

5.1.6.4 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.

5.1.6.5 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.

5.1.6.6 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.

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5.1.7 Functional earthing

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

- It is permitted to connect the functional earthing circuit to a protective conductor terminal or to a protective bonding conductor.
- The functional earthing circuit shall be separated from ELV, PEB and PELV circuits by at least functional insulation.
- The functional earthing 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.

Compliance is checked by inspection.

5.1.8 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.

5.1.9 High leakage current

Where equipment has a continuous leakage current of more than 3,5 mA AC or 10 mA DC in normal use, the protective conductor 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 60990:2016. The equipment shall be isolated from earth and the measuring circuit connected between the protective conductor terminal and the protective conductor.

5.1.10 Solid insulation

5.1.10.1 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.

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5.1.10.2 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, 7.10.2.

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 test method shall be performed according to the method detailed in clause 10.6.4.3. 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 5.1.10 is checked by inspection, measurement and test.

5.1.11 Clearances and creepage distances

5.1.11.1 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 RMS 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 RMS 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 5.1.11, in accordance with Clause 10.

5.1.11.2 Clearances

5.1.11.2.1 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

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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.

Table 3 – Altitude multiplication factor

Altitude metres	**Clearance multiplying factor**
2 000	1,00
3 000	1,14
4 000	1,29
5 000	1,48

For installations above 2 000 m, refer to Table C.11. If necessary, take appropriate measures to limit the impulse voltages the equipment is subjected to, for example, use spark gaps or transient suppressors etc.

5.1.11.2.2 Clearances for primary circuits

The clearances in air relating to primary circuits are determined by the rated impulse voltage (refer to C.1.4).

Basic insulation is the minimum requirement between primary circuits and other circuits, (primary or non-primary circuits) including accessible parts and earthed parts. Additional insulation (for example, functional or supplementary insulation) may be required, depending upon the isolation class (see Annex A). To minimize the risk of fire, it is necessary to correctly design functional insulation, such as that across a primary circuit.

NOTE The withstand voltages in Table C.1 to Table C.10 are for inhomogeneous fields. In many cases, the clearance in air between two parts of the equipment is between inhomogeneous and homogeneous; hence, clearances can be proven by testing.

The clearance values are stated in Annex C, for impulse voltages other than those given in Annex C tables refer to IEC 60664-1:2007, Annex A.

5.1.11.2.3 Clearances for non-primary circuits

Clearances for non-primary circuits shall withstand the maximum transient overvoltage that can be present on the circuit. If transient overvoltages cannot occur, clearances are based on the nominal working voltage.

The clearance values are stated in Annex C; for impulse or working voltages other than those given in Annex C tables refer to Annex A of IEC 60664-1:2007.

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5.1.11.3 Creepage distances

It shall be assumed that the equipment within the scope of this standard is subject to continuous voltage stress over a long period, requiring the design of appropriate creepage distances.

Creepage distances shall be determined with reference to Annex A and Annex C.

Examples for design and measurement of creepage distances are given in 5.2 and 6.2 of IEC 60664-1:2007.

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

If pollution degree 3 or 4 causes persistent conductivity, for example, due to carbon or metal dust, the dimensions for creepage distances cannot be specified. Instead, the surface of insulation has to be designed to avoid a continuous path of conductive pollution (for example, by means of ribs or grooves, as determined by 5.2.2.5 and 5.2.5 of IEC 60664-1:2007).

Table C.12 indicates additional protection which may be used to reduce the pollution degree within the equipment. If Table C.12 is used to determine reduced creepage distance, it should be ensured that this is not less than the minimum allowed clearance.

Compliance of creepage distances with 5.1.10.2.4 shall be verified by measurement in the case of doubt. It cannot be verified by voltage withstand testing.

Interpolation of creepage distances in Annex C tables is permitted, for both primary and non-primary circuits.

5.2 Single-fault conditions

5.2.1 Testing in single-fault condition

The equipment shall not present a risk of electric shock or fire after a single-fault test. It does not have to be functional after the test.

The following requirements apply.

- Examination of the equipment and its circuit diagram will generally show the fault conditions which are liable to result in electric shock or fire hazards and which therefore shall be applied.
- Fault tests shall be made except where it can be demonstrated that it is improbable that a hazard will arise from a particular single-fault condition.
- It is not required that a single-fault condition is applied to double or reinforced insulation.
- The equipment shall be operated under the least favourable combination of reference test conditions.

These conditions include worst-case tolerance of rated voltage and current, worst-case equipment orientation, whether covers or other removable parts may not be fitted during normal conditions, maximum specified external fuse rating.

NOTE Small parts, such as screws and rivets which are not accessible and are isolated from HLV circuits by at least basic insulation, are not taken into consideration.

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7.11 provides an alternative to testing for protection against spread of fire under a single-fault condition but is not applicable to electric shock hazards.

5.2.2 Application of single-fault condition

5.2.2.1 General

A single-fault condition shall be applied one at a time and shall be applied in turn in the most convenient order. Multiple simultaneous faults shall not be applied; they may, however, result from the application of a single-fault. The application of a single fault may result in the equipment being in a hazardous state and the test personnel should take appropriate precautions such as safety screens, etc.

After the application of a single-fault condition, the equipment or relevant part shall meet the requirements of 5.2.4.

Single-fault condition assessment shall include the following.

5.2.2.2 Protective impedance

The following requirements apply.

- If protective impedance is formed by a combination of components, each component shall in turn be short-circuited or disconnected.
- If protective impedance is formed by a combination of basic insulation and a voltage- or current-limiting device, both the basic insulation and the voltage or current-limiting device shall be subjected to single faults, applied one at a time. Basic insulation shall be short-circuited. The voltage- or current-limiting device shall be short-circuited or disconnected, whichever is less favourable.

Parts of a protective impedance which are high-integrity components need not be short circuited or disconnected.

5.2.2.3 Transformers

Transformer non-primary windings and sections of tapped windings, which are loaded under normal conditions shall be tested in turn, one at a time, to simulate short circuits in the load. All other windings are loaded or not loaded, whichever load condition is less favourable.

The primary and non-primary windings of the transformer shall have a short circuit applied between them unless separated by reinforced or double insulation. The reinforced or double insulation shall be tested where thermal damage to the insulation may create a risk of electric shock.

Short circuits shall also be made on the load side of any current-limiting impedance or over-current protective device which is connected directly to the winding.

5.2.2.4 Outputs

Outputs shall be short-circuited one at a time.

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5.2.2.5 Insulation between circuits and parts

Functional insulation between circuits and parts shall be short-circuited where this could cause overheating of any material creating a risk of fire, unless that material is of flammability class V-1 or better of IEC 60695-11-10.

Basic insulation in primary circuits with less than the specified clearance distance shall be bridged to check against the spread of fire.

Supplementary, reinforced and double insulation need not be short-circuited. The exception to this is where thermal damage to the insulation may create a risk of electric shock.

5.2.2.6 Primary circuits and hazardous voltage non-primary circuits

Single-fault conditions shall be applied by open-circuiting or short-circuiting components in primary circuits and hazardous voltage non-primary circuits, within the equipment, where these may create a risk of electric shock or fire.

5.2.2.7 Overloads

Single-fault conditions shall be applied where a circuit or component overload may create a fire or electric shock hazard. This includes connection of the most unfavourable load impedances to terminals and connectors which deliver power or signal outputs from the equipment.

It is permitted to use fusible links, overcurrent protection devices and the like to provide adequate protection.

Where there are multiple outlets with the same internal circuitry, the single-fault test can be limited to one outlet only.

5.2.2.8 Intermittently rated resistors

Continuous dissipation in resistors designed for intermittent dissipation shall be considered under the single-fault condition assessment.

5.2.2.9 DC inputs

DC inputs shall be assessed for effects of reverse polarity under worst case conditions.

It is permitted to use fusible links, overcurrent protection devices and the like to provide adequate protection.

Where there are multiple inlets with the same internal circuitry, the test can be limited to one inlet only.

5.2.3 Duration of tests

The equipment shall be operated until further change as a result of the applied fault is unlikely. Each test is normally limited to 1 h since a secondary fault arising from a single-fault condition will usually manifest itself within that time. If there is an indication that a risk of electric shock, spread of fire or injury to persons may eventually occur, for example if the temperature has not stabilized, the test shall be continued until one of these hazards does occur or for a maximum period of 4 h, unless a hazard occurs before then.

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